UNITED STATES DISTRICT COURT
SOUTHERN DISTRICT OF FLORIDA
MIAMI DIVISION

ANDREA ROSSI and LEONARDO CORPORATION,

Plaintiffs,

v.

THOMAS DARDEN; JOHN T. VAUGHN, INDUSTRIAL HEAT, LLC; IPH INTERNATIONAL B.V.; and CHEROKEE INVESTMENT PARTNERS, LLC,

Defendants.

CASE NO. 1:16-cv-21199-CMA

INDUSTRIAL HEAT, LLC and IPH INTERNATIONAL B.V.,

Counter-Plaintiffs,

v.

ANDREA ROSSI and LEONARDO CORPORATION,

Counter-Defendants,

and

J.M. PRODUCTS, INC.; HENRY JOHNSON; FABIO PENON; UNITED STATES QUANTUM LEAP, LLC; FULVIO FABIANI; and “JOHN DOE” a/k/a “James A. Bass”,

Third-Party Defendants.

AMENDED ANSWER, ADDITIONAL DEFENSES, COUNTERCLAIMS AND THIRD-PARTY CLAIMS

ANSWER AND ADDITIONAL DEFENSES

For their Answer and Additional Defenses to the complaint ("Complaint") of Plaintiffs Andrea Rossi ("Rossi") and Leonardo Corporation ("Leonardo") (collectively, "Plaintiffs"), Defendants Thomas Darden ("Darden"), John T. Vaughn ("Vaughn"), Industrial Heat, LLC ("Industrial Heat"), IPH International, B.V. ("IPH"), and Cherokee Investment Partners, LLC ("Cherokee") (collectively, "Defendants") state the following:

NATURE OF ACTION

1. Defendants deny that the energy catalyzer ("E-Cat") technology "generates a low energy nuclear reaction resulting in an exothermic release of energy" along the lines claimed by Plaintiffs – which is that a reactor using the E-Cat technology produces more than 50 times the energy it consumes. Compl. ¶ 71. Such claims are not scientifically verifiable or reproducible. *See e.g.*, U.S. Patent and Trademark Office ("USPTO"), "Non-Final Rejection," dated January 11, 2016 as to Patent App. No. 12/736,193 (attached hereto as Exhibit 1); discussions of third party testing *infra*. In addition, the procedures and mechanisms which Plaintiffs have used in their experiments and testing of the E-Cat technology are flawed and unreliable in many respects. *See e.g. id.*; response to Paragraph 72 *infra*. Lastly, the E-Cat technology has never been independently validated by a scientifically reliable methodology to produce the energy levels Plaintiffs now claim, and has failed to produce any commercially viable product. Indeed, using the E-Cat technology Plaintiffs directly provided them, Industrial Heat and IPH have been unable to produce any measurable excess energy. Defendants deny the remaining allegations in Paragraph 1.

2. Defendants deny the allegations in Paragraph 2.

3. Defendants deny the allegations in Paragraph 3.

4. Defendants deny the allegations in Paragraph 4.

5. Defendants deny the allegations in Paragraph 5.

6. Defendants lack sufficient knowledge or information to admit or deny the allegations in Paragraph 6 as to Plaintiffs' reasons for bringing this action, and therefore deny them. To the extent that Paragraph 6 alleges that Industrial Heat and IPH have infringed upon Plaintiffs' intellectual property, Defendants deny that allegation.

PLAINTIFFS' ALLEGATIONS AS TO THE PARTIES

7. Defendants admit the allegations in Paragraph 7.

8. Defendants admit the allegations in Paragraph 8. Defendants also admit that there was a separate corporation named Leonardo Corporation that was incorporated in New Hampshire. Defendants lack sufficient knowledge or information to admit or deny the remaining allegations in Footnote 2 appended to Paragraph 8, and on that basis deny those remaining allegations. For purposes herein, Defendants use "Leonardo," as Plaintiffs use "Leonardo" in the Complaint, as encompassing both the Florida corporation named Leonardo Corporation (which is the Plaintiff in this action) and the New Hampshire corporation named Leonardo Corporation. Defendants note, however, that during the time period relevant to the Complaint, the two companies existed as separate corporations, and the Leonardo Corporation that was a party to the License Agreement entered into on October 26, 2012 (the "License Agreement") was the New Hampshire corporation.

9. Defendants admit the allegations in Paragraph 9.

10. Defendants deny that Vaughn is a "Manager" at Cherokee, as "Manager" of a LLC is defined in 6 Delaware Code §§ 18-101(10), 18-401, and 18-402. Defendants admit the remaining allegations in Paragraph 10.

11. Defendants admit that Industrial Heat is a Delaware limited liability company. Defendants deny that the address listed in Paragraph 11 is the address of Industrial Heat's principal place of business.

12. Defendants admit that IPH is a *Besloten vennootschap*, a Dutch private limited liability company. Defendants deny that the address listed in Paragraph 12 is the address of IPH's principal place of business.

13. Defendants admit the allegations in Paragraph 13.

PLAINTIFFS' ALLEGATIONS AS TO JURISDICTION AND VENUE

14. Paragraph 14 states legal conclusions to which no response is required. Defendants admit that this Court had subject matter jurisdiction at the time Plaintiffs filed the Complaint under 28 U.S.C. §§ 1331, 1332, and 1338(a).

15. Paragraph 15 states legal conclusions to which no response is required.

16. Paragraph 16 states legal conclusions to which no response is required. Defendants admit that diversity exists under 28 U.S.C. § 1332 because this case is between citizens of different States and in which citizens or subjects of a foreign state are additional parties.

17. Paragraph 17 states legal conclusions to which no response is required. Defendants admit that Industrial Heat entered into a contract with a specific forum selection/choice of law provision. Defendants deny the remaining allegations in Paragraph 17.

18. Paragraph 18 states legal conclusions to which no response is required. To the extent any response is required, Defendants deny the allegations in Paragraph 18.

19. Paragraph 19 states legal conclusions to which no response is required. To the extent any response is required, Defendants deny the allegations in Paragraph 19.

20. In light of the Court's dismissal of Count VIII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 20. In addition, Paragraph 20 states legal conclusions to which no response is required. To the extent any response is required regarding Plaintiffs' allegations of patent infringement, Industrial Heat and IPH deny those allegations.

21. Defendants deny the allegations in Paragraph 21.

22. Defendants deny the allegations in Paragraph 22.

23. Defendants deny the allegations in Paragraph 23.

24. Paragraph 24 states legal conclusions to which no response is required. To the extent any response is required, Defendants deny the allegations in Paragraph 24.

25. Paragraph 25 states legal conclusions to which no response is required. Defendants admit that Leonardo's principal place of business is in this District. Defendants further admit that a substantial part of the events giving rise to the claims alleged in the Complaint occurred in this District. Defendants deny the remaining allegations in Paragraph 25.

PLAINTIFFS' ALLEGATIONS AS TO PATENTS AT ISSUE IN THIS SUIT

26. Defendants admit that Plaintiffs filed numerous patent applications, provisional patent applications, and PCT applications, and at least one trademark application. Defendants deny the remaining allegations in Paragraph 26.

27. Defendants deny that the document referenced in Paragraph 27 was a "European Patent"; the document referenced in Paragraph 27 is simply a patent application filed with the European Patent Office. Defendants admit that the European Patent Office published such application, which was Application No. EP 08873805.9 (the "European Patent Application"), on or about December 15, 2010 and that said application was entitled "Method and Apparatus for Carrying out Nickel and Hydrogen Exothermal Reaction." Defendants deny that the European

Patent Office "duly and legally published" the European Patent Application. Defendants further note that the European Patent Application parallels that U.S. patent application which was rejected by the USPTO as referenced in their response to Paragraph 1 *supra*; *see* Ex. 1.

28. Defendants admit that on or about April 6, 2011, the Italian Patent and Trademark Office (*Ufficio italiano brevetti e marchi*) issued Italian Patent No. 0001387256 (the "Italian Patent") and that said patent was entitled "*Processo ed apparecchiatura per ottenere reazioni esotermiche, in particolare da nickel ed idrogeno*." Defendants lack sufficient knowledge or information to admit or deny that the Italian Patent and Trademark Office "duly and legally issued" the Italian Patent.

29. Defendants admit that on August 25, 2015, the USPTO issued U.S. Patent No. 9,115,913 B1 entitled "Fluid Heater" (the "U.S. Patent"). Defendants also admit that a copy of the U.S. Patent is attached to the Complaint as Exhibit A. However, Defendants note that the U.S. Patent is not a patent for a catalyst that generates a low energy nuclear reaction or any other reaction resulting in an exothermic release of energy; such a catalyst is more appropriately described in Rossi's U.S. Patent application that was rejected by the USPTO as referenced in Defendants' response to Paragraph 1 *supra* (*see* Ex. 1). Defendants lack sufficient knowledge or information to admit or deny that the U.S. Patent was "duly and legally issued," at least to the extent that such an allegation suggests that the patent is valid and enforceable. More recently, and subsequent to the issuance of the U.S. Patent, the International Searching Authority issued a written opinion in connection with a related Patent Cooperation Treaty ("PCT") application determining that many claims in that PCT application lacked novelty or inventive step. *See* International Searching Authority, "Written Opinion," dated October 19, 2015 as to PCT App. No. PCT/US2015/042353 (attached hereto as Exhibit 2).

30. In light of the Court's dismissal of Counts II and VIII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 30. In addition, Paragraph 30 states legal conclusions to which no response is required. To the extent any response is required regarding Plaintiffs' allegations of patent infringement, Industrial Heat and IPH deny that they infringed the purported "European Patent," the "Italian Patent," or the "U.S. Patent."

PLAINTIFFS' FACTUAL BACKGROUND ALLEGATIONS

31. Defendants lack sufficient knowledge or information to admit or deny the allegations concerning the number of years Rossi has purportedly spent working, or the nature of the work Rossi has purportedly performed, on the E-Cat. Defendants deny that the E-Cat produces energy substantially in excess of the amount of energy input into the reaction at a cost substantially below that of more traditional energy sources; *see* Ex. 1.[1] Indeed, using the E-Cat technology Plaintiffs directly provided them, Industrial Heat and IPH have been unable to produce any measurable excess energy.

32. Defendants lack sufficient knowledge to admit or deny that the design and construction of the E-Cat device, as well as the process by which it operates, constitute the intellectual property of Plaintiffs; *see* response to Paragraph 1 *supra*. Defendants deny the remaining allegations in Paragraph 32.

33. Defendants admit that Plaintiffs have filed a broad array of IP-related applications, including the European Patent Application, the patent applications corresponding to the U.S. Patent and the Italian Patent, and numerous provisional patent applications and PCT applications. Defendants deny the remaining allegations in Paragraph 33.

34. Defendants deny the allegations in Paragraph 34.

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[1] As alleged in the Complaint, Plaintiffs claim that an E-Cat unit produces more than 50 times the energy it consumes. Compl. ¶ 71.

35. Defendants deny the allegations in Paragraph 35.

36. Defendants deny the allegations in Paragraph 36.

37. Defendants admit that Vaughn met with Rossi in Zurich, Switzerland to discuss licensing of the E-Cat IP. For purposes of this Answer, Additional Defenses, Counterclaims, and Third-Party Claims, the "E-Cat IP" is defined as in the License Agreement, which states that the "E-Cat IP" consists of:

> patents, designs, trade secrets, technology, know-how (including all the knowledge necessary to produce thermal energy by means of apparatuses derived from the technology), products and business plans and all other intellectual property related directly or indirectly to energy production and conversion technologies and to the development, manufacture and sale of products using such technologies, including the Energy Catalyzer ("E-Cat") the catalyzer formula used to fuel the E-Cat, the "Hot-Cat" and the related energy production and conversion technologies.

License Agreement at page 1. The E-Cat IP also "include[s] all documents, manuals, technical data, formulae, and other items and materials necessary or useful to enable the [Industrial Heat or IPH] to (i) operate the 1 MW E-Cat Unit, (ii) make E-Cat Products, and (iii) exploit the E-Cat IP as contemplated by this Agreement." *Id.* § 16.1. Defendants deny the remaining allegations in Paragraph 37, including to the extent they claim that Cherokee was interested in or willing to pay for a license of the E-Cat IP.

38. Defendants deny the allegations in Paragraph 38.

39. Defendants deny the allegations in Paragraph 39, including all subparts.

40. Defendants admit that Plaintiffs negotiated the terms of what would become the License Agreement. Defendants also admit that the License Agreement was executed on October 26, 2012 by Plaintiffs. Defendants further admit that Rossi traveled to Cherokee's office in North Carolina to execute the License Agreement. Defendants deny the remaining

allegations in Paragraph 40, including any allegations that the License Agreement was "with Cherokee." As the License Agreement states, it was with Industrial Heat.

41. Defendants deny the allegations in Paragraph 41.

42. Defendants lack sufficient knowledge or information to admit or deny the allegations as to Plaintiffs' knowledge of the timing of the formation of Industrial Heat. Defendants admit that Industrial Heat was formed on or about October 24, 2012. Defendants deny the remaining allegations in Paragraph 42.

43. Defendants deny the allegations in Paragraph 43, including all subparts.

44. Defendants admit that an incomplete copy of the License Agreement is attached as Exhibit B to the Complaint. Defendants also admit that Plaintiffs entered into the License Agreement with Industrial Heat and AmpEnergo, Inc. ("AEG") on October 26, 2012. Defendants state the License Agreement speaks for itself, and therefore deny any allegations in Paragraph 44 inconsistent therewith. Defendants deny the remaining allegations in Paragraph 44.

45. Defendants state that the License Agreement speaks for itself, and therefore deny any allegations in Paragraph 45 inconsistent therewith.

46. Defendants state that the License Agreement speaks for itself, and therefore deny any allegations in Paragraph 46, including all subparts, inconsistent therewith.

47. Defendants admit the allegations in Paragraph 47.

48. Defendants lack sufficient knowledge or information to admit or deny that Leonardo owned the facility referenced in Paragraph 48. Defendants admit the remaining allegations in Paragraph 48.

49. Defendants deny the allegations in Paragraph 49. As to Footnote 2 appended to Paragraph 49, Defendants state that the License Agreement speaks for itself, and therefore deny any allegations inconsistent therewith.

50. Defendants state that the First Amendment to the License Agreement, entered on April 29, 2013 ("First Amendment"), speaks for itself, and therefore deny any allegations in Paragraph 50 inconsistent therewith. Defendants admit that Plaintiffs executed the First Amendment on April 29, 2013. Defendants further admit that a copy of the First Amendment is attached to the Complaint as Exhibit C. Defendants deny the remaining allegations in Paragraph 50.

51. Defendants deny the allegations in Paragraph 51.

52. Defendants deny the allegations in Paragraph 52.

53. Defendants deny the allegations in Paragraph 53.

54. Defendants admit that Rossi and Leonardo consented to Industrial Heat's assignment of the License Agreement to IPH. Defendants deny the remaining allegations in Paragraph 54.

55. Defendants state that the First Amendment speaks for itself, and therefore deny any allegations in Paragraph 55 inconsistent therewith.

56. Defendants admit that Plaintiffs selected Fabio Penon ("Penon") as the Expert Responsible for Validation ("ERV") in connection with the Validation test performed in Ferrara, Italy. Defendants state that the License Agreement and First Amendment speak for themselves, and therefore deny any allegations in Paragraph 56 inconsistent therewith. Defendants deny the remaining allegations in Paragraph 56.

57. Defendants admit that from April 30 to May 1, 2013, Penon conducted measurements in connection with the Validation test of certain E-Cat reactors operated by Plaintiffs. Defendants deny the remaining allegations in Paragraph 57. The Validation test did not follow the Validation protocol as set forth in the License Agreement and the First Amendment (the "Validation Protocol"). For example, the Validation Protocol required 30 E-Cat reactors to be operated as a unit ("Unit A") for twenty-four consecutive hours. However, only 18 E-Cat reactors were operated as Unit A during the testing period. In addition, the Validation Protocol required the flow of heated fluid from the E-Cat reactors to be measured during the Validation test. However, these measurements were not taken during the Validation test. Furthermore, the Validation Protocol required that twenty-four consecutive hours of testing be done on Unit A. However, less than twenty-four consecutive hours of testing was done on Unit A. There are various other examples of the Validation Protocol not being followed during the Validation test.

58. Defendants admit that Penon produced a report following the testing of the E-Cat reactors which was done during the Validation test. Defendants further admit that Industrial Heat paid the second payment of $10 million under the License Agreement and the First Amendment. Defendants state that this payment was made to an escrow agent and was subject to the requirement that Plaintiffs transfer "all the E-Cat IP" to Industrial Heat and IPH. *See* License Agreement § 3.2(b). Defendants deny the remaining allegations in Paragraph 58.

59. Defendants admit that in August 2013, the E-Cat Unit was delivered to Industrial Heat at its facility in North Carolina. The "E-Cat Unit" is defined in the License Agreement as the "Plant" and is sometimes referred to as the "1 MW E-Cat Unit" or the "1 MW Plant." The specifications of the E-Cat Unit/Plant are contained in Exhibit C to the License Agreement.

Defendants lack sufficient knowledge or information to admit or deny that the E-Cat Unit was delivered from Ferrara, Italy. Defendants deny the remaining allegations in Paragraph 59.

60. Defendants deny the allegations in Paragraph 60.

61. Defendants deny the allegations in Paragraph 61.

62. Defendants admit that Industrial Heat and Rossi executed the proposed Second Amendment to the License Agreement (the "Proposed Second Amendment"), which is dated "October __, 2013." However, the Proposed Second Amendment was not executed by Leonardo, IPH, or AEG. Defendants state that the Proposed Second Amendment speaks for itself, and therefore deny any allegations in Paragraph 62 inconsistent therewith. Defendants admit that a copy of the Proposed Second Amendment is attached to the Complaint as Exhibit D. Defendants deny that the Proposed Second Amendment was valid to amend the License Agreement. In any event, the Proposed Second Amendment addressed the testing of "a six cylinder Hot Cat unit" (the "Six Cylinder Unit"), not the E-Cat Unit that was the subject of the License Agreement and the First Amendment. The Six Cylinder Unit in the Proposed Second Amendment is separate and distinct from the E-Cat Unit or Plant as referenced in the License Agreement, the First Amendment, and the Complaint. Photographs accurately depicting the Six Cylinder Unit are attached hereto as Exhibit 3. The Six Cylinder Unit remains in North Carolina.

63. Defendants deny the allegations in Paragraph 63.

64. Defendants deny that the "test" referenced in Paragraph 64 – meaning the operation of the Plant in Doral, Florida in 2015 and early 2016 – was the "Guaranteed Performance" to be performed under the License Agreement. Defendants deny the allegations in Paragraph 64 as to Plaintiffs locating a customer in Miami, Florida who agreed to allow its facility to be used for a "Guaranteed Performance" test. The company Plaintiffs "located" for

the test referenced in Paragraph 64 was a company closely affiliated with Plaintiffs (J.M. Products, Inc.) that had no actual use for the steam produced by the Plant, and thus was not a "customer" for the steam power to be produced by the Plant. Defendants deny the remaining allegations in Paragraph 64.

65. Defendants deny the allegations in Paragraph 65.

66. Defendants deny that the test referenced in Paragraph 66 was the Guaranteed Performance to be performed under the License Agreement. Defendants lack sufficient knowledge or information to admit or deny that Penon performed a thorough inspection of or installed his monitoring equipment on the Plant on February 19, 2015. Defendants deny the remaining allegations in Paragraph 66.

67. Defendants admit that Industrial Heat and/or IPH engaged Barry West and Fulvio Fabiani ("Fabiani") as independent contractors to assist Rossi in operation of the Plant in Florida and caused them to be paid for their services. Defendants deny the remaining in Paragraph 67.

68. Defendants deny the allegations in Paragraph 68.

69. In light of the Court's dismissal of Counts II and VIII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 69. To the extent any response is required, Defendants deny the allegations in Paragraph 69.

70. In light of the Court's dismissal of Count VIII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 70. To the extent that any response is required, Defendants admit that Industrial Heat raised substantial sums of money from numerous investors, including entities affiliated with the Woodford Funds. Defendants deny the remaining allegations in Paragraph 70.

71. Defendants admit that the E-Cat Unit was operated in Florida during a period in 2015 and 2016. As reflected in Rossi's internet blog postings at the time, that Unit was the Plant – *i.e.*, the 1 MW E-Cat – which is described in Exhibit C to the License Agreement. An excerpt from Rossi's blog posting, as reprinted on e-catworld.com, is attached as Exhibit 4. Defendants deny the remaining allegations in Paragraph 71. Furthermore, Defendants note that there were many flaws in how the purported Guaranteed Performance test referenced in Paragraph 71 was performed. Several, but by no means all, of those flaws were identified in a document provided to Penon on March 25, 2016. A copy of this document is attached hereto as Exhibit 5.

72. Defendants deny that the test referenced in Paragraph 72 was the Guaranteed Performance to be performed under the License Agreement. Defendants admit that on March 29, 2016, Penon sent his final report regarding the operation of the Plant to Darden and Rossi. Defendants state that this report speaks for itself, and therefore deny any allegations in Paragraph 72 inconsistent therewith. Defendants deny that the Plant satisfied all of the performance requirements imposed by the License Agreement; *see* Ex. 5. Defendants also deny Plaintiffs' allegations in Paragraph 72 regarding the amount of energy produced by the Plant during the testing period; *see* Ex. 1. Defendants deny the remaining allegations in Paragraph 72.

73. Defendants deny that the test referenced in Paragraph 73 was the Guaranteed Performance to be performed under the License Agreement. Defendants state that Penon's report speaks for itself, and therefore deny any allegations in Paragraph 73 inconsistent therewith. Defendants deny Plaintiffs' allegations in Paragraph 73 regarding the amount of energy produced by the Plant during the testing period; *see* Ex. 1. Defendants deny the remaining allegations in Paragraph 73.

74. Defendants admit that on March 29, 2016, Leonardo demanded payment of $89 million, and that such demand has been refused and the payment has not been made. Defendants deny the remaining allegations in Paragraph 74.

75. Defendants deny the allegations in Paragraph 75.

COUNT I

76. In response to Paragraph 76, Industrial Heat and IPH repeat and reallege their responses to Paragraphs 1-75 above as if fully restated herein.

77. Industrial Heat and IPH state that the License Agreement speaks for itself, and therefore deny any allegations in Paragraph 77 inconsistent therewith. Industrial Heat and IPH further deny that the Proposed Second Amendment attached to the Complaint as Exhibit D was valid to amend the License Agreement.

78. Industrial Heat and IPH deny the allegations in Paragraph 78 to the extent that they are meant to allege that the Guaranteed Performance as defined by the License Agreement was successfully achieved. Industrial Heat and IPH state that the assignment from Industrial Heat to IPH speaks for itself, and therefore deny any allegations in Paragraph 78 inconsistent therewith.

79. Industrial Heat and IPH deny the allegations in Paragraph 79.

80. Industrial Heat and IPH admit that they have not paid $89 million to Leonardo. Defendants deny the remaining allegations in Paragraph 80.

81. Industrial Heat and IPH lack sufficient knowledge or information to admit or deny the allegations in Paragraph 81.

COUNT II

82. In light of the Court's dismissal of Count II of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 82.

83. In light of the Court's dismissal of Count II of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 83.

84. In light of the Court's dismissal of Count II of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 84.

85. In light of the Court's dismissal of Count II of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 85.

86. In light of the Court's dismissal of Count II of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 86.

87. In light of the Court's dismissal of Count II of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 87.

COUNT III

88. In response to Paragraph 88, Industrial Heat and IPH repeat and reallege their responses to Paragraphs 1-2, 5, 7-16, 17(a-b), 17(d-f), 18-43, 48, 51, 57, 59, 61, 63-73, and 75 above as if fully restated herein.

89. Paragraph 89 states legal conclusions to which no response is required. To the extent any response is required, Industrial Heat and IPH deny the allegations in Paragraph 89. In fact, assuming the License Agreement is valid, the "exclusive license to use the E-Cat IP and related technology" irrevocably belonged to Industrial Heat and/or IPH after the $10 million payment was made under the License Agreement, meaning Plaintiffs could not have conferred the "benefit" of that license on Industrial Heat or IPH subsequent to the $10 million payment.

Alternatively, if somehow (for reasons unstated in the Complaint) the License Agreement were not valid, the "exclusive license to use the E-Cat IP and related technology" would never have been transferred to Industrial Heat or IPH in the first instance, meaning it could not have been a "benefit" that Plaintiffs conferred on Industrial Heat or IPH.

90. Paragraph 90 states legal conclusions to which no response is required. To the extent any response is required, Industrial Heat and IPH deny the allegations in Paragraph 90.

91. Paragraph 91 states legal conclusions to which no response is required. To the extent any response is required, Industrial Heat and IPH deny the allegations in Paragraph 91.

92. Paragraph 92 states legal conclusions to which no response is required. To the extent any response is required, Industrial Heat and IPH deny the allegations in Paragraph 92.

COUNT IV

93. In response to Paragraph 93, Defendants repeat and reallege their responses to Paragraphs 1-75 and 83-86 above as if fully restated herein.

94. Defendants deny the allegations in Paragraph 94.

95. Paragraph 95 states legal conclusions to which no response is required. To the extent any response is required, Defendants deny the allegations in Paragraph 95. Defendants state that significant portions of the E-Cat IP have been disclosed publicly. For example, Rossi has filed a number of publicly available patent applications, provisional patent applications, PCT applications, and applications in foreign countries disclosing the E-Cat IP. A non-exhaustive list of such applications is attached hereto as Exhibit 6. Furthermore, the E-Cat IP was disclosed to Industrial Heat and IPH pursuant to the License Agreement without any restriction on Industrial Heat or IPH's further disclosure of such. In fact, the License Agreement permitted Industrial

Heat and IPH to sublicense the E-Cat IP to anyone they wanted on any terms they desired, without any confidentiality restrictions. *See* License Agreement §§ 1 & 16.4.

96. Paragraph 96 states legal conclusions to which no response is required. To the extent any response is required, Defendants deny the allegations in Paragraph 96. The E-Cat IP is defined in the License Agreement. *See* response to Paragraph 37 *supra*. Defendants state that the License Agreement speaks for itself, and therefore deny any allegations in Paragraph 96 inconsistent therewith.

97. Defendants deny the allegations in Paragraph 97.

98. The Court has rejected all but one of Plaintiffs' theories of misappropriation of trade secrets as alleged in Paragraph 98 (*see* [D.E. 24]); as a result, no response to such allegations is required. In addition, Paragraph 98 states legal conclusions to which no response is required. To the extent any response is required, Defendants deny the allegations in Paragraph 98, including all subparts.

99. The Court has rejected Plaintiffs' theory of misappropriation of trade secrets as alleged in Paragraph 99 (*see* [D.E. 24]); therefore, no response to Paragraph 99 is required. To the extent any response is required, Defendants deny the allegations in Paragraph 99.

100. Defendants deny the allegations in Paragraph 100.

101. The Court has rejected Plaintiffs' theory of a "confidential and fiduciary relationship" as alleged in Paragraph 101 and has dismissed Count VII (*see* [D.E. 24]); therefore, no response to Paragraph 101 is required. In addition, Paragraph 101 states legal conclusions to which no response is required. To the extent any response is required, Defendants deny the allegations in Paragraph 101. There are no provisions in the License Agreement requiring Industrial Heat or IPH to keep the E-Cat IP confidential. The only provision of the License

Agreement (Section 16.4) requiring a party to keep the E-Cat IP confidential applies to Plaintiffs and AEG alone.

102. Defendants deny the allegations in Paragraph 102.

103. The Court has rejected all but one of Plaintiffs' theories of misappropriation of trade secrets as alleged in Paragraph 103 (*see* [D.E. 24]); therefore, no response to such allegations is required. In addition, Paragraph 103 states legal conclusions to which no response is required. To the extent any response is required, Defendants deny the allegations in Paragraph 103, including all subparts.

104. Defendants deny the allegations in Paragraph 104. In fact, the License Agreement permitted Industrial Heat and IPH to sublicense the E-Cat IP to anyone they wanted on any terms they desired, without any confidentiality restrictions. *See* License Agreement §§ 1 & 16.4. In addition, Rossi has publicly disclosed significant portions of the E-Cat IP; *see* Ex. 6.

105. Paragraph 105 states a legal conclusion for which no response is required. To the extent any response is required, Defendants deny the allegations of Paragraph 105.

COUNT V

106. In light of the Court's dismissal of Count V of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 106.

107. In light of the Court's dismissal of Count V of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 107.

108. In light of the Court's dismissal of Count V of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 108.

109. In light of the Court's dismissal of Count V of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 109.

110. In light of the Court's dismissal of Count V of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 110.

COUNT VI

111. In response to Paragraph 111, Industrial Heat and IPH repeat and reallege their responses to Paragraphs 1-75, 83-86, 94-104, and 107-109 above as if fully restated herein.

112. Defendants deny the allegations in Paragraph 112, including all subparts.

113. Defendants deny the allegations in Paragraph 113, including all subparts.

114. Defendants deny the allegations in Paragraph 114.

115. Defendants deny the allegations in Paragraph 115, including all subparts.

116. Defendants deny the allegations in Paragraph 116.

117. Defendants deny the allegations in Paragraph 117.

COUNT VII

118. In light of the Court's dismissal of Count VII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 118.

119. In light of the Court's dismissal of Count VII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 119.

120. In light of the Court's dismissal of Count VII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 120.

121. In light of the Court's dismissal of Count VII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 121.

122. In light of the Court's dismissal of Count VII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 122.

123. In light of the Court's dismissal of Count VII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 123.

124. In light of the Court's dismissal of Count VII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 124.

125. In light of the Court's dismissal of Count VII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 125.

126. In light of the Court's dismissal of Count VII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 126.

127. In light of the Court's dismissal of Count VII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 127.

COUNT VIII

128. In light of the Court's dismissal of Count VIII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 128.

129. In light of the Court's dismissal of Count VIII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 129.

130. In light of the Court's dismissal of Count VIII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 130.

131. In light of the Court's dismissal of Count VIII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 131.

132. In light of the Court's dismissal of Count VIII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 132.

133. In light of the Court's dismissal of Count VIII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 133.

134. In light of the Court's dismissal of Count VIII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 134.

135. In light of the Court's dismissal of Count VIII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 135.

136. In light of the Court's dismissal of Count VIII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 136.

137. In light of the Court's dismissal of Count VIII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 137.

138. In light of the Court's dismissal of Count VIII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 138.

139. In light of the Court's dismissal of Count VIII of the Complaint (*see* [D.E. 24]), no response from Defendants is required to Paragraph 139.

PLAINTIFFS' PRAYER FOR RELIEF

Defendants deny that Plaintiffs are entitled to any relief on the Complaint.

AFFIRMATIVE AND OTHER ADDITIONAL DEFENSES

Without conceding that they bear the burden of persuasion on any of the following defenses, Defendants assert the following separate affirmative and other additional defenses:

First Defense

1. Plaintiff Leonardo lacks standing to bring any claims against Defendants because the assignment of the License Agreement from Leonardo Corporation, Inc., a New Hampshire corporation, to Plaintiff Leonardo was invalid.

Second Defense

2. Plaintiffs have failed to state a claim upon which relief may be granted.

Third Defense

3. Plaintiffs' equitable claims are barred, in whole or in part, by the doctrines of estoppel, waiver, laches, and other applicable equitable doctrines.

Fourth Defense

4. Plaintiffs' equitable claims are barred, in whole or in part, by reason of Plaintiffs' unclean hands.

Fifth Defense

5. Plaintiffs' claims are barred, in whole or in part, as a result of Plaintiffs' antecedent breaches of contract.

Sixth Defense

6. Plaintiffs' claims are barred, in whole or in part, as a result of Plaintiffs' unlawful actions, including their conduct in violation of the Florida Deceptive and Unfair Trade Practices Act.

Seventh Defense

7. Plaintiffs' claims are barred, in whole or in part, as a result of Plaintiffs' fraudulent misrepresentations.

Eighth Defense

8. Plaintiffs' claims are barred, in whole or in part, because any injury that Plaintiffs may have suffered was proximately caused or contributed to by the acts or omissions of Plaintiffs and/or third parties other than Defendants.

Ninth Defense

9. Plaintiffs' fraud claim is barred because of the merger and integration provision in the License Agreement (Section 16.8) as well as the ratification provision in the First Amendment (Section 2).

Tenth Defense

10. Plaintiffs' non-contract claims are barred, in whole or in part, because Plaintiffs' alleged damages are too speculative.

Additional Defenses

Defendants do not knowingly or intentionally waive any applicable affirmative or other defenses not stated above, and reserve the right to assert and rely on such other applicable affirmative or other defenses as may later become available or apparent. Defendants further reserve the right to amend their answer and/or affirmative or other defenses accordingly and/or to delete defenses that they determine during the course of this litigation are not warranted or required.

COUNTERCLAIMS AND THIRD-PARTY CLAIMS

Industrial Heat and IPH (collectively "Counter-Plaintiffs") bring this action against Leonardo; Rossi; J.M. Products, Inc. ("JMP"); Henry Johnson ("Johnson"); Penon; United States Quantum Leap, LLC ("USQL"); Fabiani; and "JOHN DOE" a/k/a James A. Bass ("Bass"). In support, Counter-Plaintiffs allege as follows:

INTRODUCTION

1. Industrial Heat and its affiliates, including IPH, are involved in developing and investing in "low energy nuclear reaction" (or LENR) technologies that have the potential to provide clean, reliable, efficient, and safe sources of energy. There are various forms of LENR

technologies, including Electrolytic Cell Reactors ("ECR"), Gas Metal Matrix Reactors ("GMMR"), and Solid State Hydride Reactors ("SSHR"). Industrial Heat and its affiliates are working on the development of all such technologies, often in conjunction with inventors who initially discovered or developed different forms or applications of these technologies.

2. Prior to 2012, Rossi claimed that he had developed an E-Cat device, which when used in connection with an E-Cat fuel/catalyzer formula ("E-Cat Fuel"), could produce well over six times the energy it consumed (which would equate to a coefficient of performance ("COP") of 6.0). Consistent with its guiding mission to develop and invest in LENR technologies, Industrial Heat entered into the License Agreement with Leonardo and Rossi in October 2012.

3. Under the License Agreement, it was possible for Leonardo to earn three different payments. The first was for the Plant, but was refundable to Industrial Heat or IPH if Leonardo and Rossi could not "validate" during a 24-hour test period that the Plant could produce at least six times the energy it consumed – a COP of 6.0 ("Validation"). License Agreement § 3.2(a). The second payment was for a license and transfer to Industrial Heat or IPH of all of the E-Cat IP, but only if Validation could be achieved. *Id.* § 3.2(b). The third payment was due if Leonardo and Rossi could demonstrate that the Plant could consistently operate at a COP of at least 4.0, if not at the COP level at which Validation was achieved, for 350 out of 400 days ("Guaranteed Performance"). *Id.* § 3.2(c).

4. Industrial Heat made the first payment under the License Agreement to Leonardo – an amount deemed by the License Agreement to "include payment in full for the Plant" – in October 2012. License Agreement § 3.2(a). That payment was in the amount of $1.5 million. Leonardo and Rossi purported to achieve the 24-hour validation from April 30 to May 1, 2013,[2]

[2] Per the First Amendment, the 24-hour validation no longer needed to be of the Plant, but only of 30 E-Cat reactors combined into a "Unit A."

claiming a COP in excess of 10.0, after which they purported to transfer all of the E-Cat IP to Industrial Heat and IPH in exchange for the second payment. The second payment under the License Agreement – in the amount of $10 million to Leonardo – was made in June 2013.

5. The long-term "Guaranteed Performance" demonstration under the License Agreement was to take place shortly after the 24-hour Validation. More specifically, Leonardo was required to deliver the Plant to Industrial Heat within 30 days following Validation, and then the Guaranteed Performance demonstration was to take place over the "400 day period commencing on the date immediately following delivery of the Plant" to Industrial Heat. *Id.* §§ 3.2(a) & 3.2(c). Guaranteed Performance required Leonardo and Rossi to operate the Plant "at the same level (or better) at which Validation was achieved for a period of 350 days (even if not consecutive) over a 400 day period." *Id.* § 5.

6. The testing Leonardo and Rossi now claim was the Guaranteed Performance did not commence immediately following the delivery of the Plant to Industrial Heat. In fact, that testing ***began*** well over one year after the Guaranteed Performance period commenced under the License Agreement – making it impossible for the Plant to achieve Guaranteed Performance during the time period required by the License Agreement.

7. Beyond the fact that Guaranteed Performance could not be achieved in the required time period, Leonardo and Rossi knew that the Plant could not produce a COP of 10.0 or greater (or even a COP or 4.0 or greater) for 350 out of 400 days. As a result, Leonardo and Rossi manipulated the testing process by, among other things, 1) insisting that the Plant be relocated to Miami, far away from Industrial Heat's offices, to provide steam to a purported manufacturing "customer" that did not actually exist; 2) manipulating, along with Fabiani, the operation of the Plant and the reports of the Plant's purported operations, to make it appear that

the Plant was producing a COP far greater than 10.0; and 3) enlisting Penon to produce a false report stating that Guaranteed Performance was achieved.

8. Eventually Counter-Plaintiffs discovered that the test that Leonardo and Rossi were conducting, in conjunction with the supposed "customer" in Miami, was not a real test at all, but a carefully scripted effort to deceive Counter-Plaintiffs into 1) providing Leonardo and Rossi with credibility in their efforts to license and promote the E-Cat IP to others and/or obtain investments from others in their business ventures, 2) making the third payment under the License Agreement to Leonardo, 3) paying a multitude of expenses of Leonardo and Rossi including in connection with their operations in Florida, and 4) paying Penon and Fabiani for services not rendered and reimbursing them for unnecessary expenses.

9. During the same time period, Counter-Plaintiffs continued their own efforts to replicate Rossi's purported results using the E-Cat IP that Leonardo and Rossi had provided them when they received the $10 million payment. Counter-Plaintiffs were unable to replicate any of Leonardo and Rossi's claimed results or otherwise generate measurable excess energy. This led Counter-Plaintiffs to realize that there were only three possible conclusions: 1) Leonardo and Rossi's claimed results, including the purported results from the Validation, were fabricated; 2) Leonardo and Rossi did not provide all of the E-Cat IP to Counter-Plaintiffs as was required under the License Agreement in exchange for the $10 million payment; or 3) both.

10. Whether as a result of 1) fabricating the Validation test results so that it appeared that a COP greater than 6.0 was achieved when it was not, 2) not providing Counter-Plaintiffs with all the E-Cat IP, or 3) both, Leonardo and Rossi clearly breached the License Agreement.

11. In addition to the foregoing breach, as well as Leonardo and Rossi's continuous efforts to deceive Counter-Plaintiffs, Leonardo and Rossi breached the License Agreement by,

among other things: 1) improperly disclosing the E-Cat IP and the terms of the License Agreement to unauthorized third parties without Counter-Plaintiffs' permission, 2) failing to assign certain patents and/or patent applications to IPH, 3) failing to inform Counter-Plaintiffs of the existence of certain patent applications and failing to fully prosecute patent applications related to the E-Cat IP, 4) participating or having a financial interest in companies that would be Counter-Plaintiffs' competitors, 5) failing to keep the original Leonardo entity (a New Hampshire corporation) active, and 6) failing to file and/or pay taxes on the payments made under the License Agreement for the Plant and the E-Cat IP.

THE PARTIES

12. Counter-Plaintiff Industrial Heat is a Delaware limited liability company having a principal place of business in North Carolina.

13. Counter-Plaintiff IPH is a Netherlands private limited liability company having a principal place of business in the Netherlands.

14. Counter-Defendant Rossi has a primary residence in Miami Beach, Florida and, upon information and belief, is a citizen of Italy.

15. Counter-Defendant Leonardo is a Florida corporation having a principal place of business in Miami Beach, Florida.

16. Third-Party Defendant JMP is a Florida corporation having a principal place of business in Doral, Florida.

17. Third-Party Defendant Johnson is a citizen of Florida with a primary residence in Boca Raton, Florida.

18. Third-Party Defendant Penon is a citizen of Italy with a primary residence in Abano Terme, Italy.

19. Third-Party Defendant Fabiani is a citizen of Italy with a primary residence in Miami Beach, Florida.

20. Third-Party Defendant USQL is a Florida limited liability company having a principal place of business in Miami Beach, Florida. Fabiani is USQL's sole member.

21. Third-Party Defendant "Bass," upon information and belief, is a citizen of Florida with a primary residence in this judicial district.

JURISDICTION AND VENUE

22. This Court has jurisdiction over this action pursuant to 28 U.S.C. § 1367. The claims pled herein are related to the claims pled in the Complaint and arise out of the same case or controversy.

23. Leonardo is subject to personal jurisdiction in this judicial district because it is a Florida corporation with a principal place of business in Miami Beach, Florida.

24. Rossi is subject to personal jurisdiction in this judicial district because he is a Florida resident with a primary residence in Miami Beach, Florida.

25. JMP is subject to personal jurisdiction in this judicial district because it is a Florida corporation with its principal place of business in Doral, Florida.

26. Johnson is subject to personal jurisdiction in this judicial district because he is a Florida resident with a primary residence in Boca Raton, Florida

27. Penon is subject to personal jurisdiction in this judicial district because he engaged in business in this judicial district from which the claim against him arises and committed tortious acts in this judicial district that are the basis of the claim against him.

28. USQL is subject to personal jurisdiction in this judicial district because it is a Florida limited liability company with its principal place of business in Miami Beach, Florida.

29. Fabiani is subject to personal jurisdiction in this judicial district because he is a Florida resident with a primary residence in Miami Beach, Florida.

30. "Bass" is subject to personal jurisdiction in this judicial district because, upon information and belief, he is a Florida resident with a primary residence in this judicial district.

31. Venue is proper in this judicial district pursuant to 28 U.S.C. §§ 1391(b)(1) & (c)(3) because Leonardo, Rossi, and Third-Party Defendants other than Penon reside in this district, and Penon does not reside in the United States. Venue is also proper in this judicial district pursuant to 28 U.S.C. § 1391(b)(2) because a substantial part of the events or omissions giving rise to the claims asserted herein occurred in this judicial district.

FACTUAL BACKGROUND

Thomas Darden's initial meeting with Rossi.

32. Industrial Heat was formed in October 2012 to support and invest in LENR technologies. If proven reliable and controllable, LENR technologies have the potential to provide an energy resource that does not generate radioactive waste or emit other harmful pollutants. Since its inception, Industrial Heat has worked to identify and partner with promising LENR inventors with an eye towards commercializing products that displace traditional fuel sources in generating both heat and electricity without emitting radioactive waste.

33. In June 2012, representatives from AEG introduced Darden to Rossi at Rossi's apartment in Miami Beach, Florida. In making the introduction, AEG explained that Rossi was an inventor working on certain LENR technology. At the time of the meeting, AEG held an exclusive right to commercially market Leonardo and Rossi's E-Cat technologies in the Americas.

34. During the June 2012 meeting, Rossi told Darden that he had developed and was continuing to develop a device (the E-Cat) that could produce energy at remarkably high levels without generating the harmful byproducts normally associated with nuclear reactions.

35. Thereafter, discussions continued among Rossi, Darden, and others regarding opportunities to develop and commercialize the E-Cat technology.

The License Agreement between Industrial Heat, Leonardo, Rossi, and AEG.

36. On or about October 26, 2012, Industrial Heat, Leonardo, Rossi, and AEG entered into the License Agreement. An incomplete copy of the License Agreement is attached as Exhibit B to the Complaint.[3]

37. The License Agreement was structured such that Leonardo could earn three payments from Industrial Heat – totaling over $100 million – if certain conditions were satisfied. *See* License Agreement § 3.2; response to Paragraph 3 *supra*. In addition to the provisions of the License Agreement that gave Leonardo and Rossi an opportunity to earn the three payments, the License Agreement also imposes numerous obligations upon Leonardo and Rossi. Some of those obligations are described further below.

38. First, Section 3.2(b) requires that Validation be achieved as provided in Section 4 of the License Agreement. Section 4, as amended by the First Amendment, states in relevant part:

> Retention by Leonardo of the $1,500,000 component of the purchase price and payment of the $10,000,000 described in Section 3.2(b) above are subject to successful Validation of the Plant. . . . The Validation will be made in the factory of Leonardo in Ferrara, Italy on April 30th and May 1, 2013 (unless otherwise agreed in writing by [Industrial Heat or IPH] and Leonardo). Validation will be deemed successful and achieved when the expert responsible for validation ("ERV") certifies that the performance standards for the Plant set forth in Exhibit

[3] Missing from the copy of the License Agreement attached to the Complaint as Exhibit B are 1) Exhibit B to the License Agreement (Rossi and Leonardo's license agreement with AEG) and 2) the first page of Exhibit C to the License Agreement.

> A to [the First Amendment] have been met. To make this measurement the ERV will measure the flow of the heated fluid and the Delta T between the temperature of the fluid before and after the E-CAT reaction."

License Agreement § 4.

39. Second, the License Agreement imposes confidentiality obligations on Leonardo and Rossi with respect to the terms of the License Agreement. The License Agreement states: "While this Agreement is in effect and after this Agreement terminates, each party hereto and its Affiliates shall keep confidential, and shall not disclose, the terms of this Agreement to any other Person without the prior consent of each other Party hereto," with certain exceptions. *Id.* § 16.4.

40. Third, the License Agreement imposes confidentiality obligations on Leonardo and Rossi with respect to the E-Cat IP. The License Agreement states that "[d]uring the term of this Agreement, each of Leonardo, Rossi, and AEG agrees to keep the E-Cat IP strictly confidential and not disclose any of the E-Cat IP to any other party," also with certain exceptions. *Id.* The License Agreement imposes no such confidentiality obligation on Counter-Plaintiffs. In fact, Counter-Plaintiffs are allowed to disclose the E-Cat IP to anyone they want.

41. Fourth, the License Agreement imposes very specific obligations upon Leonardo with respect to patent prosecution and maintenance. In particular, the License Agreement requires that Leonardo, with respect to all Licensed Patents (as defined in the License Agreement): 1) prepare, file, and prosecute patent applications relating to the Licensed Patents; 2) maintain the Licensed Patents; 3) pay all fees and expenses associated with the just mentioned first two requirements; 4) keep Counter-Plaintiffs informed of the filing and progress of the prosecution of Licensed Patents and related patent applications; 5) consult with Counter-Plaintiffs concerning decisions that could affect the scope or enforcement of any issued claims or the potential abandonment of patent applications or patents relating to the Licensed Patents; and

6) notify Counter-Plaintiffs in writing of any additions, deletions, or changes in status of the Licensed Patents or patent applications related to the Licensed Patents. *See id.* § 7.1. The License Agreement also imposes limitations on Leonardo's ability to abandon any patent application or patent that is a Licensed Patent. *See id.* § 7.2.

42. Fifth, the License Agreement contains a "Covenant Not to Compete" provision that prohibits Leonardo, Rossi, or any of their affiliates from directly or indirectly owning, managing, operating, joining, or having a financial interest in any other business or enterprise "(a) engaged in the design, development, manufacture, distribution, lease, rental or sale of any E-Cat Products, or provision of any services related thereto or (b) which is competitive with the E-Cat Products, unless Leonardo . . . shall have obtained the prior written consent of [Counter-Plaintiffs]." *Id.* § 13.3.

43. Sixth, the License Agreement requires that Leonardo and Rossi "file all necessary documentation and returns with respect to any applicable sales, use, transfer, real property transfer, recording, gains, stock transfer and other similar taxes and fees pertaining to the respective revenues derived by the Parties in respect of the E-Cat IP (such as taxes and fees), including any interest or penalties thereon." *Id.* § 13.5. The License Agreement also requires Leonardo and Rossi to keep the E-Cat IP "free and clear of any Liens." *Id.* §§ 12(a) & 12(e).

44. Finally, the License Agreement, as amended by the First Amendment, prohibits Leonardo and Rossi from "assign[ing] or otherwise transfer[ring] any of [their] rights . . . under this Agreement, in each case whether voluntarily, involuntarily, by operation of law or otherwise, without [Counter-Plaintiffs'] prior written consent." *Id.* § 16.7; First Amendment § 1.C.

45. As explained more fully herein, Leonardo and/or Rossi violated each of the aforementioned provisions of the License Agreement.

46. Furthermore, Leonardo and Rossi made certain representations and warranties in the License Agreement. For example, Leonardo and Rossi, "jointly and severally," represented that "[Leonardo was] duly organized, validly existing and in good standing as a corporation or other entity as represented herein under the laws and regulation of its jurisdiction of incorporation or organization" and that "it [had], and throughout the term of the License [would] retain, the full right, power and authority to enter into this Agreement and to perform its obligations." License Agreement §§ 11(a) & 11(b). Furthermore, Leonardo and Rossi, jointly and severally, each represented that they "[had] and throughout the Term [would] retain the full, unconditional and irrevocable right, power and authority to License the E-Cat IP." *Id.* § 12(a). Leonardo and Rossi also represented that "each had filed all necessary tax returns" and "ha[d] paid all taxes." *Id.* § 12(j).

The First Amendment to the License Agreement and assignment of Industrial Heat's rights to IPH.

47. On or about April 29, 2013, Leonardo, Rossi, AEG, and Industrial Heat executed the First Amendment, which is attached to the Complaint as Exhibit C.

48. On that same date, Industrial Heat and IPH executed an Assignment and Assumption of License Agreement (the "Assignment and Assumption"), wherein Industrial Heat assigned its rights under the License Agreement to IPH. The Assignment and Assumption is attached hereto as Exhibit 7. On the same date that the Assignment and Assumption was executed, Leonardo and Rossi executed a certification that "the representations and warranties of Leonardo and Rossi contained in the License Agreement . . . [were] true and correct as of the date of [the] Certification, as if made on the date [t]hereof, and further, that such representations and warranties w[ould] remain true and correct" upon payment of the $10 million. *See* Ex. 8.

49. At or about the time of the Validation testing, Industrial Heat tendered a payment of $10 million to a designated escrow agent. Pursuant to the License Agreement, the $10 million was not paid directly to Leonardo and Rossi because Leonardo and Rossi were required not only to conduct the Validation testing, but also to provide all E-Cat IP to Industrial Heat in order to be entitled to the $10 million.

Testing the Plant in Italy, North Carolina, and Florida.

Validation testing in Italy.

50. Because Leonardo and Rossi knew that the Plant could not achieve Validation as defined in the License Agreement, they manipulated the Validation testing procedure to deceive Counter-Plaintiffs into making the second payment under the License Agreement.

51. The Validation test was originally supposed to be performed on the Plant over the course of 24 hours. However, in an effort to manipulate the Validation test, Rossi, on behalf of Leonardo, contacted Industrial Heat to report that Italian law required certain modifications to the Validation test. On April 23, 2013, Rossi stated:

> This morning I had a meeting with the Health Office of the Province of Ferrara, which has to authorize the 24 hours test (it is unthinkable to make it without authorization, we could be stopped by the police upon a phone call due to the noise of the air escape of the condensers, because we must dissipate the energy not having any possible utilization for it). We found an acceptable solution. He explained to me that the Italian law "DPR (Decreto del Presidente della Repubblica) # 551- Dec. 21 1999 requests an authorization for any plant that makes more than 35 kWh/h and this authorization takes at least 6 months. But we are advantaged, because LENR do not exist in the known technology, therefore when we say 35 kWh we say kWh consumed, because plants that produce more than the energy they consume "do not exist". Now, 35 x 6 = 210 kW[.] Therefore if we can consume up to 35 kWh/h without authorization, this implies that in out LENR case I can produce up to 210 kWh/h, which is a consistent amount of energy. I will steal something (maybe the COP will be more) . . . .
>
> Ex. 9.

52. Upon information and belief, Rossi had no such meeting with the Ferrara Health Office, and Rossi's statement was false that Italian law would not allow for the 24-hour Validation process as set forth in the License Agreement without first obtaining a permit that would require "at least 6 months" to obtain.

53. Unaware that Rossi had misrepresented his meeting with the Ferrara Health Office and Italian law, Industrial Heat agreed to amend the License Agreement so that Validation would require testing of only 30 reactors instead of the entire Plant.

54. The modifications to the Validation Protocol were memorialized in Exhibit A to the First Amendment. As modified, the Validation Protocol required that "[t]wo separate units ('Unit A' and 'Unit B'), each composed of a different set of 30 individual E-Cat reactors, [] be tested for a period of 24 hours." First Amendment, Ex. A. The modified Validation Protocol further states that "[f]or purposes concerning validation achievement, only the performance of Unit A will be considered." *Id.* The performance requirements for Unit A are as follows:

> Unit A will be required to consistently produce energy that is at least six times greater than the energy it consumes (that is, a coefficient of performance 'COP' of six or greater) and steam that is consistently 100 degrees Celsius or greater during the 24 hour test period.

Id. The Validation Protocol also states that Unit A would be tested from 9:00 a.m. on April 30, 2013 through 9:00 a.m. an May 1, 2013. *Id.*

55. Later in April 2013, Rossi confirmed that the Validation test could be performed with 30 E-Cat reactors. But just before the Validation test was commenced, Rossi claimed that even testing 30 E-Cat reactors was undoable due to restraints under Italian law, and explained that the test needed to be conducted with only 18 E-Cat reactors. This claim by Rossi was false.

56. Rossi further manipulated the Validation process by ensuring that his friend and colleague, Penon, served as the ERV for the Validation testing. Industrial Heat requested that

"one of the big testing companies" work alongside Penon in the measurement and validation of the test. Rossi vehemently objected, insisting that having one of the big testing companies involved would "create big problems" for him.

57. The Validation testing occurred from April 30 through May 1, 2013. The testing lasted for slightly less than the 24-hour period required by the Validation Protocol and included only 18 E-Cat reactors. On or about May 7, 2013, Penon issued his Evaluation Test Report on the Validation test (the "Evaluation Report"). According to the Evaluation Report, the 18 individual E-Cat reactors tested over the course of the 23 1/2 hour period produced a COP of 10.85.

58. When Industrial Heat representatives arrived at the Validation testing site, Rossi provided them with a copy of a report (which he had received days earlier) by third parties who tested two different E-Cat reactors. That report, later published as "Indication of anomalous heat energy production in a reactor device containing hydrogen loaded nickel powder," was prepared by several Italian and Swedish scientists (Giuseppe Levi, Evelyn Foschi, Torbjorn Hartman, Bo Hoistad, Roland Pettersson, Lars Tegner, and Hanno Essen) who hailed from some of Europe's most prominent academic institutions (Royal Institute of Technology, Uppsala University and Bologna University). *See* Ex. 10 (the "Ferrara Report"). The Ferrara Report stated that one E-Cat reactor produced a COP of 5.6, though the scientists noted that that COP might be overstated. *Id*. at page 13. The Ferrara Report also stated that the second E-Cat reactor produced a COP of 2.6 or 2.9. *Id*. at page 24.[4] These reported COP numbers, while less than what would have been

[4] The E-Cat reactors addressed in the Ferrara Report were different in design from the E-Cat reactors in the Plant.

required for validation under the License Agreement, nevertheless reflected positive COP findings by third parties from well known universities in Europe.[5]

59. On or about April 30, 2013, coinciding with the Validation testing and consistent with the License Agreement's requirements, Industrial Heat tendered a payment of $10 million to a designated escrow agent. Pursuant to the License Agreement, the payment of the $10 million was not made directly to Leonardo because, following any Validation testing, Leonardo and Rossi were also required to provide all E-Cat IP to Counter-Plaintiffs in order to be entitled to the $10 million payment.

Rossi and Industrial Heat's inability to replicate Validation results in North Carolina.

60. Following the Validation testing, a process was undertaken for Leonardo and Rossi to assemble for transfer to Counter-Plaintiffs all E-Cat IP. On June 9, 2013, the escrow agent released the $10 million to Leonardo. In exchange, Leonardo and Rossi purportedly transferred all E-Cat IP to Counter-Plaintiffs. In fact, on the same day that the $10 million payment was released (June 9, 2013), Rossi met with Darden to provide him personally with the last piece of the E-Cat IP to be transferred – the formula for the E-Cat Fuel required to enable an E-Cat reactor to produce the high COP claimed by Leonardo and Rossi.

61. Leonardo caused the Plant to be delivered to Industrial Heat's facility in North Carolina in August 2013. This was later than the time required by the License Agreement, as amended by the First Amendment. *See* License Agreement § 3.2(a); First Amendment § 1.A.

62. Shortly after delivery, Industrial Heat hired several independent contractors to assist Rossi in connection with the development, modification, and testing of the Plant, of various E-Cat reactors, and of a prototype Six Cylinder Unit.

[5] Since its publication, the Ferrara Report has been subject to criticism, but none of those criticisms was available at the time Rossi provided the report to the Industrial Heat representatives.

63. Shortly after the Plant was delivered, Industrial Heat retained Fabiani, who had long worked with Rossi, as an independent contractor. More specifically, on September 1, 2013, Industrial Heat entered into a Technical Consulting Agreement with USQL, through its sole member, Fabiani ("USQL Agreement"). The USQL Agreement is attached hereto as Exhibit 11. Industrial Heat engaged USQL and Fabiani – who joined the USQL Agreement in his individual capacity – to "provide services related to the manufacture and development" of the Plant and related E-Cat IP. USQL Agreement at 1. The USQL Agreement required, among other things, that USQL and Fabiani:

> promptly disclose to Industrial Heat any and all improvements, inventions, developments, discoveries, innovations, systems, techniques, processes, formulas, programs and other things that may be of assistance to Industrial Heat or its affiliates, whether patentable or unpatentable, that (i) relate to the actual or demonstrably anticipated research or development by Industrial Heat or any of its affiliates, or (ii) result from any work performed by USQL for or at the request of Industrial Heat, or (iii) are developed on Industrial Heat's time or using the equipment, supplies or facilities or any Confidential Information or trade secret information of Industrial Heat, or any of its affiliates; and that are made or conceived by USQL . . . while engaged by Industrial Heat.

Id. § 7.

64. Leonardo and Rossi were fully aware that, per the clear and express terms of the License Agreement, they were required to commence any "Guaranteed Performance" in 2013. Nevertheless, Leonardo and Rossi made no efforts to commence such a test during 2013. Instead, from approximately September 2013 through December 2013, Rossi was on site at Industrial Heat's facility in North Carolina working with Industrial Heat personnel in efforts both (a) to develop new versions of E-Cat reactors or new devices in which E-Cat reactors would operate and (b) to replicate the results of prior E-Cat testing as either claimed by Leonardo and Rossi or reported by Penon in connection with the Validation testing in Italy.

65. Despite Rossi's presence and participation in the testing in North Carolina, the E-Cat testing in North Carolina was never able reliably or credibly to reproduce the COP of 10.85 as reported by Penon (or even reach the lowest COP threshold identified in the License Agreement, which was a COP of 4.0).

66. At the time, Industrial Heat personnel were uncertain whether the lack of success was due to the failure of the E-Cat IP technology, or to efforts by Rossi to undermine the testing. Industrial Heat was aware that Rossi had engaged in just such conduct in the past. For example, Rossi and/or Leonardo had agreed to license the E-Cat IP to a company called Hydro Fusion in Europe. *See* Ex. 12. However, in order to be released from their obligation, Leonardo and Rossi purposely distorted the results of a testing of the E-Cat technology being performed for Hydro Fusion to dissuade Hydro Fusion from moving forward with the agreement:

> With this company Hydrofusion we [meaning Leonardo and Rossi] had agreed upon a draft to sell them IP, know how and manufacturing license for Europe but Germany, France and Italy. By our law, if you send a proposal you are engaged to accept if the proposee accepts all the conditions of the proposal. After receiving your last text at the end of August I decided to go ahead with you, *therefore I had to get rid of this engagement*. The only way out was to invite them to a test, ask them to bring with them their consultant. *I made the test abort*, maintaining the temperatures below the starting limit. *Then I made up some discussions*, I said they made a wrong test, they escaped, I am free.
>
> We did not have damages of image, because, knowing what was on the road, I had made before their test a disclaimer, saying that the Hot temperature E-Cat was just a prototype, still under test and validation and subject to modification, thing that I am repeating everywhere. Now I am publishing that I am surprised of all this ado for nothing, since I already said that for the Hot Cat we needed more tests before saying it is a product ready for the market. At this point we can organize with Cherokee a world strategy, since all the other licensees are just commercial: for example in Africa we will have just to pay a royalty to the local agent upon our sale price, but they all are very good and they can sell either energy or plants. Nobody has rights upon the IP, know how, manufacturing and so on.
>
> Warmest Regards,
>
> Andrea

See id. (emphases added). On the same day (September 10, 2012) but in a separate, earlier email, Rossi described his efforts at deceiving Hydro Fusion as a "masterpiece": "I got rid of the European big license I had to sign. I made a masterpiece making them go voluntarily . . . I will explain personally."[6] *See* Ex. 13.

67. After Rossi left North Carolina, Counter-Plaintiffs' personnel continued their work on developing new devices in which E-Cat reactors would operate and trying to replicate the results of prior E-Cat testing as either claimed by Leonardo and Rossi or reported by Penon. Rossi would visit the North Carolina facility on occasion to provide his input and opinions as to the device designs (and design changes) and the testing methodologies and results. None of the testing replicated (or came close to replicating) the high COP results previously claimed by Leonardo, Rossi, and Penon, or otherwise generated measurable excess energy.

68. In late 2013 and early 2014, Leonardo and Rossi made arrangements with the team of scientists who had published the Ferrara Report to conduct another test of a single E-Cat reactor (not an entire Plant or an entire Six Cylinder Unit) over a roughly one month time period in February and March 2014 in Lugano, Switzerland. At the conclusion of the experiment, the scientists concluded in their report (the "Lugano Report") that the E-Cat reactor produced a COP of 3.2 and 3.6 across two different "runs" of the reactor (which is still less than the lowest COP number reflected in the License Agreement). *See* Ex. 14. This conclusion was subsequently criticized in a series of publications identifying flaws in the methodology the scientists employed which led to overstatement of their COP calculations. These publications, however, did not surface until 2015.

[6] Leonardo and Rossi's decision to "get rid of" their Hydro Fusion "engagement" was not of significance to Industrial Heat at the time because Industrial Heat was not negotiating for a license that would cover the same geographic territory as Hydro Fusion's license.

The Plant moves to Miami to service a fake "customer."

69. In 2014, knowing that the high COP results that Leonardo, Rossi, and Penon had previously claimed could not be replicated by the various testing of E-Cat reactors in North Carolina (some done with the direct participation of Rossi) or even by the scientists in Lugano (though Rossi had significant control over their testing), Leonardo, Rossi, and others devised a scheme to get the Plant removed from under Industrial Heat's control in North Carolina and to a location in Florida where Leonardo, Rossi, and others could operate the Plant without careful oversight and could control how any measurements of the Plant's performance were conducted.

70. To that end, Leonardo and Rossi enlisted their attorney, Johnson, to create a company that would pose as a "customer" in the Miami area that needed and would pay for steam produced by the Plant. Johnson registered the company, JMP, as a Florida corporation in June 2014. *See* Ex. 15. JMP was originally incorporated as J.M. Chemical Products, Inc. in June 2014, but changed its name to J.M. Products, Inc. in September 2014.

71. Thereafter, Leonardo and Rossi made their pitch to Counter-Plaintiffs as to why they should allow Leonardo and Rossi to take the Plant down to Florida to operate it in Florida. That pitch is best captured in their July 5, 2014 email to Counter-Plaintiffs (and others):

> Dear All:
>
> In the incoming meeting we will have next week, please allow me to encourage you to take a decision regarding where to put at work our 1 MW plant. I really and strongly hope you will consider the solution I found, to rent it to JM, in its factory in Florida *where they will use it to process their chemical products*. Please think carefully before losing them. *They are positive to us, but in September must start and they must know asap if they have to use our plant or provide otherwise*. This solution will:
>
> 1- allow to Industrial Heat to say to the Investors that they are getting 360,000 dollars per year of rental, with a payback of a plant like this, whose construction cost is 200,000 $, in less than 6 month

> 2- allow to your Customer-Investors-Visitors to *hear from a real Customer* that he is making money with our plant
>
> 3- allow us to start in September the operation of the plant, with no further loss of time
>
> 4- allow us not to expose the know how, since the maintainence of the plant is made by us and the plant remains our property: a rental is not a sale
>
> 5- *allow us to make all the Authorities make all the measurements necessary to get the Authorizations for the next plants*
>
> 6- allow you to get orders to supply for rent thousands of plants
>
> 7- allow the plant work for 24 hours per day for 360 days per year, while if used as a room heater it could work only 4 months, not per 24 hours per day, with obvious loss of profit.
>
> *Your proposal to put the plant in a factory owned by yourself at least until recently is dramatically less convincing.*
>
> Let me do this and I will make a masterpiece (half masterpiece has already been done *finding the Customer as a Chemical Industry* and getting the authorization from the Florida State Radiation Control Office).
>
> Fulvio is completing the control system, made by 110 computers interconnected. Also that is a masterpiece.
>
> Warmest Regards to all,
> Andrea

See Ex. 16 (emphases added).

72. Of note in Leonardo and Rossi's proposal is that there is no discussion of moving the Plant to Florida to try to achieve "Guaranteed Performance" under the License Agreement. Instead, Leonardo and Rossi enticed Counter-Plaintiffs to allow the Plant to be moved to Florida so that it could be used to provide power to "a real Customer" – a customer in the "Chemical Industry" that had a need for the steam power the Plant could produce "to process their chemical products." *See id.* This, Leonardo and Rossi claimed, would provide a real-world demonstration, or test, of the Plant as a viable means of providing power to commercial users. *See id.* It would

also, Leonardo and Rossi claimed, allow for regulatory agencies, to the extent required, to conduct any tests or measurements they needed to authorize the use of future Plants for other commercial purposes (*i.e.*, "allow us to make all the Authorities make all the measurements necessary to get the Authorizations for the next plants"). *See id.* Leonardo and Rossi further pressured Counter-Plaintiffs to decide on this proposal quickly because this chemical industry customer "must know asap" if it could use the Plant to provide the steam power it needed or if it had to "provide otherwise." *See id.*

73. Unbeknownst to Counter-Plaintiffs, everything material in the Leonardo and Rossi proposal was false – there was no customer in Florida who needed steam power for its chemical products processing, there was no intention for Leonardo and Rossi to operate the Plant to provide power to a real customer, and there was no intention for Leonardo and Rossi to seek authorizations from regulatory agencies to allow the Plant or subsequent E-Cat plants to be used for other commercial purposes. Instead, the sole intention of Leonardo and Rossi all along was to find a way to get the Plant away from Counter-Plaintiffs and then to conduct a fatally flawed (and fatally late) run at demonstrating "Guaranteed Performance" so that they could falsely claim to be entitled to an additional $89 million payment under the License Agreement.

74. Also in furtherance of this scheme, Rossi, both in his individual capacity and as the representative of Leonardo, and Johnson, both in his individual capacity and as the representative of JMP, traveled to North Carolina in August 2014 to meet with individuals from Industrial Heat. During this meeting, Rossi and Johnson made a number of false representations to Industrial Heat, most notably that JMP (at the time called J.M. Chemical Products, Inc.) was a confidential subsidiary of Johnson Matthey p.l.c. ("Johnson Matthey"), and that Johnson Matthey was interested in using the E-Cat technology in connection with a confidential

manufacturing process it wanted to operate in Florida. In fact, in August 2014 Johnson on behalf of JMP even warranted in writing that JMP "[was] owned by an entity formed in the United Kingdom, and none of Leonardo, Dr. Andrea Rossi, Henry W. Johnson nor any of their respective subsidiaries, directors, officers, agents, employees, affiliates, significant others, or relatives by blood or marriage [had] any ownership interest" in JMP. *See* Compl. Ex. B. (last page of Plaintiffs' Exhibit). JMP, however, has never been a subsidiary of Johnson Matthey, was not operating or planning to operate any manufacturing process in Florida, and was in fact owned by persons whom Johnson represented in writing did not have any ownership interest in JMP.

75. Not knowing that the representations made by Leonardo, Rossi, JMP, and Johnson about the customer in Florida and the operations to take place in Florida were false, Industrial Heat entered into an agreement with JMP and Leonardo to deliver the Plant to JMP's "production facility" in Miami, Florida. The agreement was memorialized in a "Term Sheet" executed by Industrial Heat, JMP, and Leonardo on August 13, 2014. The Term Sheet is attached hereto as Exhibit 17.

76. Industrial Heat would not have entered into the Term Sheet agreement had it known that JMP was not a real operating company, that JMP actually had no commercial use for the steam power generated by the Plant, or that JMP was created solely as a ruse to induce Industrial Heat to ship the Plant to Florida.

77. JMP's role in the scheme magnified when JMP started sending falsified invoices to Industrial Heat stating the amount of energy or steam JMP was purportedly receiving and using from the Plant during a given month. A selection of the invoices is attached hereto as Exhibit 18.

78. JMP's role further intensified when it, along with Leonardo, Rossi, Johnson and Fabiani went so far as to create a fictional JMP employee ("Bass") as Director of Engineering for JMP. Despite diligent search, Counter-Plaintiffs have not been able to identify or locate "Bass," for the simple reason that he does not exist. Rather, Leonardo, Rossi, JMP, Johnson and Fabiani created "Bass" as a means of making JMP appear to be a real manufacturing company that would need a Director of Engineering and to create a person with whom they would allegedly interact on technical issues involving JMP's non-existent operations and operational needs.

79. They even had a "John Doe" individual pose as "Bass" in a meeting with Industrial Heat at JMP's Doral facility and express JMP's satisfaction with the steam power JMP was receiving from the Plant and using to run its manufacturing operations. Attached as Exhibit 20 is a copy of the business card provided by this John Doe representing himself as "James A. Bass" and as JMP's "Director of Engineering." This John Doe also meet with others perpetuating this same false persona, falsely claiming JMP was using steam from the Plant in a secretive manufacturing process. JMP, Leonardo, Rossi, Johnson, Fabiani and John Doe's unconscionable and deceptive practices are further evidence that the testing in Miami was nothing but a sham designed to create the illusions that the Plant performed at levels that could satisfy Guaranteed Performance and that the prior Validation testing was valid.

80. In mid-2015, Industrial Heat hired Joseph Murray ("Murray") to serve as Vice President of Engineering, and empowered him to assemble a team of engineers and scientists to elevate the level of Industrial Heat's testing and evaluation of LENR technology. Among other things, one of the projects undertaken by that team was rigorous testing of the E-Cat IP. That testing demonstrated quite clearly that the results previously claimed by Leonardo, Rossi, and

Penon simply could not be replicated using the E-Cat IP that Leonardo and Rossi had provided to Counter-Plaintiffs.

81. Notwithstanding that Leonardo and Rossi allowed visitors to the facility in Doral where the Plant was located on a fairly regular basis, in July 2015, Rossi denied Murray access to the Plant without any reasonable justification. *See* Ex. 19. Had Murray – given his established engineering background – been allowed to access the Plant in July 2015, he would have immediately recognized the deficiencies in the operations that were being conducted by Leonardo and Rossi.

82. Indeed, when Murray eventually gained access to the Plant in February 2016 and examined the Plant, the methodology being used to operate the Plant, and the methodology being used to measure those operations, he immediately recognized that those methodologies were fatally flawed. Some of the flaws that he was quickly able to identify are explained in Exhibit 5. Murray also recognized that the building in which the Plant was located had no method to ventilate the heat that would be produced by the Plant were it producing the amount of steam claimed by Rossi, Leonardo, and Penon such that persons would not have been able to work in the building if the Rossi/Leonardo/Penon claims were true. This conflicted with the claims of individuals who had been in the building when the Plant was operating, all of whom claimed the temperature in the building was near or not much greater than the outside temperature. Photographs of the building ceiling from the inside are attached hereto as Exhibit 26.

83. Leonardo, Rossi, JMP, Johnson, USQL, Fabiani, and John Doe also restricted access to the JMP area at the Doral location, claiming that there was a secretive manufacturing process being conducted there, when in fact it was simply recycling steam from the Plant and sending it back to the Plant as water.

84. Fabiani, USQL and Penon also played critical roles in the scheme to hide the fact that the Plant does not perform up to the standards set forth in the License Agreement.

85. The USQL Agreement imposes an affirmative obligation upon USQL and Fabiani promptly to disclose information relating to their work on the Plant or the E-Cat IP. *See* USQL Agreement § 7. The USQL Agreement also makes clear that information obtained by USQL or Fabiani during the course of their work under the USQL Agreement is the sole property of Industrial Heat. *Id*. § 6.

86. Despite the fact that Fabiani and USQL are required to "promptly disclose" an array of information related to their work on the Plant or the E-Cat IP, USQL and Fabiani have purposely only been providing very limited information to Industrial Heat. They have not been providing Industrial Heat with accurate, complete information on the Plant, knowing that such information would demonstrate that the Plant was not performing at levels claimed by Leonardo, Rossi and Penon.

87. Furthermore, Fabiani and USQL have refused and continue to refuse to provide records, "tests and results" and other information relating to their engagement under the USQL Agreement to Industrial Heat, even though they agreed that such information is the property of Industrial Heat. *Id*. § 6. They have so refused because they are aware that such information demonstrates that the Plant was not performing at levels claims by Leonardo, Rossi and Penon.

88. As just one example, in late February 2016, shortly after the conclusion of the purported Guaranteed Performance test, USQL and Fabiani committed to send certain data and a report by the end of March 2016 that would "bring to light all the flaws and functional deficiencies of the system" and identify "the plant stop periods (total or partial)." In later emails, USQL and Fabiani also committed to provide Industrial Heat with the raw data that USQL and

Fabiani collected while working with the Plant in Doral, Florida. Despite repeated reminders, however, USQL and Fabiani have refused to provide either the report or the raw data to Industrial Heat. *See, e.g.*, Ex. 21.

89. Leonardo, Rossi, JMP, Johnson, USQL and Fabiani are all interconnected in a number of ways. As just one example, Johnson is currently listed as the President of both JMP and Leonardo. He is also the incorporator of USQL and remains its registered agent.

90. For his part, among other things, Penon primarily contributed to the scheme in a variety of ways relating to the purported measurement of the Plant's operations in Florida during the purported Guaranteed Performance test.[7] To start, his initial plan and design for measuring the power coming into and out of the Plant was, as he well knew, fundamentally flawed – including using improper equipment to measure the flow of fluid into the Plant and no equipment to measure the flow of heated fluid out of the Plant. Moreover, when the purported Guaranteed Performance test departed from Penon's plan and design almost immediately after the testing began – including that the number of reactors being operated was far less than the number of reactors specified in Penon's plan and design – Penon simply disregarded the massive deviation. *See* Ex. 5.

91. Penon further knowingly relied on flawed or fabricated data collections in his supposed evaluation of the Plant's performance. For example, Leonardo and Rossi have admitted (on their internet blog postings) that there were days when portions of the Plant were not operating, but Penon in his final report does not report any material decrease in output of the Plant on those days. Rather, he makes the (inexplicable) claim in his final report that on these days the Plant's performance either did not change or somehow even increased.

[7] Penon's participation in the scheme was not limited to this time period. In connection with the Validation test, Penon backed Leonardo and Rossi's false contention that Italian law only allowed for the test to be conducted using 18 E-Cat reactors. Penon also knowingly did not follow the Validation Protocol. *See* response to Paragraph 57, *supra*.

92. In February 2016 at an in-person meeting with Penon, Murray identified a number of flaws in how Penon was conducting his measurements of the Plant. Some of those flaws were also presented in writing to Penon on March 25, 2016. *See id.* Despite have full knowledge of the flaws, Penon nevertheless issued his false final report on March 28, 2016, claiming that guaranteed performance was achieved – and that the COPs achieved by the Plant were literally many multiples greater than ever claimed by anyone else (other than Leonardo and Rossi) who had ever tested an E-Cat reactor. Not surprisingly, since the day he left Florida in February 2016, Penon has refused to discuss his measurements, his measurement plan and design, or his report with Counter-Plaintiffs (though he has requested that Counter-Plaintiffs pay him for his work).

COUNT I: BREACH OF CONTRACT
(Validation and Disclosure of E-Cat IP)
(Industrial Heat and IPH against Leonardo and Rossi)

93. Counter-Plaintiffs reallege the allegations in Paragraphs 1 through 88 as if fully set forth herein.

94. The License Agreement states: "On the date the Escrow Agent pays the $10,000,000 to Leonardo, the License will commence and Leonardo and Rossi will immediately transfer, and the Validation Agent (as defined in Schedule 3.2(b)) will deliver to the Company all E-Cat IP." License Agreement § 3.2(b).

95. The escrow agent released the $10 million payment to Leonardo and Rossi on June 9, 2013, at which point Leonardo and Rossi became obligated to transfer and deliver to Counter-Plaintiffs all E-Cat IP.

96. Leonardo and Rossi purportedly transferred and delivered all E-Cat IP to Counter-Plaintiffs on June 9, 2013. However, after numerous attempts, both with and without Rossi's involvement, Counter-Plaintiffs have been unable, using the transferred E-Cat IP, to replicate the

results included in the Evaluation Report purportedly certifying that Validation was achieved from April 30 to May 1, 2013, or otherwise generate measureable excess energy.

97. Only one of three conclusions can be drawn from the foregoing facts: 1) Leonardo and Rossi did not transfer and deliver all E-Cat IP to Counter-Plaintiffs; 2) Validation was never achieved and Penon's reported COP calculations were false; or 3) both.

98. Each of these scenarios leads to only one conclusion: Leonardo and Rossi breached the terms of the License Agreement, either by not achieving Validation, not transferring or delivering all of the E-Cat IP to Counter-Plaintiffs, or both.

99. As a result of Leonardo and Rossi's breach, Counter-Plaintiffs have suffered and continue to suffer damages including, but not limited to: a) both the $1.5 million and $10 million payments made to Leonardo in connection with the License Agreement; b) other payments made to Leonardo or Rossi to reimburse them for unnecessary (in light of the conduct alleged herein) services, equipment, and expenses; and c) multi-million dollar payments made to a third party pursuant to the License Agreement, *see* License Agreement § 16.6.

COUNT II: BREACH OF CONTRACT
(Various Provisions in the License Agreement)
(Industrial Heat and IPH against Leonardo and Rossi)

100. Counter-Plaintiffs reallege the allegations in Paragraphs 1 through 88 as if fully set forth herein.

Confidentiality

101. The License Agreement imposed two distinct confidentiality obligations as it relates to Leonardo and Rossi. *See* License Agreement § 16.4.

102. The License Agreement provides that "[w]hile this Agreement is in effect and after this Agreement terminates, each party hereto and its Affiliates shall keep confidential, and

shall not disclose, the terms of this Agreement to any other Person without the prior consent of each other Party hereto," except in two specific situations not relevant to Leonardo and Rossi's disclosures referenced below. *Id.*

103. The License Agreement also provides that "[d]uring the term of this Agreement, each of Leonardo, Rossi, and AEG agrees to keep the E-Cat IP strictly confidential and not disclose any of the E-Cat IP to any other party," except in specific situations not relevant to Leonardo and Rossi's disclosures referenced below. *Id.*

104. Notwithstanding the clarity of the confidentiality provisions set forth above, Rossi, both individually and on behalf of Leonardo as its owner and sole operating officer, repeatedly violated the confidentiality provisions.

105. Addressing solely the time period prior to the filing of their Complaint in April 2016, Leonardo and Rossi violated the first confidentiality provision by disclosing various specific terms of the Agreement:

a. Leonardo and Rossi disclosed that their agreement with Counter-Plaintiffs required a test of the Plant.

b. Leonardo and Rossi disclosed that their agreement with Counter-Plaintiffs required a test to be conducted over 400 days.

c. Leonardo and Rossi disclosed that their agreement with Counter-Plaintiffs required a test involving 350 days of operation of the E-Cat Plant.

d. Leonardo and Rossi disclosed that their agreement with Counter-Plaintiffs required a guaranteed performance, or "guarantees of performance" test.

106. Making matters worse, Leonardo and Rossi thereafter filed their Complaint, with the License Agreement attached to it, in a public court record without any attempt to seal the Agreement. Within an exceedingly short time, as Leonardo and Rossi knew would occur, the Agreement was replicated and made available to anyone in the world with access to the Internet. As a consequence of Leonardo and Rossi's public disclosure of the License Agreement, the

confidentiality provision barring disclosure of the License Agreement's specific terms has been rendered a nullity.

107. Addressing solely the time period prior to the filing of their Complaint in April 2016, Leonardo and Rossi violated the second confidentiality provision by disclosing various information about the E-Cat IP:

a. Leonardo and Rossi, without prior consent from Counter-Plaintiffs, provided samples of the E-Cat Fuel (purportedly from both before and after an E-Cat reactor was operated) to the scientists who prepared the Lugano Report. The scientists analyzed the E-Cat Fuel samples and published the results of their analysis. *See* Ex. 14.

b. Leonardo and Rossi, without prior consent from Counter-Plaintiffs, disclosed specific information about the E-Cat Fuel to Norman Cook, a professor at Kansai University in Osaka, Japan. Rossi and Cook thereafter published a paper detailing new information about the E-Cat Fuel sample not disclosed in the Lugano Report. *See* Ex. 22.

c. Leonardo and Rossi, without prior consent from Counter-Plaintiffs, have made public comments about the E-Cat Fuel sample on the Internet.

108. None of the E-Cat Fuel sample disclosures referenced in the prior Paragraph were protected by a non-disclosure agreement – as evidenced by the fact that the information obtained from the disclosures is publicly available. On information and belief, Leonardo and Rossi have made additional E-Cat Fuel sample disclosures without Counter-Plaintiffs' consent and without the protection of a non-disclosure agreement, including as recently as May 2016.

109. Leonardo and Rossi's disclosure of the terms of the License Agreement harms Counter-Plaintiffs. For example, because the terms of the License Agreement have been made public, other entities (including current counter-parties to agreements) can use the License Agreement's terms in negotiations over similar agreements with Counter-Plaintiffs.

110. Disclosure of the E-Cat IP also harmed Counter-Plaintiffs. For example, Counter-Plaintiffs have paid $11.5 million to Leonardo and millions more to a third party per the License

Agreement for (among other things) control over any disclosure of the E-Cat IP. Clearly any value associated with the exclusive control over the disclosure of the E-Cat IP was diminished with any disclosure of the E-Cat IP by Leonardo and Rossi without Counter-Plaintiffs' consent. Leonardo and Rossi disclosed that confidential information to third parties and, in some instances, made it available for large scale public consumption. To the extent that the E-Cat IP has commercial value, Counter-Plaintiffs' ability to capture that value is substantially harmed by Leonardo and Rossi's improper disclosures.

Failure to Assign Licensed Patents

111. The License Agreement requires Leonardo and Rossi to assign the Licensed Patents, as defined in License Agreement § 16.1 and License Agreement Exhibit A, to Counter-Plaintiffs upon request: "Upon the request of [Counter-Plaintiffs], Leonardo and Rossi shall assign to [Counter-Plaintiffs] the Licensed Patents with respect to the Territory[.]" License Agreement § 10.

112. On February 17, 2016, IPH, through its counsel, requested that Leonardo and Rossi "assign to IPH the Licensed Patents (as defined by the [License] Agreement) with respect to the Territory (as also defined in the [License] Agreement)." IPH also provided Leonardo and Rossi an appropriate assignment form by which to assign the Licensed Patents. The request and assignment form are attached hereto as Exhibit 23.

113. Leonardo and Rossi refused to assign the Licensed Patents to IPH in violation of the express and unambiguous terms of the License Agreement.

114. Leonardo and Rossi's failure to assign the Licensed Patents to IPH caused IPH to suffer damages in that it is unable to secure any value that might be derived from having control over the Licensed Patents.

Failure to Inform/Consult on Patent Applications

115. The License Agreement contains clear directives relating to informing and consulting with Counter-Plaintiffs regarding patent prosecution and maintenance of the E-Cat IP. Section 7.1 of the License Agreement states:

> For each patent application and patent under the Licensed Patents, Leonardo shall:
>
> (a) prepare, file and prosecute such patent application;
> (b) maintain such patent;
> (c) pay all fees and expenses associated with its activities pursuant to Section 7.1(a) and (b) above;
> (d) keep [Counter-Plaintiffs] currently informed of the filing and progress in all material aspects of the prosecution of such patent application, and the issuance of patents from any such patent application;
> (e) consult with [Counter-Plaintiffs] concerning any decisions which could affect the scope or enforcement of any issued claims or the potential abandonment of such patent application or patent; and
> (f) notify the Company in writing of any additions, deletions or changes in the status of such patent or patent application.

License Agreement § 7.1.

116. Section 7.2 of the License Agreement states: "If Leonardo wishes to abandon any patent application or patent that is a Licensed Patent, it shall give [Counter-Plaintiffs] ninety (90) days prior written notice of the desired abandonment. Leonardo shall not abandon any such Licensed Patent except upon the prior written consent of [Counter-Plaintiffs]." *Id.* at § 7.2.

117. After executing the License Agreement, Leonardo filed patent applications relating to the Licensed Patents without informing Counter-Plaintiffs.

118. Leonardo also failed to keep Counter-Plaintiffs informed of the progress of the patent applications relating to the Licensed Patents. Finally, Leonardo, without prior written consent from Counter-Plaintiffs, abandoned several patent applications.

119. Leonardo and Rossi charged to Counter-Plaintiffs fees and expenses associated with preparing, filing, and prosecuting patent applications relating to the Licensed Patents, which fees and expenses Counter-Plaintiffs paid.

120. As a result of the foregoing, Counter-Plaintiffs have been harmed, not only as a result of the fees and expenses they paid, but also the diminution in value of the E-Cat IP for which they paid millions of dollars as a result of Leonardo's improper handling of patent applications.

Covenant Not to Compete

121. The License Agreement contains a clear and defined non-compete provision:

> For as long as the Company or any of its subsidiaries is engaged in any business related to the E-Cat Products and . . . Leonardo, Rossi or any Affiliate are performing services for the Company or such transferee (whether as an employee, consultant or otherwise and specifically including the period of services required by Section 13.1) and for an additional period of two (2) years after the last of Leonardo, Rossi or such Affiliate shall have ceased to provide such services, none of Leonardo, Rossi or any of their Affiliates will (except as an officer, director, stockholder, employee, agent or consultant of the Company or such subsidiary or the Company) directly or indirectly own, manage, operate, join, or have a financial interest in, control or participate in the ownership, management, operation or control of, or be employed or engaged as an employee, agent or consultant, or in any other individual or representative capacity whatsoever, or use or permit their names to be used in connection with, or be otherwise connected in any manner with any business or enterprise (a) engaged in the design, development, manufacture, distribution, lease, rental or sale of any E-Cat Products, or the provision of any services related thereto or (b) which is competitive with the E-Cat Products, unless Leonardo or such Affiliate shall have obtained the prior written consent of the Company or such subsidiary of the Company, as the case may be.

License Agreement § 13.3.

122. Since at least the filing of their Complaint, and likely for months prior, Leonardo and Rossi have been open in broadcasting that they are engaged in designing and developing what are classified as "E-Cat Products" under the License Agreement. They have also been open that they are doing so in combination with a company or companies unaffiliated with Counter-

Plaintiffs. *See e.g.*, Ex. 24. Leonardo and Rossi have even claimed that they have recently sold at least three E-Cat Units. *See e.g.*, Ex. 25.

123. Counter-Plaintiffs have not provided written consent to such conduct.

124. As a result, the conduct – regardless of whether it will ever lead to the creation of a viable commercial product that can be sold, leased, or rented – is in direct conflict with the License Agreement.[8]

125. Leonardo and Rossi's violations of the License Agreement's covenant not to compete have caused Counter-Plaintiffs to suffer harm, including the diminution in value of the E-Cat IP for which they paid millions of dollars.

Failure to Pay Taxes

126. Prior to Leonardo and Rossi entering the License Agreement, it was well known that Rossi had taxation issues with the Italian government, which even led to him facing criminal tax charges in Italy.

127. As a result, the License Agreement has several carefully crafted provisions to ensure that Leonardo and Rossi would comply with their tax obligations as they relate to any payments from Counter-Plaintiffs.

128. First, the License Agreement (Section 12(j)) required a representation from both Leonardo and Rossi that each has filed all necessary "tax returns or reports" and "has paid all taxes required by any jurisdiction or subdivision or agency thereof" prior to entering the License Agreement. License Agreement § 12(j).

[8] The License Agreement also includes a "Right of First Offer" provision that requires Leonardo and Rossi to provide Counter-Plaintiffs with notice of their intent to license the E-Cat IP outside of the Territory covered by the License Agreement, and to give Counter-Plaintiffs an opportunity to purchase such license. License Agreement § 13.2. Upon information and belief, Leonardo and Rossi have breached this provision as well by licensing or offering to license the E-Cat IP outside of the Territory without first offering such license to Counter-Plaintiffs.

129. Second, the License Agreement (Section 13.5) required each party to file all necessary documentation and returns as to any tax applicable to its or his "respective revenues derived . . . in respect of the E-Cat IP." *Id.* § 13.5.

130. Third, the License Agreement (Section 12(a)) required Leonardo and Rossi to keep the E-Cat IP "free and clear of any Liens." *Id.* § 12(a); *see also id.* § 12(e).

131. Fourth, IPH had Leonardo and Rossi provide it with a signed certificate certifying that all of their representations and warranties from the License Agreement, which included their representations as to compliance with their tax obligations, were true and correct as of the date of the certification (April 29, 2013) and would continue to be true after Leonardo was paid $10 million under the License Agreement. *See* Ex. 8.

132. Notwithstanding the foregoing, on information and belief, Leonardo and Rossi have not paid their federal taxes on payments made to them from Counter-Plaintiffs, and have not filed all tax returns or reports relating to payments made to them from Counter-Plaintiffs.

133. As a result of Leonardo and Rossi's failure to file or pay their federal taxes, Counter-Plaintiffs have suffered harm because the value of the E-Cat IP is diminished by the likelihood of it being subject to or encumbered by a Federal tax lien, which in turn diminishes its alienability and marketability.

COUNT III: FRAUDULENT INDUCEMENT
(Term Sheet)
(Industrial Heat against Rossi, Leonardo, JMP, and Johnson)

134. Industrial Heat realleges the allegations in Paragraphs 1 through 88 as if fully set forth herein.

135. Rossi, Leonardo, JMP, and Johnson falsely represented to Industrial Heat that JMP was a manufacturing company with a real commercial use for the steam power generated by the Plant.

136. In reality, JMP was not a manufacturing company, had no commercial use for the steam power generated by the Plant, and was created solely as a ruse to induce Industrial Heat to ship the Plant to Florida.

137. Rossi, Leonardo, JMP, and Johnson made such false representations to induce Industrial Heat to enter into the Term Sheet so that Leonardo and Rossi could operate the Plant without Industrial Heat's direct supervision or oversight, thereby allowing them to manipulate the operation of the Plant, any measurement of the operation of the Plant, and any purported "Guaranteed Performance" testing of the Plant.

138. Industrial Heat justifiably relied on such false representations in entering into the Term Sheet. Industrial Heat would not have agreed to the Term Sheet but for such false representations.

139. As a result of Rossi, Leonardo, JMP, and Johnson's fraudulent inducement, Industrial Heat has suffered and continues to suffer damages. Among the damages are the following: the cost of transporting the Plant to Florida; the cost of operating the Plant in Florida; the cost of engaging and paying two independent contractors, one of whom was Fabiani; and a host of additional expenses charged to Industrial Heat in connection with the operation and maintenance of the Plant in Florida.

COUNT IV: FLORIDA DECEPTIVE AND UNFAIR TRADE PRACTICES ACT
(Industrial Heat and IPH against all Counter-Defendants and Third-Party Defendants)

140. Counter-Plaintiffs reallege the allegations in Paragraphs 1 through 135 as if fully set forth herein.

141. As described in greater detail above, Rossi, Leonardo, Johnson, JMP, Penon, Fabiani, USQL, and John Doe a/k/a "James A. Bass" (the "FDUTPA Defendants") were all engaged in a common scheme against Counter-Plaintiffs.

142. The first part of the scheme was to manipulate Counter-Plaintiffs into allowing the Plant to be sent from the Industrial Heat facility in North Carolina – where any work on, operation of, or testing of the Plant could be supervised and overseen by Counter-Plaintiffs – to Florida, where Leonardo, Rossi, USQL, Fabiani, and Penon could operate the Plant and purportedly conduct measurements of the Plant's operations away from the oversight and control of Counter-Plaintiffs.

143. The second part of the scheme was to manipulate the operation of the Plant and the measurements of the Plant's operations to create the false and deceptive appearance and impression that the Plant was performing at astronomical levels, with COP measurements not only well in excess of anything achieved by any third party testing of the E-Cat technology, but in fact many multiples higher than anything achieved by any third party testing. For example, notwithstanding flaws in their testing methodology that would have caused them to overstate their conclusions of the COP they were measuring from an E-Cat reactor, the Lugano scientists concluded that the E-Cat reactors they measured were producing a COP of 2.6, 2.9, 3.2, 3.6 or 5.6. According to the manipulated and fabricated testing and measurements of the FDUTPA Defendants, they – through Leonardo, Rossi, and Penon – claimed that they were achieving COPs more than 10 times greater than the Lugano scientists, and in fact as high as 40+ times greater than the Lugano scientists.

144. The final part of the scheme, of course, was for Leonardo and Rossi, based on the false and deceptive operations of the Plant in Florida, to claim to Counter-Plaintiffs that they

were required to pay Leonardo and Rossi $89 million and, when Counter-Plaintiffs rightfully refused, to institute litigation against Counter-Plaintiffs.

145. Another goal of the scheme was to obtain various payments from Counter-Plaintiffs for work that one or more of the FDUTPA Defendants was performing not to benefit Counter-Plaintiffs, but in fact with the goal of harming Counter-Plaintiffs. Among these payments were service payments to USQL, Fabiani, and Penon; expense reimbursements to Leonardo, Rossi, USQL, Fabiani, and Penon (including for travel, apartment rentals, visa-related costs, repair work to the Plant, patent attorneys, and patent application fees); and payments for equipment (or the transportation of equipment) to be used – or purportedly to be used – by the FDUTPA Defendants.

146. In furtherance of this scheme, the FDUTPA Defendants engaged in the unconscionable, unfair, and deceptive acts and practices described above, including:

a. Deceiving Counter-Plaintiffs about JMP, the operations of JMP, the supposed role of "Bass", and the reasons for JMP wanting to use the steam power that could be generated by the Plant.

b. Deceiving Counter-Plaintiffs as to the reasons for wanting to move the Plant from North Carolina to Florida.

c. Manipulating the operation of the Plant and the measurements of the Plant's operations to create the false impression and appearance that it was producing a COP far in excess of the COP it was in fact achieving.

d. Providing false information to Counter-Plaintiffs as to the operation of the Plant and the measurements of the Plant's operations.

e. Refusing to provide other information properly requested by Counter-Plaintiffs, and to which Counter-Plaintiffs were entitled pursuant to the License Agreement, the Term Sheet, the USQL Agreement, and/or the nature of the purportedly (but in fact, not) independent work being done by Penon.

f. Preventing or blocking Counter-Plaintiffs from obtaining truthful information about the Plant's operations, the measurements of those operations, the role of JMP, the use by JMP of steam provided by the Plant, the role of Penon, or the bases for expenses or costs charged to Counter-Plaintiffs.

g. Charging Counter-Plaintiffs for services, expenses, and equipment that were purportedly being used either for the benefit of, and to further the goals of, Counter-Plaintiffs when in fact no such services, expenses, or equipment were being used for Counter-Plaintiffs' benefit.

147. The acts and practices alleged above, including in the prior paragraph, were unconscionable, unfair, and deceptive. As such, they have been declared unlawful pursuant to Section 501.204 of the Florida Deceptive and Unfair Trade Practices Act ("FDUTPA").

148. As a result of the foregoing acts and practices declared unlawful under FDUTPA, Counter-Plaintiffs have suffered and continue to suffer actual damages, as described above.

COUNT V: BREACH OF CONTRACT
(Industrial Heat against Fabiani and USQL)

149. Industrial Heat realleges the allegations in Paragraphs 1 through 88 as if fully set forth herein.

150. Industrial Heat retained USQL and Fabiani to "provide services related to the manufacture and development" of products relating to the E-Cat IP. *See* USQL Agreement, Page 1. They were required to act in a manner in, and not opposed to, the best interests of Industrial Heat. *See id*. § 3.

151. The USQL Agreement makes clear that information obtained by USQL and Fabiani arising out of the services they agreed to provide to Industrial Heat is the property of Industrial Heat. For example, the USQL Agreement states:

> All Confidential Information, records, files, memoranda, reports, drawings, plans, designs, specifications, tests and results, recordings, documents and the like (together with all copies thereof), including any of the foregoing that are electronically maintained, relating to the business of Industrial Heat or the engagement of USQL [and Fabiani] pursuant to this Agreement that USQL [and Fabiani] shall use or prepare or come in contact with in the course of, or as a result of, the engagement of USQL [and Fabiani] under this Agreement shall remain the sole property of Industrial Heat . . . .

Id. § 6.

152. The USQL Agreement also requires that USQL and Fabiani promptly disclose to Industrial Heat (among other things) developments and discoveries relating to the Plant or the E-Cat IP:

> USQL [and Fabiani] further agree[] that . . . [they] will promptly disclose to Industrial Heat any and all improvements, inventions, developments, discoveries, innovations, systems, techniques, processes, formulas, programs and other things that may be of assistance to Industrial Heat or its affiliates, whether patentable or unpatentable, that (i) relate to the actual or demonstrably anticipated research or development by Industrial Heat or any of its affiliates, or (ii) result from any work performed by USQL [and Fabiani] for or at the request of Industrial Heat, or (iii) are developed on Industrial Heat's time or using the equipment, supplies or facilities or any Confidential Information or trade secret information of Industrial Heat, or any of its affiliates; and that are made or conceived by USQL [and Fabiani], alone or with others, while engaged by Industrial Heat (collectively referred to herein as the "New Developments"). USQL [and Fabiani] agree that all New Developments shall be and remain the sole and exclusive property of Industrial Heat and that it shall upon the request of Industrial Heat, and without further compensation, but at the cost and expense of Industrial Heat, do all things reasonably necessary to [e]nsure Industrial Heat's or its affiliate's ownership of such New Developments.

Id. § 7.

153. USQL and Fabiani breached the USQL Agreement by failing to provide services to Industrial Heat relating to the manufacture and development of the Plant and the E-Cat IP. More specifically, USQL and Fabiani disregarded their contractual obligations to Industrial Heat in order to assist Leonardo and Rossi in their deceptive operations in Florida. Indeed, instead of working in "the best interests of Industrial Heat," as required by USQL Agreement § 3, Fabiani and USQL were – as Fabiani publicly admitted – working "under Rossi's orders," including assisting Rossi in actions directly against Industrial Heat's interests as alleged above.

154. USQL and Fabiani also breached the USQL Agreement by failing to provide Industrial Heat with information relating to the scheme to manipulate the operation and testing of the Plant. USQL and Fabiani had an affirmative obligation to inform Industrial Heat of the

scheme to manipulate the Plant's operations and the testing. Such information would constitute a "New Development" that USQL and Fabiani were required to disclose to Industrial Heat pursuant to the USQL Agreement. USQL and Fabiani also refused to provide other information to Industrial Heat, as alleged above. USQL and Fabiani intentionally withheld information from Industrial Heat relating to the scheme and, therefore, breached the USQL Agreement.

155. USQL and Fabiani further breached the USQL Agreement by failing to provide Industrial Heat with information, including reports and data, relating to the operation of the Plant in Doral, Florida. Industrial Heat made several demands for such information and USQL and Fabiani have repeatedly refused to provide Industrial Heat with the reports and data. *See, e.g.*, Ex. 21.

156. Industrial Heat and IPH have suffered harm as a result of USQL and Fabiani's breaches of the USQL agreement including USQL and Fabiani's failure to further the best interest of Industrial Heat, failure to provide Industrial Heat with information relating to the scheme pled herein, and failure to provide Industrial Heat with other information requested by Industrial Heat or that they were required to provide Industrial Heat. These breaches have deprived Industrial Heat of the benefit of its bargain with USQL and Fabiani, led to Industrial Heat paying USQL and Fabiani for services not rendered, deprived Industrial Heat of property that is its property per the USQL Agreement, and prevented Industrial Heat from learning of the deceptive scheme as alleged above.

COUNTER-PLAINTIFFS' PRAYER FOR RELIEF

WHEREFORE, Counter-Plaintiffs respectfully request that the Court enter judgment in their favor and against Counter-Defendants and Third Party Defendants as follows:

i. For compensatory and expectation damages and/or restitution in an amount to be determined at trial;

ii. For costs of suit and for attorneys' fees and costs;

iii. For pre-judgment interest; and

iv. For such other and further relief as this Court deems just and proper.

Dated: August 11, 2016. Respectfully submitted,

/s/ Christopher R. J. Pace

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<u>**CERTIFICATE OF SERVICE**</u>

I HEREBY CERTIFY that on August 11, 2016, I electronically filed the foregoing with the Clerk of the Court by using the CM/ECF system which will send a notice of electronic filing to all counsel or parties of record. This Amended Answer, Additional Defenses, Counterclaims and Third-Party Claims will be served on the Third-Party Defendants pursuant to Federal Rule of Civil Procedure 4 or other permissible means of service.

/s/ Christopher R. J. Pace
Christopher R.J. Pace

EXHIBIT 1

UNITED STATES PATENT AND TRADEMARK OFFICE

UNITED STATES DEPARTMENT OF COMMERCE
United States Patent and Trademark Office
Address: COMMISSIONER FOR PATENTS
P.O. Box 1450
Alexandria, Virginia 22313-1450
www.uspto.gov

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
12/736,193	09/16/2010	Andrea Rossi	1724-001	2834

47888 7590 01/11/2016
HEDMAN & COSTIGAN, P.C.
ONE ROCKEFELLER PLAZA, 11TH FLOOR
NEW YORK, NY 10020

EXAMINER	
BURKE, SEAN P	
ART UNIT	**PAPER NUMBER**
3646	
NOTIFICATION DATE	**DELIVERY MODE**
01/11/2016	ELECTRONIC

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

PTOmail@hgcpatent.com
ipdocket@hgcpatent.com

Office Action Summary	**Application No.** 12/736,193	**Applicant(s)** ROSSI, ANDREA	
	Examiner SEAN P. BURKE	**Art Unit** 3646	**AIA (First Inventor to File) Status** No

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *3* MONTHS FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *6/12/2015*.

☐ A declaration(s)/affidavit(s) under **37 CFR 1.130(b)** was/were filed on ______.

2a)☐ This action is **FINAL**. 2b)☒ This action is non-final.

3)☐ An election was made by the applicant in response to a restriction requirement set forth during the interview on ______; the restriction requirement and election have been incorporated into this action.

4)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims*

5)☒ Claim(s) *1-7,9 and 10* is/are pending in the application.

5a) Of the above claim(s) ______ is/are withdrawn from consideration.

6)☐ Claim(s) ______ is/are allowed.

7)☒ Claim(s) *1-7,9 and 10* is/are rejected.

8)☐ Claim(s) ______ is/are objected to.

9)☐ Claim(s) ______ are subject to restriction and/or election requirement.

* If any claims have been determined allowable, you may be eligible to benefit from the **Patent Prosecution Highway** program at a participating intellectual property office for the corresponding application. For more information, please see http://www.uspto.gov/patents/init_events/pph/index.jsp or send an inquiry to PPHfeedback@uspto.gov.

Application Papers

10)☒ The specification is objected to by the Examiner.

11)☐ The drawing(s) filed on ______ is/are: a)☐ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

Certified copies:

a)☐ All b)☐ Some** c)☐ None of the:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. ______.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

** See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Information Disclosure Statement(s) (PTO/SB/08a and/or PTO/SB/08b) Paper No(s)/Mail Date ______.

3) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. ______ .

4) ☒ Other: *Detailed Action*.

1. The present application is being examined under the pre-AIA first to invent provisions.

DETAILED ACTION

Status of Claims

2. Claims 1-7, 9 and 10 are under examination.

Affidavit

3. The affidavit filed by the inventor on 12 June 2015 is acknowledged, however the arguments of the affidavit are not persuasive. Applicant avers that the two submitted papers demonstrate independent confirmation of the device operability. Examiner respectfully disagrees.

4. Regarding the Parkhomov papers, as discussed previously, the purported reaction cannot be initiated without substantial energy. Assuming arguendo that a nuclear reaction occurs between hydrogen and nickel, it is fundamental that such a reaction produces both β and γ emissions. However, the paper author explicitly states that no such radiation was measured by the attendant dosimeter.[1] The absence of any detected radioactive signature is an indicia of inoperability.

5. The only indicator of operability in the Parkhomov papers is the claim of anomalous heat production. As has been stated previously, there are many potential sources anomalous heat in such a setup. One glaring example might be a chemical reaction between the nickel and lithium hydride. Or a reaction between the aluminum components and one of the fuel constituents. However, if the reaction is indeed

[1] Parkhomov, Exhibit D, § IV; Exhibit E, § V.

chemical and it is coming from elements that have been purified in the production process, it is axiomatic that the reaction cannot be exothermic.

6. As such, the Parkhomov papers are not persuasive.[2]

Response to Arguments

7. Applicant's arguments filed 12 June 2015 have been fully considered but they are not persuasive. A detailed response follows.

8. Applicant traverses the operability rejections, arguing that the dummy system served as a proper control because the only difference between the control run and the experimental run was that the latter system contained fuel. "Instead of building two identical systems, the operating characteristics of the same reactor was determined, with the same experimental set up before and after the fuel loading was carried out."[3] It is hard to believe that Lugano et al. could certify this fact, because by the Applicant's own admission, they were not permitted to inspect the machine internals. How can a person determine if there is fuel in the device if he is not permitted to see within it? This

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[2] Beyond the experimental criticisms, no reasonable person of ordinary skill in the art would accept an article from "The Journal of Unconventional Science" at face value. A selection of articles **from the same issue** reveal: "прибор новой физики. Часть 3. Лабораторные исследования торсинда" (A report on a spinning disk capable of harnessing the torque captured by the syzygy of a lunar eclipse), "13C, онтогенез и парадокс эволюции," (A paper exploring a new fundamental force - beyond the known four forces - as a determinate for the slow pace of evolution), "Могут ли двойной слепой контроль и двойная рандомизация быть критериями достоверности в “психофизических” экспериментах. (Обоснование необходимости введения мета-прибора в психофизические исследования)" (An admittedly laudable call for the use of double-blind criteria in the study of telekinesis), "Нетрадиционные исследования – псевдонаука, техномистицизм или новая область знания?" (Literally: "Unconventional Research: Pseudoscience, Technomysticism or a New Field of Knowledge?" The author advocates the latter.) and "Сверхъестественное. Научно доказанные факты (анонс книги)," (A review of a book entitled "Supernatural: Scientifically Proven Fact").

While the titles and summaries of the articles speak for themselves, given the cyclic nature of this prosecution, the Examiner reiterates that one of ordinary skill in the art would have serious cause to doubt the credibility of any article published in the Journal of Unconventional Science.

[3] Remarks, p. 6.

kind of passive acceptance discredits any claim of operability made by the group. As such, the Lugano report still remains unpersuasive.

9. Applicant cites *Newman*[4] in support of the contention that an applicant is not required to know how a device operates in order to receive a patent for it. While this is a correct statement of the law, it is premature. The Applicant has not proven **if** the device works; much less **how** it works. For the reasons discussed above and below, there is no credible assertion of operability.

10. The Applicant argues that the blog posting cited as Exhibit B, if it is not a credible reference, it should not be used in the rejection. This is a circular argument. The reference is not believable because it not peer reviewed. It demonstrates the precise form of undiscerning "review" that seems peculiar to the cold fusion art. Notwithstanding this observation, the reference was originally cited by the Applicant, not the Examiner.[5]

11. Applicant's remaining arguments reiterate that the inventor is not responsible for a theory of operation. Examiner reiterates the prior arguments as further notes that while Applicant is not bound by theory, the claimed invention is explicitly directed to "A method of carrying out an exothermal reaction of nickel and hydrogen." To date, there is no credible evidence of this reaction. Nor would one of ordinary skill in the art, after

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[4] 783 F.2d 971 (Fed. Cir. 1986).

[5] Applicant further argues that the subject of blog post, Brian Ahern, "has long been a critic of the present applicant" but neglects to mention that Dr. Ahern also has a long track record in the annals of cold fusion. C.f. Swartz, "Survey of the Observed Excess Energy and Emissions in Lattice Assisted Nuclear Reactions," http://world.std.com/~mica/Swartz-SurveyJSE2009.pdf last visited 4 January 2016.

Applicant further states that Brian Ahern is "a distinguished MIT professor." While Dr. Ahern is no doubt distinguished, it appears that he is not a professor at MIT. Currently, the only Brian Ahern in the MIT directory is a Brian W. Ahern, a third year student in the biological engineering department.

reviewing the claimed evidence, consider Applicant's claims dispositive. Accordingly, Applicant's traversal the operability rejection is not persuasive.

12. Applicant's remaining arguments refer to the recent amendments. They are addressed in the rejections below.

Specification

13. The specification is objected to as directed solely to an inoperable device. Specifically, the present invention appears to be derived from the discredited "dry LENR" process embodied by Andrea Rossi's "e-Cat" device. As discussed below, claims directed to this mode of fusion have been rife with fraud and fail to measure up to even cursory examination under the generally accepted laws of physics.

14. Rossi's e-Cat device is a purported nuclear fusion reactor which exposes nickel powder to hydrogen gas at modest pressure (around 2 bar) and temperature (between 150-500°C).[6] According to Rossi, the nickel nuclei absorb protons from the hydrogen gas and undergo β decay to form various isotopes of copper. Rossi does not propose a theory of operation for the device, but simply reviewing the products and the reactants would cause one of ordinary skill to doubt the operability of the system.

15. First, there is the issue of nickel. Nickel-62, one of the reactant isotopes, has the highest nuclear binding energy of any known isotope.[7] In laymen's terms, this means that nickel-62 is the most stable and non-reactive nucleus in the known universe.

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[6] *See* Application. 12/736,193 (US 2011/0005506 A1). Note, the Abstract in this reference states a temperature range of 150-5000°C. This would appear to be a typographical error since the steel containment would melt at 1510°C. Examiner notes that this error is not repeated in elsewhere in the specification or the claims.

[7] *See* Fewell, "The Atomic Nuclide With the Highest Mean Binding Energy," http://adsabs.harvard.edu/abs/1995AmJPh..63..653F (last visited 17 December 2015).

However, the other common isotopes of nickel (^{58}Ni, ^{60}Ni, ^{61}Ni and ^{64}Ni) share similar binding energies. This relative stability explains why the metal accumulates in stars - even under the most extreme fusion conditions imaginable, nickel will not react with other elements. However, for the sake of argument, we will assume that an unknown mechanism is causing nickel to react with hydrogen.

16. If nickel were to react with hydrogen, it would do so according to the following mechanisms:[8]

$$^{58}Ni + \ ^{1}H \rightarrow \ ^{59}Cu *$$
$$^{60}Ni + \ ^{1}H \rightarrow \ ^{61}Cu *$$
$$^{61}Ni + \ ^{1}H \rightarrow \ ^{62}Cu *$$
$$^{62}Ni + \ ^{1}H \rightarrow \ ^{63}Cu *$$
$$^{64}Ni + \ ^{1}H \rightarrow \ ^{65}Cu *$$

17. Where the star (*) signifies that copper is unstable and will undergo β-decay back to a nickel isotope of corresponding mass. This mechanism obviously fails because it does not produce the claimed reaction products.

18. One could create copper from nickel with neutrons, but then it is not clear where the present invention would obtain such a source. However, for the sake of argument, we assume that the unknown mechanism *also* has a ready supply of neutrons. If this is the case, then we can convert ^{62}Ni and ^{64}Ni into ^{63}Cu and ^{65}Cu respectively under the following reactions:[9]

$$^{62}Ni + \ ^{1}n \rightarrow \ ^{63}Ni * \rightarrow \ ^{63}Cu + \beta^{-} + \gamma + \upsilon_e^{-}$$
$$^{64}Ni + \ ^{1}n \rightarrow \ ^{65}Ni * \rightarrow \ ^{65}Cu + \beta^{-} + \gamma + \upsilon_e^{-}$$

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[8] *See* Thieberger, "The Physics of why the e-Cat's Cold Fusion Claims Collapse," pp. 7-8.
[9] *Id.* at 10.

19. If one were to build a machine to leverage these reactions, one would expect the proportion of the products to equal the proportion of the reactants. Thus, the ratio of nickel-62 to nickel-64 should equal the ratio of copper-63 to copper-65. However, this is not the case.[10]

20. Putting aside the theoretical considerations, there is the additional matter of verifiability. To date, there exists no credible independent, peer-reviewed evaluation of the e-Cat device. Nor has there been a credible attempt at explaining the purported nickel phenomenon. Additionally, attempts to independently verify the Rossi device appear to have been met with resistance.[11]

21. A person of ordinary skill in the art would have cause to doubt the operability of the claimed invention for three reasons. First, the inventors make the incredible claim of exothermic fusion of hydrogen and nickel in a laboratory environment. For the reasons discussed above, the known and existing laws of nature do not support this reaction. Next, the proponents have only been able to produce an ash that reflects the standard isotopic distribution of copper, not the distribution of copper that would occur if nickel were actually undergoing the fusion process. Finally, the absolute dearth independent confirmation and the carefully crafted "demonstrations" would cause a person of ordinary skill in the art to doubt the operability of the device as claimed.

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[10] *See* Aleklett, "Rossi energy catalyst - a big hoax or new physics?" Aleklett's Energy Mix, pp. 2-3. https://aleklett.wordpress.com/2011/04/11/rossi-energy-catalyst-a-big-hoax-or-new-physics/ (last accessed 18 December 2015).

[11] *See* "Can Andrea Rossi's Infinite-Energy Black Box Power the World - Or Just Scam It?" Popular Science http://www.popsci.com/science/article/2012-10/andrea-rossis-black-box (last accessed 18 December 2015).

Claim Rejections - 35 USC § 101

22. 35 U.S.C. 101 reads as follows:

> Whoever invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvement thereof, may obtain a patent therefor, subject to the conditions and requirements of this title.

21. Claims 1-7, 9 and 10 are rejected under 35 U.S.C. 101 because the disclosed invention is inoperative and therefore lacks utility. The claims are rejected for the reasons disclosed above.

Claim Rejections - 35 USC § 112

22. The following is a quotation of the first paragraph of 35 U.S.C. 112(a):

> (a) IN GENERAL.—The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor or joint inventor of carrying out the invention.

The following is a quotation of the first paragraph of pre-AIA 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same, and shall set forth the best mode contemplated by the inventor of carrying out his invention.

23. Claims 1-7, 9, and 10 rejected under 35 U.S.C. 112(a) or 35 U.S.C. 112 (pre-AIA), first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the invention. Specifically, any claim that is inoperable is necessarily non-enabled. *In re Swartz,* 232 F.3d 862 (Fed. Cir. 2000).

Claim Rejections - 35 USC § 103

24. The following is a quotation of pre-AIA 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

25. The factual inquiries set forth in *Graham v. John Deere Co.*, 383 U.S. 1, 148 USPQ 459 (1966), that are applied for establishing a background for determining obviousness under pre-AIA 35 U.S.C. 103(a) are summarized as follows:

1. Determining the scope and contents of the prior art.
2. Ascertaining the differences between the prior art and the claims at issue.
3. Resolving the level of ordinary skill in the pertinent art.
4. Considering objective evidence present in the application indicating obviousness or nonobviousness.

26. Claims 1 and 7 are rejected under pre-AIA 35 U.S.C. 103(a) as being unpatentable over Butler et al., "Radiative Proton Capture by Ni^{58}, Ni^{60}, and Co^{59}."

27. Notwithstanding the inoperability of the claimed device, the reaction itself is obvious over Butler. Note, the Butler device uses the more traditional method of nucleosysynthesis which employs accelerating protons into a stationary target. However, even if the alleged reaction could occur, one of ordinary skill in the art would understand that the reaction would be subject to varying the basic reaction parameters.

28. Applicant traverses the rejection because the Butler device employs nickel-plated silver and not nickel powder. However, if the reaction is to occur as described in the specification, it is not clear why the solid form of the fuel would matter.

29. Accordingly, claims 1 and 7 are rejected as obvious over Butler.

Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to SEAN P. BURKE whose telephone number is (571)270-5493. The examiner can normally be reached on Monday-Friday, 10:00 AM to 6:30 PM EST.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Jack Keith can be reached on (571) 262-6878. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free). If you would like assistance from a USPTO Customer Service Representative or access to the automated information system, call 800-786-9199 (IN USA OR CANADA) or 571-272-1000.

/SEAN P BURKE/

Examiner, Art Unit 3646

EXHIBIT 2

PATENT COOPERATION TREATY

From the
INTERNATIONAL SEARCHING AUTHORITY

To: FRANK OCCHIUTI
OCCHIUTI & ROHLICEK LLP
321 SUMMER STREET
BOSTON, MA 02210

PCT

WRITTEN OPINION OF THE
INTERNATIONAL SEARCHING AUTHORITY

(PCT Rule 43*bis*.1)

Date of mailing (*day/month/year*)	19 OCT 2015
Applicant's or agent's file reference: 60040-003WO1	**FOR FURTHER ACTION** See paragraph 2 below

International application No.	International filing date (*day/month/year*)	Priority date (*day/month/year*)
PCT/US2015/042353	28 July 2015	01 August 2014

International Patent Classification (IPC) or both national classification and IPC
IPC(8) - F24J 1/00 (2015.01)
CPC - F24J 1/00 (2015.09)

Applicant ROSSI, ANDREA

1. This opinion contains indications relating to the following items:

- [x] Box No. I Basis of the opinion
- [ ] Box No. II Priority
- [ ] Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- [ ] Box No. IV Lack of unity of invention
- [x] Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement
- [ ] Box No. VI Certain documents cited
- [ ] Box No. VII Certain defects in the international application
- [ ] Box No. VIII Certain observations on the international application

2. **FURTHER ACTION**

If a demand for international preliminary examination is made, this opinion will be considered to be a written opinion of the International Preliminary Examining Authority ("IPEA") except that this does not apply where the applicant chooses an Authority other than this one to be the IPEA and the chosen IPEA has notified the International Bureau under Rule 66.1*bis*(b) that written opinions of this International Searching Authority will not be so considered.

If this opinion is, as provided above, considered to be a written opinion of the IPEA, the applicant is invited to submit to the IPEA a written reply together, where appropriate, with amendments, before the expiration of 3 months from the date of mailing of Form PCT/ISA/220 or before the expiration of 22 months from the priority date, whichever expires later.

For further options, see Form PCT/ISA/220.

Name and mailing address of the ISA/	Date of completion of this opinion	Authorized officer
Mail Stop PCT, Attn: ISA/US Commissioner for Patents P.O. Box 1450, Alexandria, Virginia 22313-1450 Facsimile No. 571-273-8300	21 September 2015	Blaine Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

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Box No. I Basis of this opinion

1. With regard to the **language**, this opinion has been established on the basis of:
   - [x] the international application in the language in which it was filed.
   - [ ] a translation of the international application into ______________ which is the language of a translation furnished for the purposes of international search (Rules 12.3(a) and 23.1(b)).

2. [ ] This opinion has been established taking into account the **rectification of an obvious mistake** authorized by or notified to this Authority under Rule 91 (Rule 43*bis*.1(a)).

3. [ ] With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, this opinion has been established on the basis of a sequence listing:
   a. [ ] forming part of the international application as filed:
      - [ ] in the form of an Annex C/ST.25 text file.
      - [ ] on paper or in the form of an image file.
   b. [ ] furnished together with the international application under PCT Rule 13*ter*.1(a) for the purposes of international search only in the form of an Annex C/ST.25 text file.
   c. [ ] furnished subsequent to the international filing date for the purposes of international search only:
      - [ ] in the form of an Annex C/ST.25 text file (Rule 13*ter*.1(a)).
      - [ ] on paper or in the form of an image file (Rule 13*ter*.1(b) and Administrative Instructions, Section 713).

4. [ ] In addition, in the case that more than one version or copy of a sequence listing has been filed or furnished, the required statements that the information in the subsequent or additional copies is identical to that forming part of the application as filed or does not go beyond the application as filed, as appropriate, were furnished.

5. Additional comments:

WRITTEN OPINION OF THE INTERNATIONAL SEARCHING AUTHORITY

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Box No. V Reasoned statement under Rule 43*bis*.1(a)(i) with regard to novelty, inventive step and industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Claims	1-28, 30, 31, 35, 36	YES
	Claims	29, 32-34	NO
Inventive step (IS)	Claims	19-28	YES
	Claims	1-18, 29-36	NO
Industrial applicability (IA)	Claims	1-36	YES
	Claims	None	NO

2. Citations and explanations:

Claims 29 and 32-34 lack novelty under PCT Article 33(2) as being anticipated by Mills.

Regarding claim 29, Mills discloses an apparatus for heating a fluid, said apparatus comprising means for containing said fluid, and means for holding a fuel mixture containing a catalyst and a reagent, and means for initiating a reaction sequence mediated by said catalyst to cause an exothermic reaction [see Fig. 1, and Paras. 0140, 0141, 0142, 0144, and 0146].

Regarding claim 32, Mills discloses a composition of matter for generating heat, said composition comprising a fuel mixture and a catalyst, said catalyst comprising a group 10 element such as nickel [see Paras. 0141, 0142, 0144, and 0146].

Regarding claim 33, Mills discloses the composition of claim 32, wherein said catalyst comprises nickel [see Paras. 0142 and 0144].

Regarding claim 34, Mills discloses the composition of claim 32, wherein said catalyst comprises nickel powder [see Paras. 0142, 0144, 0188, and 0195].

Claim 35 lacks an inventive step under PCT Article 33(3) as being obvious over Mills.

Regarding claim 35, Mills discloses the composition of claim 34. Mills fails to explicitly disclose the composition, wherein said nickel powder has been treated to enhance porosity thereof. It is submitted that the supports utilized in the fuel mixture or composition of Mills would appear to enhance the porosity of the nickel powder [see Paras. 0146, 0164, 0185, and 0188]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the composition of Mills by including the recited nickel powder, for the purpose of optimizing the generation of heat from the fuel mixture.

Claims 1, 2, and 6-16 lack an inventive step under PCT Article 33(3) as being obvious over Coffey et al. (hereafter Coffey) in view of Mills.

Regarding claim 1, Coffey discloses an apparatus for heating fluid, said apparatus comprising a tank for holding fluid to be heated, and a fuel wafer in fluid communication with said fluid, said fuel wafer including a fuel mixture including reagents or reactant powders, and an ignition source in thermal communication with said fuel mixture, wherein the ignition source is selected from the group consisting of an induction heater, an electrical resistor, a heater that relies on natural gas combustion, and a heater that relies on combustion of fuel [see Figs. 12, 17, and 20, and Paras. 0007, 0072, 0085 and 0090]. Coffey fails to explicitly discloses the apparatus, wherein said fuel wafer including a fuel mixture including reagents and a catalyst. Mills teaches that it is known in the art to include fuel mixture comprising reagents and a catalyst in an apparatus for heating a fluid [see Fig. 1, and Paras. 0140, 0141, 0142, 0144, and 0146]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited fuel mixture in view of the teachings of Mills, for the purpose of optimizing the generation of heat from a desired fuel mixture.

Regarding claim 2, Coffey in view of Mills discloses the apparatus of claim 1. Coffey further discloses the apparatus, wherein said ignition source comprises an electrical resistor [see Fig. 20 and Para. 0090].

Regarding claim 6, Coffey in view of Mills discloses the apparatus of claim 1. Coffey fails to explicitly disclose the apparatus, wherein said catalyst comprises nickel powder. Mills teaches that it is known in the art to include fuel mixture comprising nickel powder catalyst in an apparatus for heating a fluid [see Fig. 1, and Paras. 0140, 0141, 0142, 0144, and 0146]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited catalyst in view of the teachings of Mills, for the purpose of optimizing the generation of heat from a desired fuel mixture.

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Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of:

Regarding claim 7, Coffey in view of Mills discloses the apparatus of claim 1. Coffey fails to explicitly disclose the apparatus, wherein said nickel powder has been treated to enhance porosity thereof. Mills teaches that it is known in the art to utilize a support for nickel powder catalyst in a fuel mixture, which would appear to enhance the porosity of the nickel powder [see Paras. 0164 and 0185 and 0188]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited nickel powder in view of the teachings of Mills, for the purpose of optimizing the generation of heat from the fuel mixture.

Regarding claim 8, Coffey in view of Mills discloses the apparatus of claim 1. Coffey fails to explicitly disclose the apparatus, wherein said catalyst comprises a group 10 element. Mills teaches that it is known in the art to include fuel mixture comprising group 10 element such as nickel in an apparatus for heating a fluid [see Fig. 1, and Paras. 0140, 0141, 0142, 0144, and 0146]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited catalyst in view of the teachings of Mills, for the purpose of optimizing the generation of heat from a desired fuel mixture.

Regarding claim 9, Coffey in view of Mills discloses the apparatus of claim 1. Coffey further discloses the apparatus, further comprising a voltage source in electrical communication with said ignition source [see Fig. 20 and Para. 0090].

Regarding claim 10, Coffey in view of Mills discloses the apparatus of claim 2. Coffey further discloses the apparatus, further comprising a voltage source in electrical communication with said ignition source [see Fig. 20 and Para. 0090].

Regarding claim 11, Coffey in view of Mills discloses the apparatus of claim 1. Coffey fails to explicitly disclose the apparatus, wherein said fuel wafer comprises a multi-layer structure having a layer of said fuel mixture in thermal communication with a layer containing said ignition source. Mills teaches that it is known in the art to utilize fuel mixture with a multi-layer structure containing a metal catalyst and support in an apparatus for heating a fluid [see Figs. 1 and 20, and Paras. 0144, 0185, and 188]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited multi-layer structure in view of the teachings of Mills, since where the general conditions of the claim are disclosed in the prior art, discovering the optimum or workable arrangement of fuel mixture and ignition source in the multi-layer structure involves only routine skill in the art, for the purpose of optimizing the generation of heat from a desired fuel mixture.

Regarding claim 12, Coffey in view of Mills discloses the apparatus of claim 2. Coffey fails to explicitly disclose the apparatus, wherein said fuel wafer comprises a multi-layer structure having a layer of said fuel mixture in thermal communication with a layer containing said ignition source. Mills teaches that it is known in the art to utilize fuel mixture with a multi-layer structure containing a metal catalyst and support in an apparatus for heating a fluid [see Fig. 1, and Paras. 0144, 0185, and 0188]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited multi-layer structure in view of the teachings of Mills, since where the general conditions of the claim are disclosed in the prior art, discovering the optimum or workable arrangement of fuel mixture and ignition source in the multi-layer structure involves only routine skill in the art, for the purpose of optimizing the generation of heat from a desired fuel mixture.

Regarding claim 13, Coffey discloses the apparatus of claim 1. Coffey fails to explicitly disclose the apparatus, wherein said fuel wafer comprises a central heating insert and a pair of fuel inserts disposed on either side of said heating insert. Coffey discloses that it is known in the art to utilize a central heating insert in a container filled with a fuel or solid state heating composition [see Fig. 14A, and Para. 0073]. Coffey further discloses the use of other geometries to define various path shapes, lengths, and thicknesses, and the use of different particle shapes, size, and ratios for the heating and reaction regulator elements [see Paras. 0072 and 0073]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited catalyst in view of the teachings of Mills, since where the general conditions of the claim are disclosed in the prior art, discovering the optimum or workable arrangement of the central heating and fuel inserts involves only routine skill in the art, for the purpose of optimizing the generation of heat from a desired fuel mixture.

Regarding claim 14, Coffey in view of Mills discloses the apparatus of claim 1. Coffey further discloses the apparatus, wherein said tank comprises a recess for receiving said fuel wafer therein [see Fig. 17, and Para. 0085].

Regarding claim 15, Coffey in view of Mills discloses the apparatus of claim 1. Coffey fails to explicitly disclose the apparatus, wherein said tank further comprises a door or safety seal for sealing said recess [see Fig. 17 and Para. 0085].

Regarding claim 16, Coffey in view of Mills discloses the apparatus of claim 1. Coffey fails to explicitly disclose the apparatus, wherein said tank comprises a radiation shield. It is submitted that the inert layers utilized in the tank of Coffey are considered indistinguishable from the recited radiation shield [see Fig. 13 and Para. 0075]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited radiation shield, for the purpose of preventing heat dissipation to the external surfaces of the tank.

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Supplemental Box

In case the space in any of the preceding boxes is not sufficient.
Continuation of:

Claims 30, 31, and 36 lack an inventive step under PCT Article 33(3) as being obvious over Mills in view of Hudson.

Regarding claim 30, Mills discloses the apparatus of claim 29. Mills fails to explicitly disclose the apparatus, wherein said catalyst that comprises a group 10 element and a reagent comprises lithium and lithium aluminum hydride, said apparatus further comprising means for periodically reinvigorating said reaction sequence. Hudson teaches that it is known in the art to include a catalyst comprising a group 10 element such as nickel and a reagent comprising lithium and lithium aluminum hydride in a fuel mixture [see Col. 2 Lns. 22-43 and Col. 4 Lns. 4-10]. It is submitted that the apparatus of Mills appears to include a reactor wherein reactants are continuously supplied and side products are continosly removed and regenerated and returned to the reactor, which would appear to reinvigorate the reaction sequence [see Para. 0147]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Mills by including the recited catalyst and means for periodicly reinvigorating the reaction sequence in view of the teachings of Hudson, for the purpose of optimizing the generation of heat from the fuel mixture.

Regarding claim 31, Mills discloses a composition of matter for generating heat, said composition comprising a mixture of nickel powder, lithium powder, and aluminum hydride powder [see Paras. 0141, 0142, 0144, and 0146]. Mills fails to explicitly disclose the compositon of matter for generating heat comprising a mixture of porosity enhanced nickel powder, lithium powder, and lithium aluminum powder. It is submitted that the supports utilized in the fuel mixture or composition of Mills would appear to enhance the porosity of the nickel powder [see Paras. 0146, 0164, 0185, and 0188]. Hudson teaches that it is known in the art to include a catalyst comprising a group 10 element such as nickel and a reagent comprising lithium and lithium aluminum hydride in a fuel mixture [see Col. 2 Lns. 22-43 and Col. 4 Lns. 4-10]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the composition of Mills by including the recited mixture in view of the teachings of Hudson, for the purpose of optimizing the generation of heat from a fuel mixture.

Regarding claim 36, Mills discloses a method of heating a fluid, said method comprising placing a mixture of nickel powder, lithium powder and aluminum hydride in thermal communication with said fluid [see Fig. 1, and Paras. 0140, 0141, 0142, 0144, and 0146]; and heating said mixture thereby initiating an exothermic reaction in said mixture [see Fig. 3, and Paras. 0157 and 0167]. Mills fails to explicitly disclose the method comprising placing a mixture of nickel powder, lithium powder and lithium aluminum hydride in thermal communication with said fluid. Hudson teaches that it is known in the art to utilize a mixture of nickel powder, lithium, and lithium aluminum hydride in a fuel mixture [see Col. 2 Lns. 22-43 and Col. 4 Lns. 4-10]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the method of Mills by including the recited mixture in view of the teachings of Hudson, for the purpose of optimizing the generation of heat from a fuel mixture.

Claim 3 lacks an inventive step under PCT Article 33(3) as being obvious over Coffey in view of Mills and Rohrbaugh et al. (hereafter Rohrbaugh)

Regarding claim 3, Coffey in view of Mills discloses the apparatus of claim 1. Coffey fails to explicitly disclose the apparatus, wherein said ignition source comprises an induction heater. Rohrbaugh teaches that it is known in the art to utilize an induction heater in a heating system for a metal strip [see Fig. 1 and Col. 3 Lns. 13-26]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited induction heater in view of the teachings of Rohrbaugh, for the purpose of providing heat for ignition of the fuel mixture.

Claim 4 lacks an inventive step under PCT Article 33(3) as being obvious over Coffey in view of Mills and C-nox GmbH & Co. KG (hereafter C-nox)

Regarding claim 4, Coffey in view of Mills discloses the apparatus of claim 1. Coffey fails to explicitly disclose the apparatus, wherein said ignition source obtains heat from combustion of natural gas. C-nox teaches that it is known in the art to obtain heat from combustion of natural gas and a electrical resistence heater, to provide a temperature required for a firing space [see Para. 0048]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited ignition source in view of the teachings of C-nox, for the purpose of providing heat for ignition of the fuel mixture.

Claim 5 lacks an inventive step under PCT Article 33(3) as being obvious over Coffey in view of Mills and Hudson.

Regarding claim 5, Coffery in view of Mills discloses the apparatus of claim 1. Mills fails to explicitly disclose the apparatus, wherein said wherein said fuel mixture comprises lithium and lithium aluminum hydride. Hudson teaches that it is known in the art to include a catalyst comprising lithium and lithium aluminum hydride in a fuel mixture [see Col. 2 Lns. 22-43]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited fuel mixture in view of the teachings of Hudson, for the purpose of optimizing the generation of heat from a desired fuel mixture.

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In case **the space in any of the preceding boxes is not sufficient.**
Continuation of:

Claims 17 and 18 lack an inventive step under PCT Article 33(3) as being obvious over Coffey in view of Mills and Layer et al. (hereafter Layer)

Regarding claim 17, Coffey in view of Mills discloses the apparatus of claim 1. Coffey fails to explicitly disclose the apparatus, further comprising a controller in communication with said voltage source. Layer teaches that it is known in the art to utilize a temperature controller for regulating heat produced by a resistive heater including a power or voltage source, to achieve a preselected temperature in a container for heating a fluid [see Paras. 0008, 0020, and 0021]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited controller in view of the teachings of Layer, for the purpose of regulating the generation of heat from a desired fuel mixture.

Regarding claim 18, Coffey in view of Mills discloses the apparatus of claim 17. Coffey fails to explicitly disclose the apparatus, wherein said controller is configured to cause vary said voltage in response to temperature of said fluid to be heated. Layer teaches that it is known in the art to utilize a temperature controller for regulating heat produced by a resistive heater including a power or voltage source, to achieve a preselected temperature in a container for heating a fluid [see Paras. 0008, 0020, and 0021]. It would have been obvious to one skilled in the art at the time the invention was made, to modify the apparatus of Coffey by including the recited controller in view of the teachings of Layer, for the purpose of regulating the voltage supplied to the resistive heater and the generation of heat from a desired fuel mixture.

Claims 19-28 meet the criteria set out in PCT Article 33(2)-(3) because the prior art does not teach or fairly suggest certain subject matter in the claims, as follows:

Regarding claim 19, the prior art of record, individually or in combination, does not teach or fairly suggest an apparatus of claim 2, wherein said tank is configured for holding fluid to be heated, wherein said fuel wafer is configured to be in thermal communication with said fluid, wherein said resistor is configured to be coupled to a voltage source, wherein said apparatus further comprises a controller in communication with said voltage source, and a temperature sensor, wherein said fuel mixture comprises lithium, and lithium aluminum hydride, wherein said catalyst comprises a group 10 element, wherein said controller is configured to monitor a temperature from said temperature sensor, and, based at least in part on said temperature, to reinvigorate a reaction in said fuel mixture, wherein reinvigorating said reaction comprises varying a voltage of said voltage source.

Claims 20-28 depend from base claim 19, and therefore meet the criteria set out in PCT Article 33(2)-(3) for at least the same reasons as does base claim 19.

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Supplemental Box

In case **the space in any of the preceding boxes is not sufficient.**
Continuation of:

The following prior art is made of record to support and further define the reasons for meeting the criteria set out in PCT Article 33(2)-(3) for base claim 19:

(i) Regarding claim 19, Coffey discloses an apparatus for heating fluid, said apparatus comprising a tank for holding fluid to be heated, and a fuel wafer in fluid communication with said fluid, said fuel wafer including a fuel mixture including reagents or reactant powders, and an ignition source in thermal communication with said fuel mixture and said catalyst, wherein the ignition source is selected from the group consisting of an electrical resistor [see Figs. 12, 17, and 20, and Paras. 0007, 0072, 0085 and 0090]. Mills teaches that it is known in the art to include fuel mixture comprising reagents and a catalyst in an apparatus for heating a fluid [see Fig. 1, and Paras. 0140, 0141, 0142, 0144, and 0146]. Layer teaches that it is known in the art to utilize a temperature controller for regulating heat produced by a resistive heater including a power or voltage source, to achieve a preselected temperature in a container for heating a fluid [see Paras. 0008, 0020, and 0021]. Hudson teaches that it is known in the art to include a catalyst comprising a group 10 element such as nickel and a reagent comprising lithium and lithium aluminum hydride in a fuel mixture [see Col. 2 Lns. 22-43 and Col. 4 Lns. 4-10]. Coffey does not teach, either alone or in combination with the prior art of record, the apparatus of claim 2, wherein said tank is configured for holding fluid to be heated, wherein said fuel wafer is configured to be in thermal communication with said fluid, wherein said resistor is configured to be coupled to a voltage source, wherein said apparatus further comprises a controller in communication with said voltage source, and a temperature sensor, wherein said fuel mixture comprises lithium, and lithium aluminum hydride, wherein said catalyst comprises a group 10 element, wherein said controller is configured to monitor a temperature from said temperature sensor, and, based at least in part on said temperature, to reinvigorate a reaction in said fuel mixture, wherein reinvigorating said reaction comprises varying a voltage of said voltage source.

Claims 1-36 meet the criteria set out in PCT Article 33(4), and thus have industrial applicability because the subject matter claimed can be made or used in industry.

EXHIBIT 3

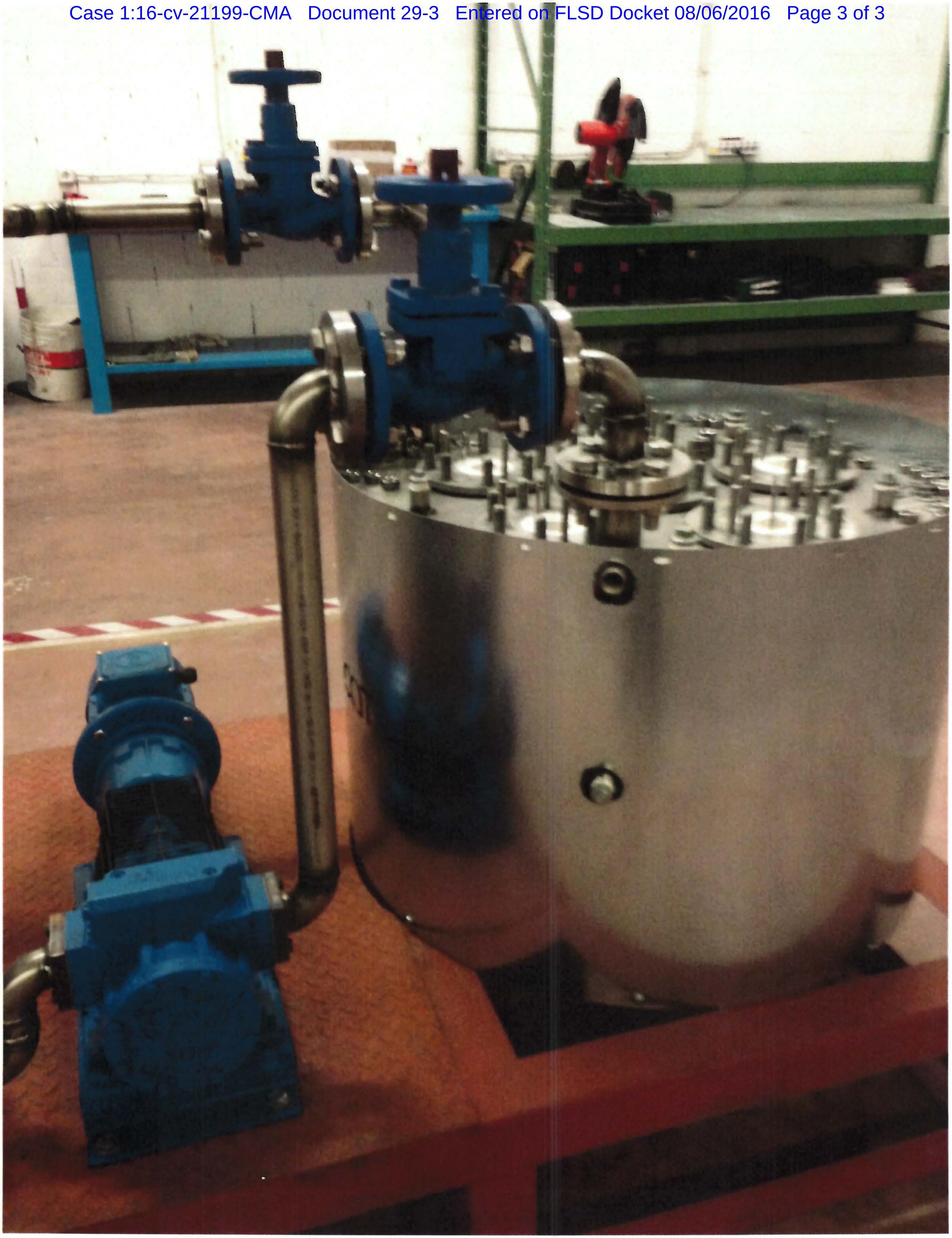

EXHIBIT 4

Now, at 08.16 a.m. of Wednesday Sept 16 the 1 MW E-Cat is stable; the E-Cat X is resisting at very promising levels, but we have to wait to know if we reached the necessary reliability.

September 13, 2015 (Day 202)

Right now it is 11.59 p.m. inside the computers container: we have just finished an important reparation to a reactor. The 1 MW is working at 3/4 of its power in this moment, but we are confident it will recover soon.

The E-Cat X continues to be very promising and extremely interesting. Now it seems much more robust and we'll see what will happen next…

September 10, 2015 (Day 202)

All right, let's put down at work: now, at 09.13 p.m. of Sept 10 I am inside the computers container, looking at the cover of ribbon of the USPTO, while the plant is well and stable.

September 7, 2015 (Day 199)

Now at 10.30 a.m. of Monday September 07 (Labor Day in the USA: greetings to all the workers of the USA!) the situation is: 1 MW E-Cat: stable and well, all data normal E-Cat X: is in operation.

September 5, 2015 (Day 197)

Now, at 08.20 a.m. of Saturday September 5th, the 1 MW plant is working well and stable but at 3/4 of its power, because we are making maintainance to a

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reactor. The "voice" is good, we are relatively calm.

September 3, 2015 (Day 195)

Today Sept 03 at10 a.m.: E-Cat X in preparation, should start Sunday. 1 MW E-Cat stable.

September 2, 2015 (Day 194)

Now, at 07.53 p.m. inside the 1 MW plant the situation is normal; the E-Cat X is still in construction. I am working on new patents.

September 1, 2015 (Day 193)

Right now in the plant it's 10.05 p.m. of September 1. The 1 MW E-Cat is working at 3/4 of the power because we have problems in one reactor, The other 3 reactors are stable and well.

August 28, 2015 (Day 189)

Today, at 09.10 a.m. of Friday Aug 28th, the 1MW E-Cat is stable, the E-Cat X is in construction. No troubles, so far.

August 22, 2015 (Day 183)

Now it's 08.05 p.m. inside the plant, it is working stable: I am working here with my great Team. The E-Cat X is in re-construction and I am convinced we have resolved the problem. If God wants, we should be close …it is very promising.

August 18, 2015 (Day 179)

EXHIBIT 5

INITIAL QUERIES FOR M. ENG. FABIO PENON AS TO MEASUREMENTS OF 1 MW PLANT (at 7861 NW 46th Street, Doral, Florida; February 16-17, 2016)

M. Eng. Fabio Penon:

I wanted to raise with you, and I was hoping you would address, several issues that surfaced during the time we were in Doral at the location of the 1 MW Plant. This is not an exhaustive list of the issues I identified or that we discussed, but they do represent some of the more glaring concerns that were identified.

1. The flow meter used.

The turbine flow meter used for your measurements was manufactured by Apator PoWoGaz. The model number is MWN130-80-NC.

The Apator PoWoGaz's device label clearly states that the unit has a minimum operational flow rate of 1.6 m^3/hour. That is a minimum of 38.4 m^3/day. Using 977.8 kg/m^3 as the density of water at 70º C, the minimum operational mass flow rate measurable with this sensor is 37,548 kg/day. With few exceptions, your daily valuation reports reflect a flow rate clearly below this level. How can the measurements of the flow meter be valid when they are consistently below the minimum operating value?

The flow meter requires that the entire pipe volume be full of liquid to function properly, as described in the Apator PoWoGaz Operating Instructions [section 6.6 in document I-EN-2-003/2013, Operating Instructions, Flange water meters DN40 - 500]. The visible iron stain waterline marks on the static vanes indicate that the pipe was not continuously full of liquid, as required by the manufacturer's specifications, but rather had a substantial portion free of liquid. *See Exhibit A*. How can the measurements of the flow meter be valid when the pipe volume was far less than full?

2. The consistency of the reported flow rate statistics.

At different points in time during the assumed 350 operational days of the "test" you were measuring, a number of the reactors were turned off (apparently for repair). At even more points in time, different units within the reactors were either turned off or simply disabled. Yet there does not appear to be any impact on the mass flow rate in the system. How is that a credible outcome?

In fact, from June 30, 2015 through July 27, 2015, the effective flowed water in the unit was, according to your daily valuation report for that period, *36,000 Kg/d on each and every day*, without deviation. *See Exhibit B*. How is that plausible? It should be virtually impossible to have that level of consistency even over just a one-week period, let alone a one-month period.

3. The number of reactor units in operation varied substantially over time.

As discussed on February 16, 2016 while at the location, 21 of the 64 units in the 4 large reactors had clearly been disabled, leaving only 43 of those 64 units that may have been operational. Also, all 51 of the smaller units were disabled. *See Exhibit C* (examples).

Similarly, at the time you completed the "MW1-USA electrical measurement" chart on October 13, 2015, out of operation were all 51 of the smaller units, one of the large reactors (containing 16 units), and 17 of the 48 units in the remaining 3 large reactors. That means only 31 units were operational. In contrast, according to your February 2015 report, 111 units were operational at the beginning of the "test."

Your reports do not account for these substantial variations. There is no explanation as to how the energy output at times increased or stayed constant during periods when a substantial number of the units were inoperable and/or the average power supply into the system was decreased. There is also no explanation as to how other variables, such as the flow rate, were not impacted in an expected manner by changes in the number of operating units.

4. System alterations on the night of February 16 or the morning of February 17.

As reflected in the images shown in the last two exhibits, the system was altered after you and we left the location on February 16. The water level in the reservoir tank is clearly different as between (a) late in the afternoon of February 16, after you had instructed that the system be shut down, and (b) on the morning of February 17, when you continued to conduct your measurements and you collected your measurement equipment. *See Exhibit D*. Also, the pump water lines in the reactor compartment contained biofoul in the lines on the afternoon of February 16, but those lines were flushed sometime thereafter and were clean as of the morning of February 17. *See Exhibit E*. How can you opine as to your measurements of the system when the environment was altered during your measurement period?

5. The flow of steam through the pipe to J.M. Products.

You stated that the pressure of the steam that was available to J.M. Products (JMP) was nominally atmospheric pressure (0 kilo Pascals gauge (kPaG) or 14.7 psia). The steam passed through a stretch of insulated pipe that was at least 6 meters long before entering the JMP space. (Presumably there was additional steam pipe on the JMP side.) According to the data you have reported, the conserved mass flow rate of the system from February to November 2015 was on average 33,558 kg/day (1398 kg/h) and the temperature of the water and steam were on average 68.7º C and 102.8º C, respectively. The steam pressure was reported (for the entire period) to be 0 kPaG and the piping is DN40.

For steam to flow, a pressure differential is required to overcome the losses in the pipe. Given the foregoing, this would require that the pressure on the JMP side of the building was significantly below atmospheric (vacuum) and that the steam would flow at extraordinary velocity. But this was obviously not the situation present at the location.

Given your reported measurements, how do you account for the lack of an adequate pressure differential to provide for the flow of steam?

* * * * *

As I noted above, the questions above are not all of the questions I have from my visit to the 1 MW Plant location, but if you can address these, it would be a good start to me better understanding what you were measuring and how you were measuring it in connection with the 1 MW Plant. (Just to be clear, I am not asking you, and I do not plan to ask you, about the license agreement or whether you are an ERV under the agreement. I am trying to focus just on the test and its measurement.)

EXHIBIT 6

United States Patent and Provisional Patent Applications

US 12/736,193

US 13/420,109

US 14/262,740

US 61/818,553

US 61/819,058

US 61/821,914

US 62/060,215

Patent Cooperation Treaty Applications

PCT/US14/35588

PCT/US15/42353

PCT/IT2008/000532

Foreign Applications

Italian Patent App. No. MI2008A0629

European Patent App. No. EP 08873805.9

EXHIBIT 7

ASSIGNMENT AND ASSUMPTION OF LICENSE AGREEMENT

THIS ASSIGNMENT AND ASSUMPTION OF LICENSE AGREEMENT (this "Assignment") is made effective as of April 29, 2013, by and between **INDUSTRIAL HEAT, LLC**, a Delaware limited liability company (the "Assignor"), and **IPH INTERNATIONAL BV**, a Netherlands company (the "Assignee").

WHEREAS, the Assignor, LEONARDO CORPORATION, ANDREA ROSSI, and AMPENERGO, INC., entered into that certain License Agreement dated as of October 26, 2012, as amended by that certain First Amendment to License Agreement dated as of April 26, 2013 (as amended, the "Agreement");

WHEREAS, the Assignor desires to assign the Agreement to the Assignee and the Assignee desires to accept such assignment and to assume all obligations of the Assignor under the Agreement;

WHEREAS, the Assignee is, indirectly, a wholly-owned subsidiary of the Assignor and Section 16.7 of the Agreement permits the assignment as provided herein;

NOW, THEREFORE, in consideration of the above premises, and other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the parties agree as follows:

1. Recitals and Exhibits. The Recitals set forth above are material and are incorporated into and made a part of this Assignment.

2. Assignment. The Assignor hereby transfers and assigns to the Assignee all right, title and interest of the Assignor in and to the Agreement.

3. Acceptance and Assumption. The Assignee hereby accepts the assignment of the Agreement and assumes all of Assignor's obligations under the Agreement.

4. Binding Effect. This Assignment shall inure to the benefit of, and be binding on, each of the parties hereto and their respective successors and assigns. This Assignment represents the entire agreement of the parties with respect to the subject matter hereof.

5. Counterparts. This Assignment may be executed in any number of counterparts, each of which shall be deemed an original but all of which together shall constitute one and the same instrument.

6. Governing Law. This Assignment and any claim, controversy or dispute arising under or related to this Assignment shall be governed by and construed in accordance with the laws of the State of Florida.

7. Further Assurances.

A. Assignor hereby agrees to provide to the Assignee such further assurances as may be reasonably requested by the Assignee at any time from and after the date hereof with respect to the Agreement and the assignment thereof to Assignee as provided herein, and, without limiting the foregoing, shall execute and deliver such affidavits, certificates and other instruments with respect to the Agreement as may be reasonably requested by the Assignee.

B. The Assignee hereby agrees to provide to Assignor such further assurances as may be reasonably requested by the Assignor at any time from and after the date hereof with respect to the Agreement and the assignment thereof to Assignee as provided herein, and, without limiting the foregoing, shall execute and deliver such affidavits, certificates and other instruments with respect to the Agreement as may be reasonably requested by the Assignor.

IN WITNESS WHEREOF, the Assignor and the Assignee have executed this Assignment effective the day and year first above written.

ASSIGNOR:

Industrial Heat, LLC

By: ______________________
Thomas F. Darden
Manager

ASSIGNEE:

IPH International BV

By: IPH Management, LLC, Managing Director

By: ______________________
Title: MANAGER

EXHIBIT 8

CERTIFICATE

The undersigned, **LEONARDO CORPORATION**, a New Hampshire corporation ("Leonardo"), and **ANDREA ROSSI** ("Rossi") each hereby certifies to **IPH INTERNATIONAL, B.V.**, an entity organized under the laws of The Netherlands (the "Company"), that the representations and warranties of Leonardo and Rossi contained in the License Agreement dated October 26, 2012, by and between Leonardo, Rossi, Industrial Heat, LLC and AmpEnergo, Inc., as amended (the "Agreement"), based on a current review of such representations and warranties, are true and correct as of the date of this Certificate, as if made on the date hereof, and further, that such representations and warranties will remain true and correct on and as of the date US $10,000,000 is delivered to the Escrow Agent as provided in Section 3.2(b) of the Agreement. Capitalized terms used herein without definition shall have the meanings given them in the Agreement.

IN WITNESS WHEREOF, the undersigned has caused this certificate to be executed as of this 29th day of April, 2013.

LEONARDO CORPORATION

By: ANDREA ROSSI

Name: [signature]

Title: CEO AND PRESIDENT

ROSSI

[signature]

Andrea Rossi

EXHIBIT 9

>------Original Message------
>From: eon3333@tiscali.it
>To: Thomas F. Darden
>To: JT Vaughn
>ReplyTo: eon3333@tiscali.it
>Subject: To Tom Darden
>Sent: Apr 23, 2013 10:23 AM
>
>----Messaggio originale----
>Da: eon333@libero.it
>Data: 23/04/2013
>12.11
>A: <eon3333@tiscali.it>
>Ogg: Andrea Rossi
>
>Dear All,1- Next
>Friday April 26 I will receive the report: as agreed with the 3rd
>Indipendent Party I am entitled to read it before the pending
>publication, even if I have not the right to ask for modification (
>that had been foreseen because in case of a negative result I would
>have needed the time to organize a defense). The report is very good, I
>got confirmation. It will be registered and deposited in the Library of
>the Swedish Academy of Science Friday 26, pending the publicationin a
>scientific magazine in May. Is an official document. I think it will
>help ypour Investors.
>2- This morning I had a meeting with the Health
>Office of the Province of Ferrara, which has to authorize the 24 hours
>test (it is unthinkable to make it without authorization, we could be
>stopped by the police upon a phone call due to the noise of the air
>escape of the condensers, because we must dissipate the energy not
>having any possible utilization for it).We found an acceptable
>solution.He explained to me that the Italian law "DPR (Decreto del
>Presidente della Repubblica) # 551- Dec. 21 1999 requests an
>authorization for any plant that makes more than 35 kWh/h and this
>authorization takes at least 6 months. But we are advantaged, because
>LENR do not exist in the known technology, therefore when we say 35 kWh
>we say kWh consumed, because plants that produce more than the energy
>they consume "do not exist".Now, 35 x 6 = 210 kWTherefore if we can
>consume up to 35 kWh/h without authorization, this implies that in out
>LENR case I can produce up to 210 kWh/h, which is a consistent amount

>of energy. I will steal something (maybe the COP will be more). In
>this case we do not need any authorization and the amount of power is
>relevant and respects the fact to be consistent, as requested in the
>Agreement. Same thing for the Hot Cats. I will activate only 1/4 of
>the reactors, and I think it will not be a problem, since if 1/4 of the
>reactors work, there is no reason that the other won't work (unless
>they have mechanical things to repair, but the issue is not there).
>
>Warmest Regards,Andrea
>
>
>

>

EXHIBIT 10

Indication of anomalous heat energy production in a reactor device containing hydrogen loaded nickel powder.

Giuseppe Levi
Bologna University, Bologna, Italy

Evelyn Foschi
Bologna, Italy

Torbjörn Hartman, Bo Höistad, Roland Pettersson and Lars Tegnér
Uppsala University, Uppsala, Sweden

Hanno Essén
Royal Institute of Technology, Stockholm, Sweden

ABSTRACT

An experimental investigation of possible anomalous heat production in a special type of reactor tube named *E-Cat HT* is carried out. The reactor tube is charged with a small amount of hydrogen loaded nickel powder plus some additives. The reaction is primarily initiated by heat from resistor coils inside the reactor tube. Measurement of the produced heat was performed with high-resolution thermal imaging cameras, recording data every second from the hot reactor tube. The measurements of electrical power input were performed with a large bandwidth three-phase power analyzer. Data were collected in two experimental runs lasting 96 and 116 hours, respectively. An anomalous heat production was indicated in both experiments.
The 116-hour experiment also included a calibration of the experimental set-up without the active charge present in the *E-Cat HT*. In this case, no extra heat was generated beyond the expected heat from the electric input.
Computed volumetric and gravimetric energy densities were found to be far above those of any known chemical source. Even by the most conservative assumptions as to the errors in the measurements, the result is still one order of magnitude greater than conventional energy sources.

INTRODUCTION

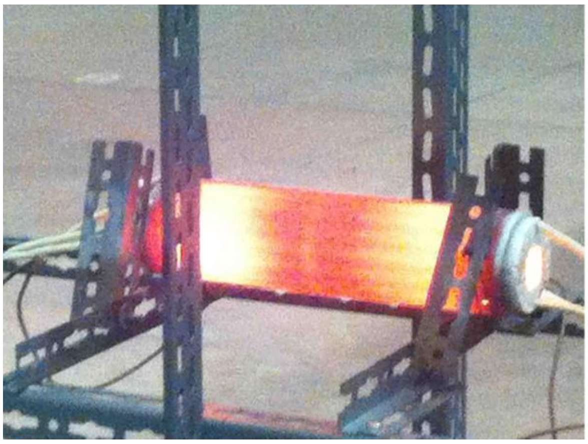
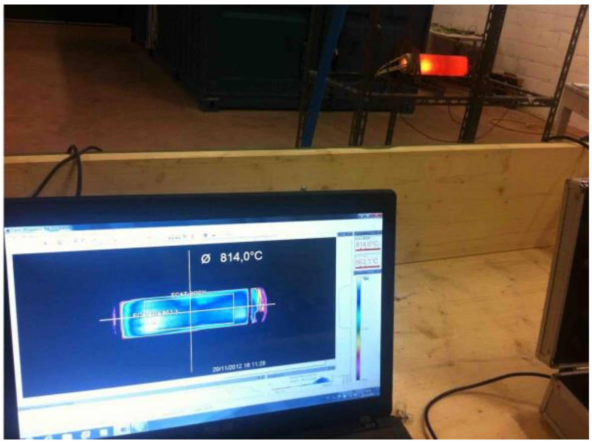
Andrea Rossi claims to have invented an apparatus that can produce much more energy per unit weight of fuel than can be obtained from known chemical processes. His invention is referred to as an energy catalyzer named *E-Cat HT*, where *HT* stands for high temperature. The original idea behind Rossi's invention goes back to experiments done in the nineties by Sergio Focardi at Bologna University and collaborators, in which they claimed to have observed an anomalous heat production in a hydrogen-loaded nickel rod [1-2]. Later, an experiment [3] was carried out by S. Focardi and A. Rossi using an apparatus with a sealed container holding nickel powder plus unknown additives pressurized with hydrogen gas. When the container was heated, substantial heat was produced in excess of the input heat. They speculated that a "low energy nuclear reaction" had taken place in order to explain the large amount of excess heat. The *E-Cat HT* – a further, high temperature development of the original apparatus which has also undergone many construction changes in the last two years – is the latest product manufactured by Leonardo Corporation: it is a device allegedly capable of producing heat from some type of reaction the origin of which is unknown.
As in the original E-Cat, the reaction is fueled by a mixture of nickel, hydrogen, and a catalyst, which is kept as an industrial trade secret. The charge sets off the production of thermal energy after having been activated by heat produced by a set of resistor coils located inside the reactor. Once operating temperature is reached, it is possible to control the reaction by regulating the power to the coils.
The scope of the present work is to make an independent test of the *E-Cat HT* reactor under controlled conditions and with high precision instrumentation. It should be emphasized that

the measurement must be performed with high accuracy and reliability, so that any possible excess heat production can be established beyond any doubt, as no known processes exist which can explain any abundant heat production in the E-Cat reactor.

The present report describes the results obtained from evaluations of the operation of the *E-Cat HT* in two test runs. The first test experiment, lasting 96 hours (from Dec. 13th 2012, to Dec. 17th 2012), was carried out by the two first authors of this paper, Levi and Foschi, while the second experiment, lasting for 116 hours (from March 18th 2013, to March 23rd 2013), was carried out by all authors. Both experiments were performed on the premises of EFA Srl, Via del Commercio 34-36, Ferrara (Italy).

The tests held in December 2012 and March 2013 are in fact subsequent to a previous attempt in November 2012 to make accurate measurements on a similar model of the *E-Cat HT* on the same premises. In that experiment the device was destroyed in the course of the experimental run, when the steel cylinder containing the active charge overheated and melted. The partial data gathered before the failure, however, yielded interesting results which warranted further in-depth investigation in future tests. Although the run was not successful as far as obtaining complete data is concerned, it was fruitful in that it demonstrated a huge production of excess heat, which however could not be quantified. The device used had similar, but not identical, features to those of the *E-Cat HT* used in the December and March runs.
Besides some minor geometrical differences, in the *E-Cat HT* used for the November test the charge in the inner cylinder was not evenly distributed, but concentrated in two distinct locations along the central axis. In addition, the primer resistor coils were run at about 1 kW, which might be the cause of the ensuing device failure. For these reasons, a more prudent reactor design was chosen for the test held in December and March, by distributing the charge evenly along its container cylinder, and limiting the power input to the reactor to 360 W.

Since the test in November shows some interesting features, we shall describe some of the results from this test in some detail before discussing, in the subsequent sections, the results from the December and March runs. Figures 1 and 2 refer to the November test, and show, respectively, the device while in operation, and a laptop computer capturing data from a thermographic camera focused on it. An Optris IR camera monitored surface temperature trends, and yielded results of approximately 860°C in the hottest areas.

Figs. 1-2. Two images from the test performed on Nov. 20th 2012. Here, the activation of the charge (distributed laterally in the reactor) is especially obvious. The darker lines in the photograph are actually the shadows of the resistor coils, which yield only a minimal part of the total thermal power. The performance of this device was such that the reactor was destroyed, melting the internal steel cylinder and the surrounding ceramic layers. The long-term trials analyzed in the present report were purposely performed at a lower temperatures for safety reasons.

Fig. 3 shows a thermal video frame from the IR camera: the temperature of 859°C refers to Area 2 (delimited by the “cross hairs”), whereas the average temperature recorded for the body of the device, relevant to the rectangle indicated as Area 1, is 793°C.

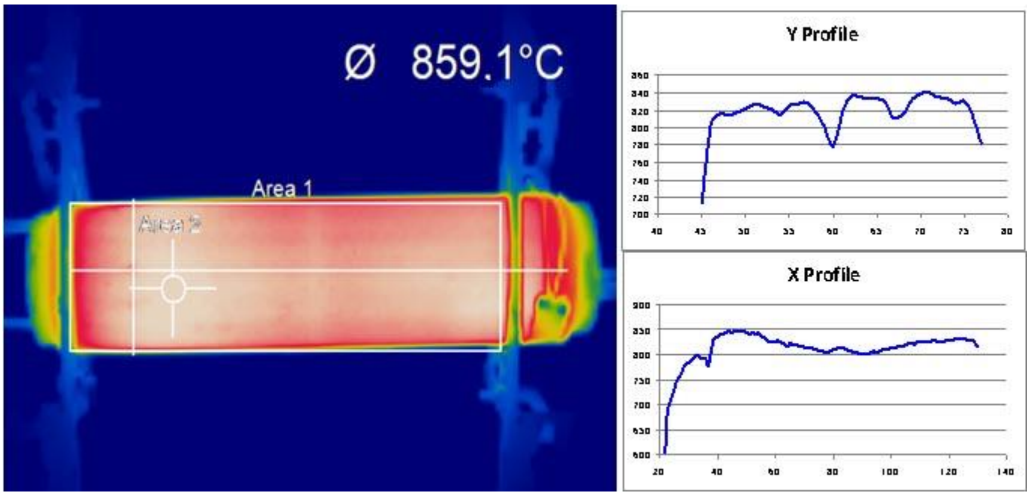


Fig. 3. Thermal image of the November test device. The temperature of 859°C refers to the area within the circle of the mark (Area 2). The graphs on right show the temperature trends along the horizontal line traversing the device (X Profile), and along the vertical line on the left of the image (Y Profile).

Graphs on the right side of fig. 3 show the temperature distribution monitored along the two visible lines in the image: the X Profile refers to the horizontal line traversing the whole device, the Y Profile shows the temperature along the vertical line located on the left side of the thermal image. This latter distribution allows one to reach some interesting conclusions.

If one relates the length of the vertical line (32 pixels) to the diameter of the device (11 cm), one may infer that each pixel in the image corresponds to a length of approximately 0.34 cm on the device (with some approximation, due to the fact that the thermal image is a two-dimensional projection of a cylindrical object). The thermal image shows a series of stripe-like, darker horizontal lines, which are confirmed by the five temperature dips in the Y Profile. This means that, in the device image, a darker line appears every 6.4 pixels approximately, corresponding to 2.2 cm on the device itself. As mentioned previously, the *E-Cat HT* needs resistor coils in order to work; these are set horizontally, parallel to and equidistant from the cylinder axis, and extend throughout the whole length of the device. By dividing the circumference of the base of the cylinder by the number of coils, one may infer that the 16 resistor coils in this device were laid out at a distance of 2.17 cm. one from the other. And, by comparing the distance between darker stripes and the distance between coils, one may reach the conclusion that the lower temperatures picked up by the thermal camera nicely match the areas overlying the resistor coils. In other words, the temperature dips visible in the diagram are actually shadows of the resistor coils, projected on the camera lens by a source of energy located further inside the device, and of higher intensity as compared to the energy emitted by the coils themselves.

PART 1: THE DECEMBER TEST

Device and experimental set-up

The *E-Cat HT*-type device in this experiment was a cylinder having a silicon nitride ceramic outer shell, 33 cm in length, and 10 cm in diameter. A second cylinder made of a different ceramic material (corundum) was located within the shell, and housed three delta-connected spiral-wire resistor coils. Resistors were laid out horizontally, parallel to and equidistant from the cylinder axis, and were as long as the cylinder itself. They were fed by a TRIAC power regulator device which interrupted each phase periodically, in order to modulate power input with an industrial trade secret waveform. This procedure, needed to properly activate the *E-Cat HT* charge, had no

bearing whatsoever on the power consumption of the device, which remained constant throughout the test. The most important element of the *E-Cat HT* was lodged inside the structure. It consisted of an AISI 310 steel cylinder, 3 mm thick and 33 mm in diameter, housing the powder charges. Two AISI 316 steel cone-shaped caps were hot-hammered in the cylinder, sealing it hermetically. Cap adherence was obtained by exploiting the higher thermal expansion coefficient of AISI 316 with respect to AISI 310 steel.
Finally, the outermost shell was coated by a special aeronautical-industry grade black paint capable of withstanding temperatures up to 1200°C.
It was not possible to evaluate the weight of the internal steel cylinder or of the caps because the *E-Cat HT* was already running when the test began. Weighing operations were therefore performed on another perfectly similar device present on the premises, comparing a cap-sealed cylinder containing the active charge with another identical cylinder, empty and without caps. The difference in weight obtained is 0.236 kg: this is therefore to be assigned to the charge loaded into the *E-Cat HT* and to the weight (not subtracted in the present test) of the two metal caps.
In the course of the test, the *E-Cat HT* was placed on a metal frame and allowed to freely radiate to the surrounding air. The contact points between the device and the frame were reduced to the minimum necessary for mechanical stability; room temperature was constantly measured by means of a heat probe, and averaged 15.7°C (= 289 K).
The instruments used to acquire experimental data were at all times active for the entire 96 hours of the test, and consisted of an IR thermography camera to measure the *E-Cat HT*'s surface temperature, and a wide band-pass power quality monitor measuring the electrical quantities on each of the three phases, to record the power absorbed by the resistor coils.

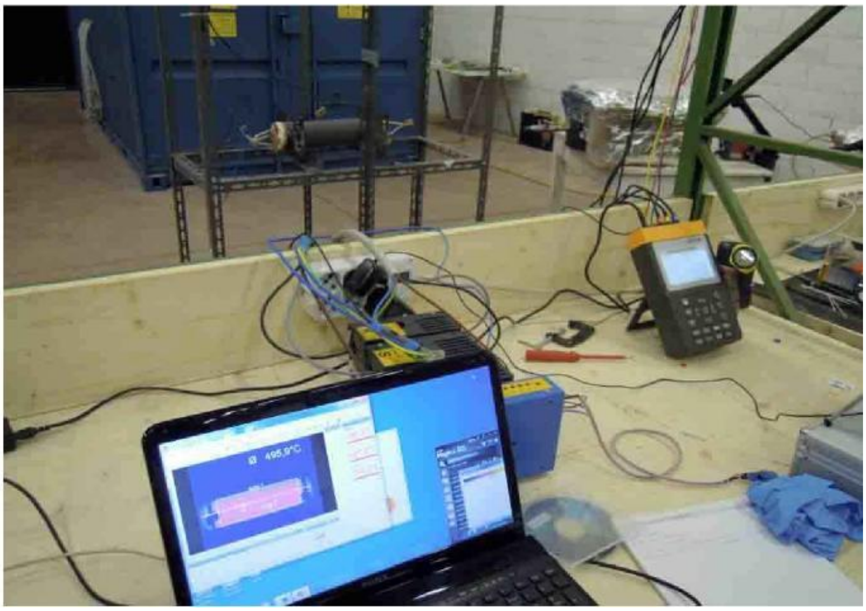


Fig. 4. Instrumentation set-up for measurements. Foreground: thermal image capture. On right: instrument used for electrical measurements. Background: the E-Cat HT *on its support frame; the IR camera is not visible here.*

The thermal camera used was an Optris PI 160 Thermal Imager with 30° × 23° lens, and UFPA 160 × 120 pixel sensors. The camera spectral interval is from 7.5 to 13 µm, with a precision of 2% of measured value. The camera was fastened to the frame of the *E-Cat HT*, and positioned about 70 cm from the device, with lens facing the lower half of the cylinder. All imaging was thus taken from below the apparatus, in order not to damage the lens from the heat transferred by rising convective air currents. This choice, however, had a negative impact on the measurements: the presence of the two metal props on the stationary image shot by the camera introduced a degree of uncertainty in the measurements, as will be explained in detail below.Camera capture rate was set at 1 Hz, and the image, visualized on a laptop display, was open to analysis throughout the course of the test.

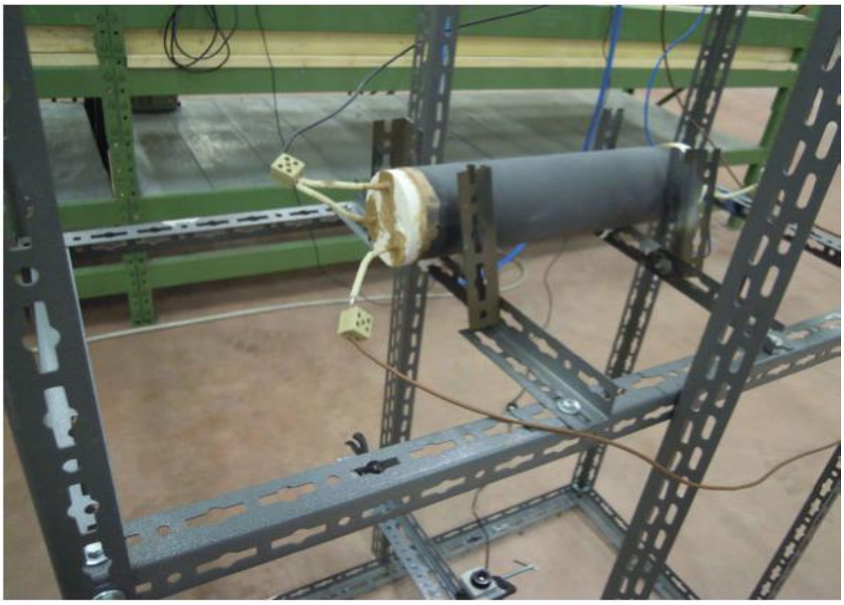


Fig. 5. E-Cat HT *on support frame. The power cables to the internal resistor coils are visible, as well as the IR camera in the lower part of the photograph.*

Electrical measurements were performed by a PCE-830 Power and Harmonics Analyzer by PCE Instruments with a nominal accuracy of 1%. This instrument continuously monitors on an LCD display the values of instantaneous electrical power (active, reactive, and apparent) supplied to the resistor coils, as well as energy consumption expressed in kWh.
Of these parameters, only the last one was of interest for the purposes of the test, which was designed to evaluate the ratio of thermal energy produced by the *E-Cat HT* to electrical power consumption for the number of hours subject to evaluation. The instrument was connected directly to the *E-Cat HT* cables by means of three clamp ammeters, and three probes for voltage measurement.
A wristwatch was placed next to the wattmeter, and a video camera was set up on a tripod and focused on both objects: at one frame per second, the entire sequence of minutes and power consumption were filmed and recorded for the 96-hour duration of the test.

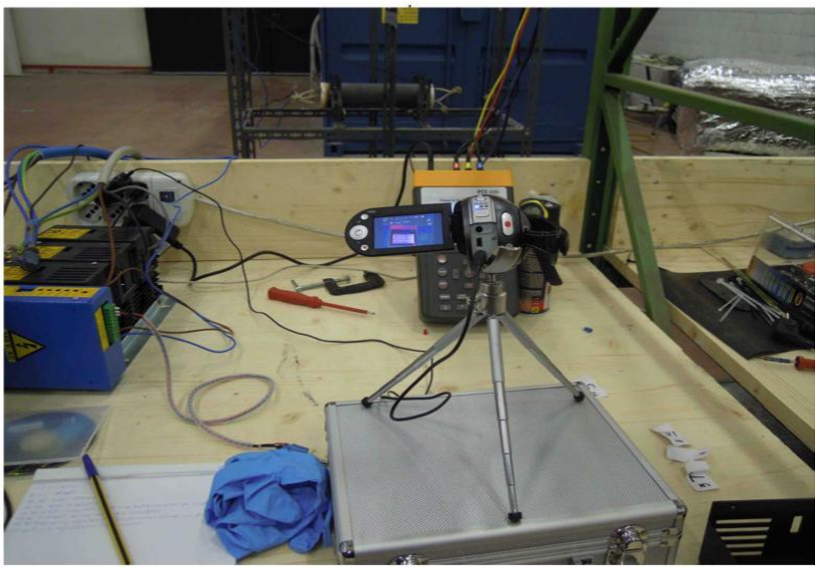


Fig. 6. The video camera on its tripod framing the display used for electrical measurements (PCE-830), and recording at 1 frame p.s. for the whole duration of the test.

Besides the set-up required for the measurements, instruments necessary for detecting possible radioactive emissions were also placed in the vicinity of the *E-Cat HT*. These measurements are essential for safety certification of the device, and were performed by David Bianchini. The full report of the methods and results of these measurements is available on demand. A partial quotation follows:
"*It was decided to use two different wide-spectrum and high-sensitivity photon detectors: the first detector was chosen for the purpose of measuring in the spatial surroundings any rate variation of ambient dose equivalent H * (10) [...], the second detector was chosen for measuring and recording CPM (counts per minute) rate variations in a specific position [...]. With respect to instrumental and ambient background, the measurements performed do not reveal significant differences either in H*(10) or CPM ascribable to the E-Cat prototype*".

Data analysis
Upon conclusion of the test, the recordings from the video camera were examined. By reading the images reproducing the PCE-830's LCD display at regular intervals, it was possible to make a note of the number of kWh absorbed by the resistor coils. Subsequently, the *E-Cat HT's* average hourly power consumption was calculated, and determined to be = 360 W.
As far as the evaluation of the energy produced by the *E-Cat HT* is concerned, two dominant components must be taken into account, the first being emission by radiation, the second the dispersion of heat to the environment by means of convection.
Heat transfer by conduction was deemed to be negligible, due to of the minimal surface of contact (not more than a few mm^2) between the device and its supports, and to the fiberglass insulation material placed at the contact points. This material, however, partially obscured the image of the *E-Cat HT*'s surface.
Energy emitted by radiation was calculated by means of Stefan-Boltzmann's formula, which allows to evaluate the heat emitted by a body when its surface temperature is known.
Surface temperature was measured by analyzing the images acquired by the IR camera, after dividing the images into multiple areas, and extracting the average temperature value associated to each area.
Conservatively, surface emissivity during measurements was set to 1, i.e. the temperature values recorded are consequently lower than real, as will be explained below.
The calculation of energy loss by convection from objects of cylindrical shape placed in air has been presented many times in academic papers that address issues related to heat transfer (see for example [4,5]). It was therefore possible to estimate the amount of heat transferred by the *ECat HT* to the surrounding air in the course of the test.
The thermal performance of the *E-Cat HT* was finally obtained as the ratio between the total energy emitted by the device and the energy dissipated by its resistor coils.

Calculating the power emitted by radiation
Planck's Law expresses how the monochromatic emissive power of a black body varies as a function of its absolute temperature and wavelength; integrating this over the whole spectrum of frequencies, one obtains the total emissive power (per unit area) of a black body, through what is known as Stefan-Boltzmann's Law:

$$M=\sigma T^4 \ [W/m^2] \qquad (1)$$

where σ indicates Stefan-Boltzmann's constant, equal to $5.67 \cdot 10^{-8}$ $[W/m^2K^4]$.
In the case of real surfaces, one must also take emissivity (ε) into account. ε expresses the ratio between the energy emitted from the real surface, and that which would be emitted by a black body having the same temperature. The formula then becomes:

$$M=\varepsilon\sigma T^4 \ [W/m^2] \qquad (2)$$

where ε may vary between 0 and 1, the latter value being the one assumed for a black body. As it was not possible to measure the emissivity of the coating used in this analysis, it was decided to conservatively assume a value of ε = 1, thereby considering the *E-Cat HT* as equivalent to a black body. This value was then input in the thermal imagery software, which allows the user to modify some of the parameters, such as ambient temperature and emissivity, even after having completed the recordings. The camera software then uses the new settings to recalculate the temperature values assigned to the recorded images. It was therefore possible to determine the *E-Cat HT*'s emitted thermal power on the basis of surface temperature values that were never overestimated with respect to actual ones.

The veracity of this statement may be proven by an example where we see what happens when one assigns a value lower than 1 to ε: in fig. 7, the thermal image of the *E-Cat HT* has been divided into 40 areas. Emissivity has been set to = 1 everywhere, except in two areas (Nos. 18 and 20), where it is set to 0.8 and 0.95, respectively. The temperature which the IR camera assigns to the two areas is 564.1°C and 511.7°C, respectively – these values being much higher than those of the adjacent areas.

It is therefore obvious that by assigning a value of 1 to ε in to every area, we are in fact performing a conservative measurement: this is a necessary precaution, given the lack of information on the real emissivity value of the *E-Cat HT*.

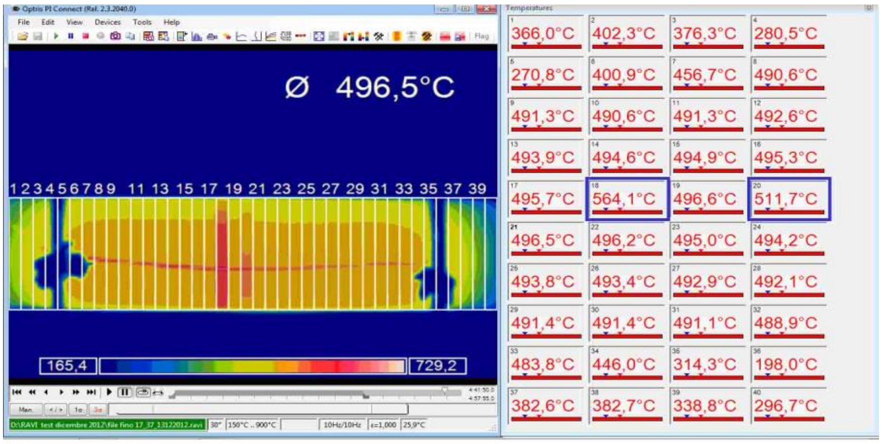


Fig. 7. This image exemplifies the effect of emissivity on the determination of temperatures. The E-Cat HT has been divided in 40 areas; in areas 18 and 20 emissivity has been set to = 0.8 and 0.95, respectively, whereas in all the remaining areas ε has been set to = 1. Measured temperatures appear to be higher in areas 18 and 20 with respect to those recorded in the other areas. If the lower values for ε were extended to all areas, this would lead to a higher estimate of irradiated energy density. For our calculations, therefore – in view of the fact that the effective value of ε was not available for our test, and that it was felt desirable to avoid any arbitrary source of overestimation – ε was left set to = 1 in all areas.

One must keep in mind that the thermal camera does not measure an object's temperature directly: with the help of input optics, radiation emitted from the object is focused onto an infrared detector which generates a corresponding electrical signal. Digital signal processing then transforms the signal into an output value proportional to the object temperature. Finally, the temperature result is shown on the camera display. The camera software derives the temperature of objects by means of an algorithm which takes several parameters and corrective factors into account, e.g. user settings for emissivity and detector temperature, taken automatically by a sensor on the lower part of the camera itself.

Moreover, every Optris camera-and-optics set has its own calibration file supplied by the manufacturer (Ref. [6]).

The image provided by the camera shows only the lower part of the *E-Cat HT*: as no other IR cameras were available, the same temperatures measured there were held good for the upper half of the device as well, and were used for subsequent calculations. We realize that convection has a

different effect on the top of the object compared to the bottom of it. Therefore, the temperature values by means of the frame setup chosen for positioning the camera should be the ones least affected by convective dispersion. This choice, however, leads to a heavy penalty in the calculation of the average surface temperature of the *E-Cat HT*: as a matter of fact, in the frames associated with the setup, the shadows of the two metal struts, and of the insulating materials placed under the device to support it, are clearly visible. These two blacked-out areas negatively distort the calculation of the surface temperature and prevent a proper view of the underlying emitting surfaces.

To overcome this problem, it was decided to divide the entire image of the IR camera into a progressively greater number of areas, for which average temperature values for the entire duration (96 hrs) of the test were calculated. Subsequently, these values were raised to the 4th power, and then averaged together to obtain a single value to be assigned to the *E-Cat HT*. By this process, the blacked-out areas are actually considered as pertaining to the surface of the *E-Cat HT*, thereby underestimating the energy emitted. It was decided to proceed in this manner in order to obtain a lower limit for emitted energy based solely on collected data, without making arbitrary assumptions that might have led to errors by overestimation.

The image obtained from the IR camera covers an area of 160 × 41 pixels and was progressively divided into 10, 20 and 40 areas, following the following criterion: in the first case, 10 areas of 16 × 41 pixels; in the second, 20 areas of 8 × 41 pixels; finally, in the third, 40 areas of 4 × 41 pixels.

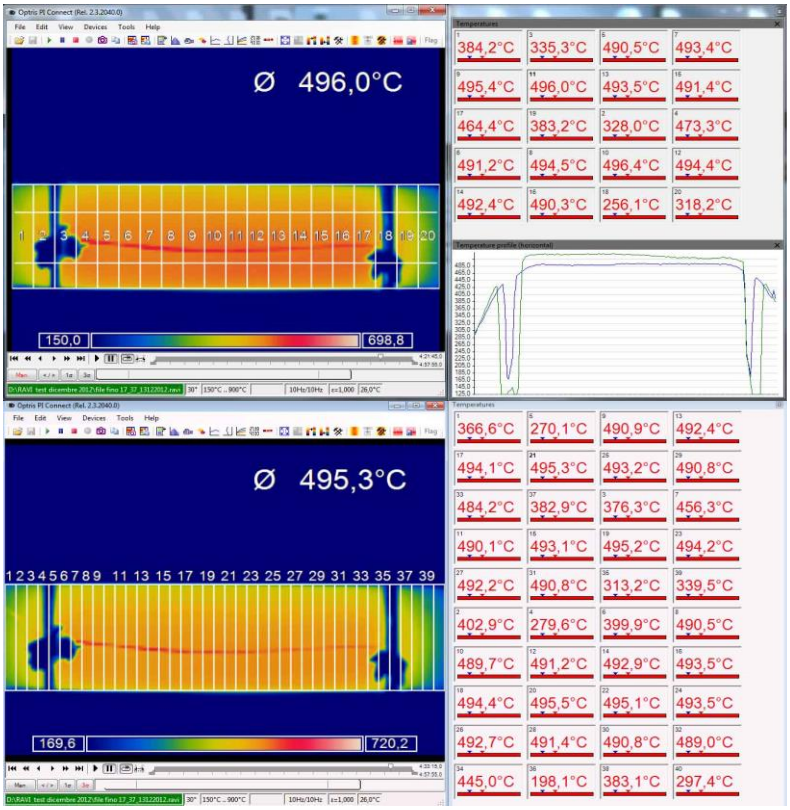


Fig. 8: The area occupied by the E-Cat HT *was first divided into 10 parts, then into 20, and finally into 40 parts. For each of these the average temperature was measured.*
Above: 20-area division of the E-Cat HT *image. The thermal profiles on the right refer to the two horizontal lines on the camera image: in the profiles, the two temperature dips corresponding to the metal struts are clearly visible.*
Below: 40-area division of the E-Cat HT *image. The red horizontal line crossing the image is due to a small crack in the ceramic outer surface caused by mechanical stress probably due to a previous thermal shock.*

For each area, as well as for the entire duration of the video footage, a time diagram of the average temperature trend was extracted; data was then saved to Excel worksheets, from which

the averages were extracted.
The temperatures thus obtained, expressed in Kelvin for each area, are presented in the following three tables.

Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7	Area 8	Area 9	Area 10
628.8 K	623.8 K	665.1 K	754.3 K	759.3 K	761.8 K	761.2 K	759.0 K	756.4 K	624.8 K

Table 1. Division into 10 areas.

By averaging these 10 values, one obtains a temperature, associable to the *E-Cat HT*, of 709 K.

Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7	Area 8	Area 9	Area 10
660.9 K	596.4 K	599.0 K	738.9 K	757.0 K	757.9 K	760.1 K	761.1 K	762.0 K	763.0 K
Area 11	**Area 12**	**Area 13**	**Area 14**	**Area 15**	**Area 16**	**Area 17**	**Area 18**	**Area 19**	**Area 20**
762.7 K	761.3 K	760.5 K	760.0 K	758.7 K	757.3 K	732.0 K	521.8 K	650.5 K	592.8 K

Table 2. Division into 20 areas.

By averaging these 20 values, one obtains an assignable temperature for the *E-Cat HT* of 710.7 K.

Area 1	Area 2	Area 3	Area 4	Area 5	Area 6	Area 7	Area 8	Area 9	Area 10
641.6 K	670.7 K	644.5 K	546.0 K	535.3 K	667.4 K	724.0 K	758.4 K	758.8 K	757.9 K
Area 11	**Area 12**	**Area 13**	**Area 14**	**Area 15**	**Area 16**	**Area 17**	**Area 18**	**Area 19**	**Area 20**
758.5 K	759.7 K	761.1 K	762.0 K	762.4 K	762.9 K	763.4 K	763.6 K	764.5 K	764.9 K
Area 21	**Area 22**	**Area 23**	**Area 24**	**Area 25**	**Area 26**	**Area 27**	**Area 28**	**Area 29**	**Area 30**
764.7 K	764.5 K	763.6 K	763.0 K	762.9 K	762.5 K	762.0 K	761.3 K	760.7 K	760.9 K
Area 31	**Area 32**	**Area 33**	**Area 34**	**Area 35**	**Area 36**	**Area 37**	**Area 38**	**Area 39**	**Area 40**
760.7 K	758.6 K	753.3 K	713.2 K	581.4 K	463.5 K	652.2 K	652.6 K	608.1 K	564.4 K

Table 3. Division into 40 areas.

By averaging these 40 values, one may assign to the *E-Cat HT* a temperature of 711.5 K.
The comparison between the different subdivisions into areas shows that the average temperature depends only slightly upon the choice of subdivision, and actually tends to increase, because the areas near the blacked-out ones are treated more effectively.
With reference to the third case above, one may calculate thermal power emitted by the *ECat HT* by first considering the average of the fourth power of the temperature of each area. One gets the following value:

$$(T^4)_{average} = 2.74 \cdot 10^{11}\ [K^4] \quad (3)$$

Emitted thermal power *(E)* may be easily obtained by multiplying the Stefan-Boltzmann formula by area of the *E-Cat HT* :

$$Area_{E\text{-}Cat} = 2\pi RL = 1036 \cdot 10^{-4}\ [m^2] \quad (4)$$

where:
R = radius of the *E-Cat HT* , equal to 0.05 [m]
L = length of the *E-Cat HT* , equal to 0.33 [m].

$$E = (5.67 \cdot 10^{-8})\,(2.74 \cdot 10^{11})\,(1036 \cdot 10^{-4}) = 1609\ [\mathrm{W}] \qquad (5)$$

In calculating the total area of the *E-Cat HT*, the area of the two bases was omitted, their surface being:

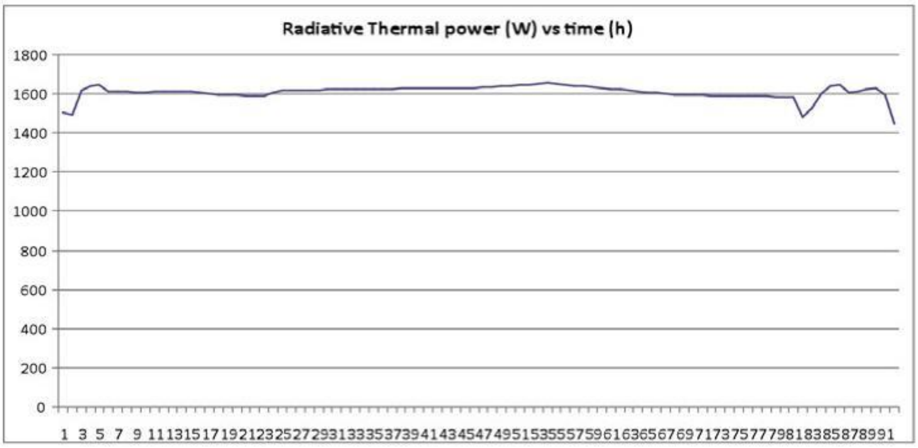
$$Area_{E\text{-}Cat\ Bases} = 2(\pi R^2) = 157 \cdot 10^{-4}\ [\mathrm{m}^2] \qquad (6)$$

This choice was motivated by the fact that for these parts of the cylinder, which are not framed by the IR camera, any estimate of irradiated energy would have been highly conjectural. We therefore preferred not to include this factor in calculating *E*, thereby underestimating radiative thermal power emitted by the *E-Cat HT.*
Emitted thermal power (*E*), apart from minute variations, remains constant throughout the measurement, as may be seen in the Plot 1 below, showing the measured radiative power vs time in hours. Power production is almost constant with an average of 1609.4 W.
To this power we must subtract the thermal power due to room temperature. On the basis of an average of 15.7°C over 96 hours, we get:

$$E\_room = (5.67 \cdot 10^{-8})\,(289)^4\,(1036 \cdot 10^{-4}) = 41\ [\mathrm{W}] \qquad (7)$$

So the final value is:

$$E - E\_room = 1609 - 41 = 1568\ [\mathrm{W}] \qquad (8)$$



Plot 1. Emitted thermal power vs time. Power production is almost constant with an average of 1609.4 W.

Note that the image reproduced by the IR camera is actually the projection of a cylindrical object on a two-dimensional plane. Consequently, the lines of sight between the camera and the cylinder radius vary between 0 and 90 degrees. In the latter case, which refers to the lateral parts of the *E-Cat HT* with respect to camera position, and thereby to the edges of the thermal image, the recorded temperatures may be significantly lower than effective ones. However, the division into rectangles adopted by us in order to calculate the average temperatures, comprises these edges (see fig. 8), which will therefore appear to be colder than they actually are due to the IR camera's angle of view. Once again, we opted to take a conservative stance, underestimating temperatures where the effective value was not easily assessable.

Calculating power emitted by convection

Let us consider a fluid temperature *Tf* lapping against a surface having area A and temperature T. Heat Q transferred in unit time by convection between the surface and the fluid may be expressed by Newton's relation:

$$Q = hA (T-T_f) = hA \Delta T \text{ [W]} \quad (9)$$

where h is defined as the heat exchange coefficient [$W/m^2 K$].
When the value of h is known, it is possible to evaluate the heat flow; thus, determining h constitutes the fundamental problem of thermal convection. Convection coefficient h is not a thermo-physical property of the fluid, but a parameter the value of which depends on all the variables that influence heat exchange by convection:

h = f (ρ, *Cp*, μ, βg, k, T-*Tf*, D), where the meaning of the symbols is as follows:

ρ = fluid density [kg/m^3]
Cp: specific heat capacity at constant pressure [J/kgK]
μ: viscosity [kg/ms]
βg: product of the coefficient of thermal expansion by gravity acceleration [m/s^2 K]
k: coefficient of thermal conductivity [W/mK]
T-*Tf* = ΔT: temperature difference between surface and fluid [K]
D: linear dimension; in our case, diameter [m].

The value of h may be obtained, for those instances involving the more common geometries and those fluids of greater practical interest, through the use of expressions resulting from experimental tests quoted in mainstream heat engineering literature. With reference to these texts [4, 5], we see that, in the case of a cylinder with a diameter less than 20 cm immersed in air at a temperature close to 294 K, the value of h may be had through the following expression:

$$h = C'' (T-T_f)^n D^{3n-1} \quad (10)$$

C" and n are two constants the value of which may be obtained if one knows the interval within which the product between the Grashof number *Gr* and the Prandtl number *Pr* falls. These dimensionless numbers are defined as follows:

$$G_r = \beta g (T-T_f) D^3 \rho^2/\mu^2; \qquad P_r = C_p\mu/k \quad (11)$$

G_r represents the ratio between the inertia forces of buoyancy and friction forces squared, while P_r represents the ratio between the readiness of the fluid to carry momentum and its readiness to transport heat.
For a wide range of temperatures one can say that:

$$k^4 (\beta g \rho^2 C_p /\mu k) = 36.0 \quad (12)$$

For the *E-Cat HT* average temperature value derived above, we get an average temperature between device and air equal to:

$$(T + T_f)/2 = (711.5 +289)/2 = 500.2 \text{ [K]} \quad (13)$$

Once this value is known, one can first of all derive the relevant coefficient of thermal conductivity k. With the aid of Table 4, which holds good for air, the value of k obtained for this

temperature is equal to 0.041 [W/mK].

k [W/mK]	**T [K]**
0.0164	173
0.0242	273
0.0317	373
0.0391	473
0.0459	573

Table 4. The extreme temperature values given constitute the experimental range. For extrapolation to other temperatures, it is suggested that the data given be plotted as log k vs log T (see reference [4]).

From (12) we have:

$$(\beta g \rho^2 C_p)/(\mu k) = 36.0/(0.041)^4 = 1.27 \cdot 10^7 \tag{14}$$

From the definitions of G_r and P_r we get:

$$G_r P_r = ((\beta g \rho^2 C_p) / (\mu k)) (T-T_f) L^3 = (1.27 \cdot 10^7) (711.5-289) (0.1)^3 = 5.36 \cdot 10^6 \tag{15}$$

Now we may consult Table 5 for the two constants we are searching for:

GrPr	**n**	**C"**
10^{-5} - 10^{-3}	0.04	-
10^{-3} - 1.0	0.10	-
1.0 - 10^4	0.20	-
10^4 - 10^9	0.25	1.32
$>10^9$	0.33	1.24

Table 5. Values are referred to a horizontal cylinder with a diameter less than 0.2 m (see ref.[4]).

One may then deduce:

C" = 1.32, n = 0.25

(10) then becomes:

$$h = (1.32) (711.5-289)^{0.25} (0.1)^{3*0.25-1} = 10.64 \text{ [W/m}^2\text{ K]} \tag{16}$$

Substituting (16) in (9) we obtain the power emitted by convection:

$$Q = (10.64) (1036 \cdot 10^{-4}) (711.5-289) = 466 \text{ [W]} \tag{17}$$

E-Cat HT performance calculation

At this point all that remains to be done, in order to get the performance (COP) of the *E-Cat HT*, is to add the radiated power to the power dispersed by convection, and relate the result to the power supplied to the heating elements. Conservatively, we can associate to these values a percentage error of 10%, in order to comprise various sources of uncertainty: those relevant to

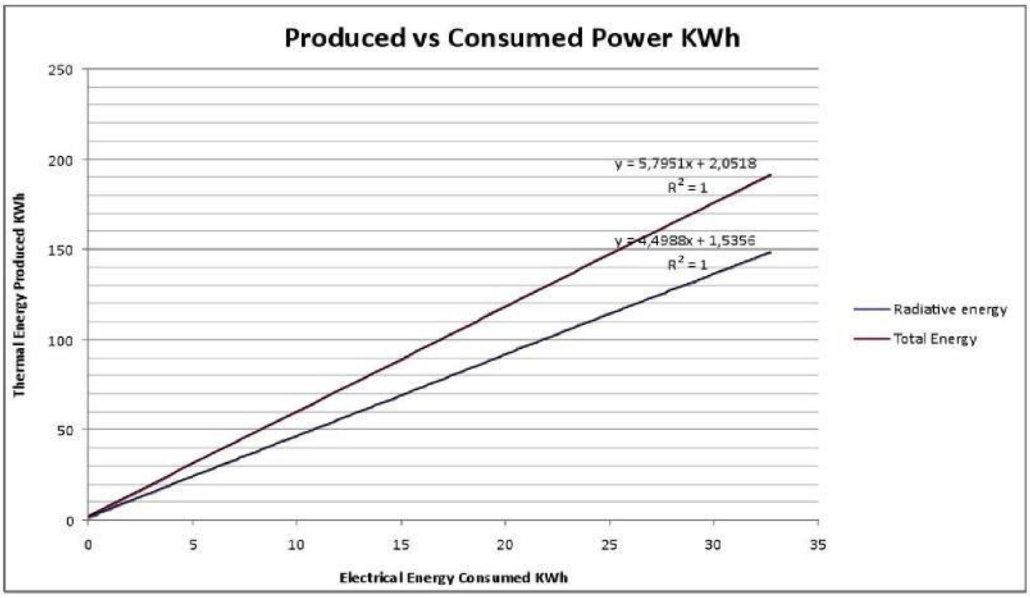
the consumption measurements of the *E-Cat HT*, those inherent in the limited range of frequencies upon which the IR cameras operate, and those linked to the calculation of average temperatures.

From (8) and from (17) we have:

1568 + 466 = (2034 ± 203) [W] (18)

COP = 2034/360 = 5.6 ± 0.8 (19)

assuming a 10% error in the powers. Plot 2 shows produced vs. consumed energy. Radiated energy is actually measured energy; total energy also takes into account the evaluation of natural convection. Data are fit with a linear function, and COP is obtained by the slope.



Plot 2. Thermal energy produced (kWh) versus electrical energy consumed (kWh).

Ragone Chart

As we have seen, the weight of the active charge of the *E-Cat HT* plus the weight of the two metal caps sealing the inner cylinder is equal to 0.236 kg.
If we assign this value to the charge powders, we shall be overestimating the weight of the charge; thus, our calculation of the values of power density and the density of thermal energy may be regarded as a lower limit.

For power density we have:

(2034-360)/0.236 = (7093 ± 709) [W/kg] (20)

Thermal energy density is obtained by multiplying (20) by the number of test hours:

7093·96 = 680949 [Wh/kg] ~ (6.81 ± 0.7) · 10^5 [Wh/kg] (21)

Figure 9 shows the "Ragone plot of energy storage", a typical diagram in which specific energy is represented as a function on a logarithmic scale of the specific power of the various energy storage technologies [Ref. 7]. Power density and thermal energy density found for the *E-Cat HT* place this device outside of the area occupied by any known conventional energy source in the Ragone chart. Given the deliberately conservative choices made in performing the measurement, we can reasonably state that the *E-Cat HT* is a non-conventional source of energy which lies between conventional chemical sources of energy and nuclear ones.

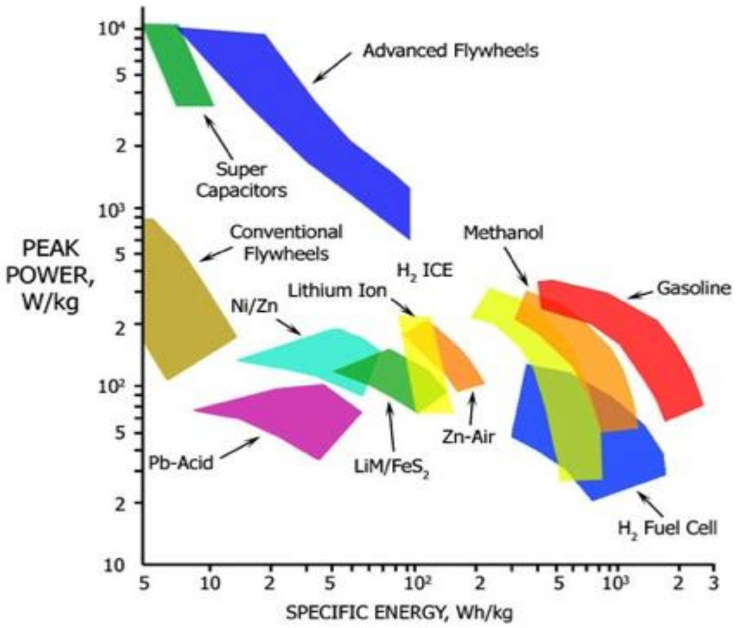


Fig. 9. "Ragone plot of energy storage"[Ref. 7]. The plot shows specific gravimetric energy and power densities relevant to various sources. The E-Cat HT, *which would be off the scale here, lies outside the region occupied by conventional sources.*

Remarks on the test

The device subject to testing was powered by 360 W for a total of 96 hours, and produced in all 2034 W thermal. This value was reached by calculating the power transferred by the ECat HT to the environment by convection and power irradiated by the device. The resultant values of generated power density (7093 W/kg) and thermal energy density ($6.81 \cdot 10^5$ Wh/kg) allow us to place the E-Cat HT above conventional power sources.

The procedures followed in order to obtain these results were extremely conservative, in all phases, beginning from the weight attributed to the powder charge, to which the weight of the two metal caps used to seal the container cylinder was added. The same may be said for the choice of attributing an emissivity of 1 to the E-Cat HT; other instances of underestimation may be found in the calculation of the radiating area of the device without the two bases, and in the fact that some parts of the radiating surfaces were covered by metal struts. It is therefore reasonable to assume that the thermal power released by the device during the trial was higher than the values given by our calculations.

Lastly, it should be noted that the device was deliberately shut down after 96 hours of operation. Therefore, from this standpoint as well, the energy obtained is to be considered a lower limit of the total energy which might be obtained over a longer runtime.

This test enabled us to pinpoint several procedural issues, first of all the fact that the device was already in operation when the trial began. This prevented us from correctly weighing the device beforehand, and conducting a thermal analysis of the same without the powder charge, prior to evaluating its yield with the charge in position. The choice of placing the thermal camera under the *E-Cat HT* should also be considered unsatisfactory, as was the impossibility of evaluating the real emissivity of the cylinder's paint coating.

All these issues were taken notice of in the light of the subsequent test held in March. This was performed with a device of new design, as a result of technological improvements effected by Leonardo Corporation in the intervening months.

PART 2: THE MARCH TEST

Device and experimental set-up

The March test was performed with a subsequent prototype of the *E-Cat HT*, henceforth termed *E-Cat HT2,* differing from the one used in the December test both in structure and control system. Externally, the device appears as a steel cylinder, 9 cm in diameter, and 33 cm in length, with a steel circular flange at one end 20 cm in diameter and 1 cm thick. The only purpose of the flange was to allow the cylinder to be inserted in one of various heat exchangers, which are currently under design. As in the case of the previous model, here too the powder charge is contained within a smaller AISI 310 steel cylinder (3 cm in diameter and 33 cm in length), housed within the *E-Cat HT2* outer cylinder together with the resistor coils, and closed at each end by two AISI 316 steel caps.

The outer surface of the *E-Cat HT2* and one side of the flange are coated with black paint, different from that used for the previous test. The emissivity of this coating, a Macota® enamel paint capable of withstanding temperatures up to 800°C, is not known; moreover, it was not sprayed uniformly on the device, as may be seen from the non-uniform distribution of colors in adjacent areas in the thermal imaging.

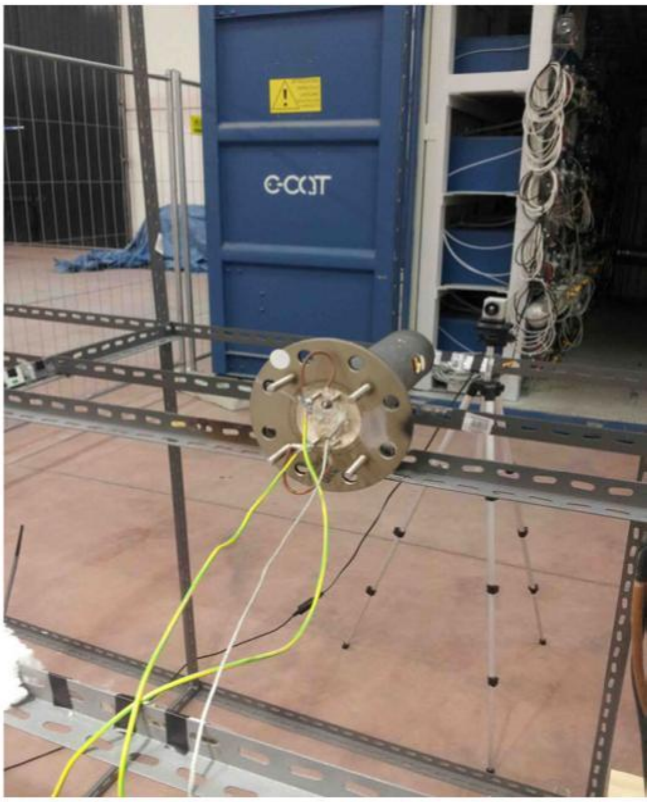


Fig. 10. Flange of the E-Cat HT2 *used for the March test. The flange is meant to facilitate insertion of the device in a heat exchanger. Electrical power is fed through the two yellow wires. The third connection was verified to be a PT100 sensor, used to give a feedback temperature signal to the control box in order to regulate the ON/OFF cycle.*

The *E-Cat HT2*'s power supply departs from that of the device used in December in that it is no longer three-phase, but single-phase: the TRIAC power supply has been replaced by a control circuit having three-phase power input and single-phase output, mounted within a box, the contents of which were not available for inspection, inasmuch as they are part of the industrial trade secret. But the main difference between the *E-Cat HT2* and the previous model lies in the control system, which allows the device to work in self-sustaining mode, i.e. to remain operative and active, while powered off, for much longer periods of time with respect to

those during which power is switched on. During the test experiment we observed that, after an initial phase lasting about two hours, in which power fed to the resistor coils was gradually increased up to operating regime, an ON/OFF phase was reached, automatically regulated by the temperature feedback signal from a PT100 sensor.

In the ON/OFF phase, the resistor coils were powered up and powered down by the control system at observed regular intervals of about two minutes for the ON state and four minutes for the OFF state. This operating mode was kept more or less unchanged for all the remaining hours of the test. During the OFF state, it was possible to observe – by means of the video displays connected to the IR cameras (see below) – that the temperature of the device continued to rise for a limited amount of time. The relevant data for this phenomenon are displayed in the final part of the present text.

The instrumentation used for the experiment was the same as that of the previous test, with the sole addition of another IR camera, used to measure the temperature of the base (henceforth: “breech”) of the *E-Cat HT2*, and of the flange opposite to it. The second camera was also an Optris PI 160 Thermal Imager, but mounting 48° × 37° lens. Both cameras were mounted on tripods during data capture, with the *E-Cat HT2* resting on metal struts. This made it possible to solve two of the issues experienced during the December test, namely the lack of information on the *E-Cat HT2* breech, and the presence of shadows from the struts in the IR imagery.

As in the previous test, the LCD display of the electrical power meter (PCE-830) was continually filmed by a video camera. The clamp ammeters were connected upstream from the control box to ensure the trustworthiness of the measurements performed, and to produce a non-falsifiable document (the video recording) of the measurements themselves.

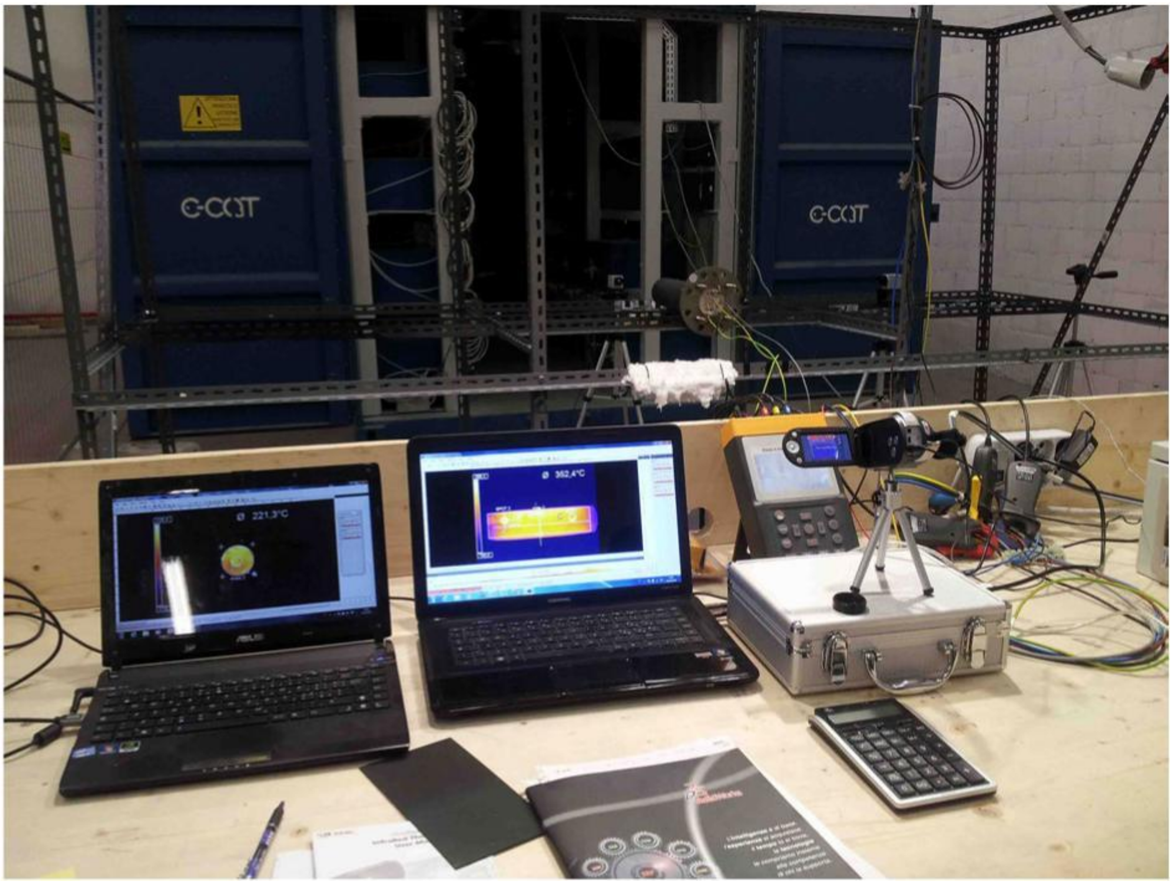


Fig. 11. Instrument set-up for the test. From left to right: the two laptops connected to the IR cameras, framing the breech (i.e. the base opposite the flange) of the E-Cat HT2 *and one of its sides, respectively, plus the video camera, and the PCE-830. Background: the* E-Cat HT2 *resting on metal struts and the two IR cameras on tripods.*

Another critical issue of the December test that was dealt with in this trial is the evaluation of the emissivity of the *E-Cat HT2*’s coat of paint. For this purpose, self-adhesive samples were used:

white disks of approximately 2 cm in diameter (henceforth: dots) having a known emissivity of 0.95, provided by the same firm that manufactures the IR cameras (Optris part: ACLSED). According to the manufacturer, the maximum temperature tolerated by a dot before it is destroyed is approximately 380°C. In the course of the test, numerous dots were applied along the side and the breech of the *E-Cat HT2*, but the ones applied to the more central areas showed a tendency to fall off, and had to be periodically replaced. Actually, the distribution of temperatures along the device is non-uniform, and the central part of the cylindrical body is where the temperature reaches values closest to the uppermost working limit for the dots themselves.

Fig. 12. Two images of the E-Cat HT2*. The first displays one of the sides, as framed by one thermal camera, the second displays the breech, framed by the second IR camera. The adhesive "dots" used to evaluate paint emissivity are visible in both images. Note how, in the image on the left, one of the dots is about to fall off due to the heat from the underlying area.*

The dots allow one to determine the emissivity of the surface they are applied to, by comparing the temperatures recorded on the dots and those of the adjacent areas. This procedure may also be applied during data analysis, directly on the completed thermal imagery video. It is possible to divide the thermal images into separate areas – in the same manner as the one used to determine the average temperature of the *E-Cat HT* in the December test – and to assign a specific emissivity to each area. This option proved quite useful later, when analyzing the imagery captured by the cameras, because it made it possible to correct the values of ε that had been assigned during the initial calibration performed while the test was in progress. The dots in the images enabled us to determine that different areas of the device had different emissivity because the paint had not been uniformly applied. Furthermore, it was possible to see how emissivity for each area varied in the course of time, probably on account of a change in the properties of the paint when subjected to continuous heat. For this reason, when analyzing the data after the test, a good number of time intervals were taken into consideration. The thermal images of the *E-Cat HT2* were then divided into areas, and adjusted to the appropriate values of emissivity relevant to every time interval. In order to calculate emitted energy, the temperature then assigned to each area of the device was determined from an average of the various results that had been obtained.
Another improvement over the December test lies in the fact that we were able to perform further measurements (falling outside the 116 hours of the trial run) on the same *E-Cat HT2* used for the test, after removing the inner charge. With this device, termed "dummy", we were able to verify the effectiveness of the methodology used to evaluate the active device, and to estimate

the energy emissions of the flange, which would have been difficult to evaluate otherwise.
Lastly, as in the December test, the *E-Cat HT2* was assessed all throughout the test for potential radioactive emissions. The measurements and their analysis were performed once again by David Bianchini, whose report and relevant results are available on demand. His conclusions are quoted below:
"*The measurements performed did not detect any significant differences in exposure and CPM (Counts per Minute), with respect to instrument and ambient background, which may be imputed to the operation of the E-Cat prototypes*".

Analysis of data obtained with the "dummy"

By "dummy" is meant here the same *E-Cat HT2* used for the test described in Part 2, but provided with an inner cylinder lacking both the steel caps and the powder charge. This "unloaded" device was subject to measurements performed after the 116-hr trial run, and was kept running for about six hours. Instrumentation and data analysis were the same as those used for the test of the active *E-Cat HT2.* We prefer to present the data relevant to the dummy beforehand, since these data made it possible to perform a sort of "calibration" of the *E-Cat HT2,* as shall be pointed out below.
The electrical power to the dummy was handled by the same control box, but without the ON/OFF cycle of the resistor coils. Thus, the power applied to the dummy was continuous.
Power to the dummy's resistor coils was stepped up gradually, waiting for the device to reach thermal equilibrium at each step. In the final part of the test, the combined power to the dummy + control box was around 910-920 W. Resistor coil power consumption was measured by placing the instrument in single-phase directly on the coil input cables, and was found to be, on average, about 810 W. From this one derives that the power consumption of the control box was approximately = 110-120 W. At this power, the heat produced from the resistor coils alone determined an average surface temperature (flange and breech excluded) of almost 300°C, very close to the average one found in the same areas of the *E-Cat HT2* during the live test.
Various dots were applied to the dummy as well. A K-type thermocouple heat probe was placed under one of the dots, to monitor temperature trends in a fixed point. The same probe had also been used with the *E-Cat HT2* to double check the IR camera readings during the cooling phase. The values measured by the heat probe were always higher than those indicated by the IR camera: this difference, minimal in the case of the *E-Cat HT2*, was more noticeable in the dummy, where temperature readings proved to be always higher by about 2°C. The most likely reason for the difference is to be sought in the fact that the probe, when covered with the dot securing it the surface, could not dissipate any heat by convection, unlike the areas adjacent to it.
In order to evaluate the power emitted by the dummy by radiation and convection, we decided to divide the image of the cylindrical body into 5 areas, to each of which, by means of dots, we assigned an average emissivity of 0.80. Lastly, the analysis of images relevant to the breech determined for this area another value for ε: 0.88.

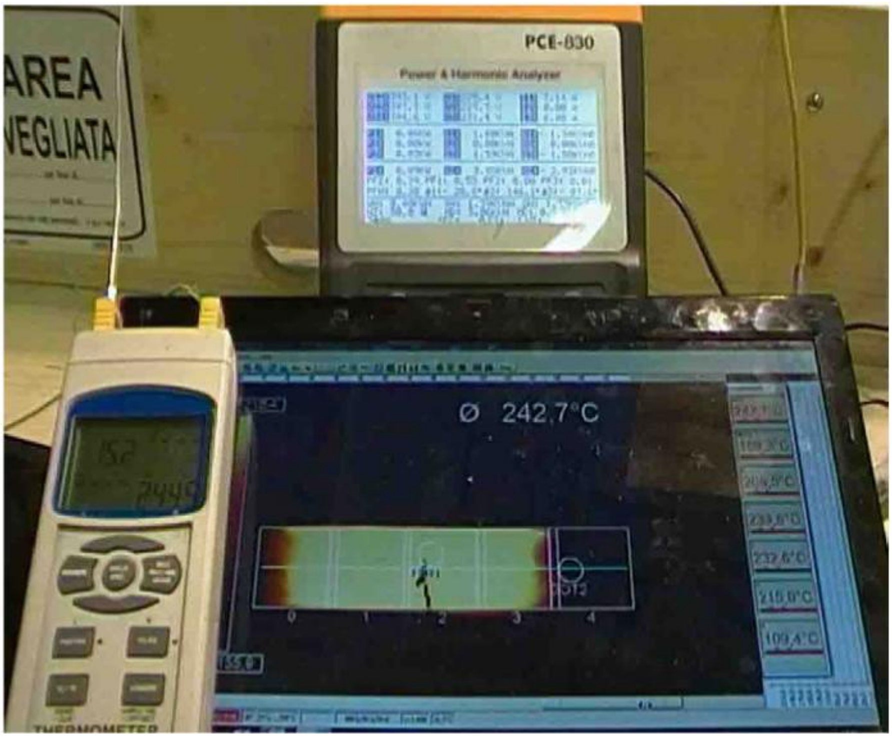


Fig. 13. Dummy measurement set-up. Center: laptop display showing the thermal image of the dummy divided into 5 areas, and the dark shadow of the thermocouple, with probe point located under a dot. Left: thermocouple LCD display, indicating a temperature of 244.5°C. This is relevant to the same area which the IR camera reading of 242.7°C, visible on the laptop display, refers to. The difference is most likely caused by lower thermal exchange between the probe and the environment..

For each of the five areas, energy emitted by radiation was calculated. Once again, Stefan-Boltzmann's formula multiplied by the area taken into consideration was used, as in Part 1, equation (5). Power emitted by convection was calculated by equations (9) and (10). The equations are repeated below for clarity's sake, followed by a table summarizing the results.

$$E = \varepsilon\sigma A T^4 \text{ [W]} \quad (5)$$

$$Q = hA\,(T - Tf) = hA\Delta T \text{ [W]} \quad (9)$$

$$h = C''\,(T - T_f)^n\, D^{3n-1} \quad (10)$$

$$Area_{Dummy} = 2\pi RL = 989.6 \cdot 10^{-4} \text{ [m}^2\text{]}$$

$$Area_{Top} = \pi R^2 = 63.61 \cdot 10^{-4} \text{ [m}^2\text{]}$$

Note that coefficients C'' and n of (10) have the same value calculated for the December test, namely C'' = 1.32, and n = 0.25, whereas the diameter D is now = 9 cm.
Moreover, $Area_{Dummy}$ refers to the cylindrical body of the device without flange or breech.
Lastly, the contributing factor due to ambient temperature, termed "*E*_room" in (7) above, has already been subtracted from the power values associated with each area. This was calculated assuming an ambient temperature value of 14.8°C.

$$E\_room = (5.67 \cdot 10^{-8})\,(288)^4\,(0.80)\,(198 \cdot 10^{-4}) = 6.18 \text{ [W]}$$

	Area 1	Area 2	Area 3	Area 4	Area 5	Sum
E (W)	84.9	112	109	102	49.3	457.2
Q (W)	53.7	63	62.6	59.9	38.3	277.5
W Total	138.6	175	171.6	161.9	87.6	734.7

*Table 6. Power emitted by radiation (*E*) and convection (Q) for each of the five areas. The value of* E_room*, about 6.18 W, has already been subtracted from power* E *in the relevant area.*

Using the second thermal imagery camera, it was possible to monitor the temperature of the breech, which was almost stable at 225°C. We were thus able to compute the contributing factor to the total radiating energy associated with this part of the dummy: a value of *E*-*E*_room = 17 W.
As for the flange, it was not possible to evaluate its temperature with sufficient reliability, despite the fact that it was partially framed by both IR cameras. A careful analysis of the relevant thermal imagery revealed how part of the heat emitted from the flange was actually reflected heat coming from the body of the dummy. In fact, the position of the flange is such that one of its sides constantly receives radiative heat emitted by the body of the cylinder: if we were to attribute the recorded temperature to the flange, we would risk overestimating the total radiative power.
Conservation of energy was used to evaluate the contributing factor of the flange, and of all other not previously accounted factors, to the total energy of the dummy. Thus, we get:

$$810\ [W] - (735 + 17)\ [W] = 58\ [W] \qquad (22)$$

This last value is the sum of the contributive factors relevant to all unknown values, namely: flange convection and radiation, breech convection (NB convection only), losses through conduction, and the margin of error associated with our evaluation.
Since the temperatures reached by the dummy and by the *E-Cat HT2* during their operation were seen to be quite similar, this value will also be used to calculate the power relevant to the *E-Cat HT2*, where it will be attributed the same meaning.

Analysis of data obtained with the *E-Cat HT2*

The *E-Cat HT2* was started approximately at 3:00 p.m. on March 18. The initial power input was about 120 W, gradually stepping up during the following two hours, until a value suitable for triggering the self-sustaining mode was reached. From then onwards, and for the following 114 hours, input power was no longer manually adjusted, and the ON/OFF cycles of the resistor coils followed one another at almost constant time intervals. During the coil ON states, the instantaneous power absorbed by the *E-Cat HT2* and the control box together was visible on the PCE-830 LCD display. This value, with some fluctuations in time, remained in any case within a range of 910-930 W. The PCE-830 LCD display showed the length of the ON/OFF intervals: with reference to the entire duration of the test, the resistor coils were on for about 35% of the time, and off for the remaining 65%.
As in the case of the dummy, in order to determine the average temperatures for the *E-Cat HT2* we opted to divide its thermal images into five areas, plus another one for the breech. An analysis of various time segments (about five hours each), taken in the course of each day of the test, revealed that the behavior of the device remained more or less constant, and became quite stable especially from the third day onwards. Using the same procedure as before, we obtained an average temperature for each of the five areas, thereafter employing equations (5), (9), and (10) in order to calculate power emitted by radiation and convection, respectively.

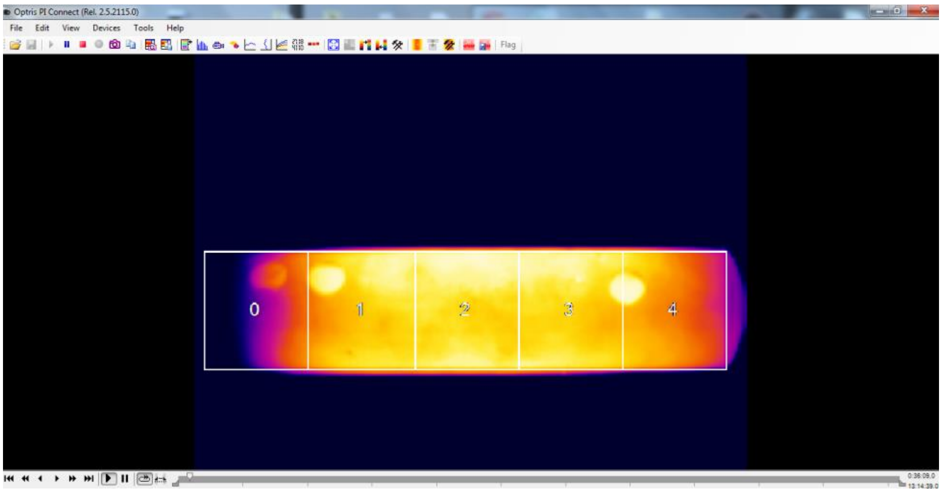


Fig. 14. 5-area division of the E-Cat HT2 *image. The flange does not appear in the image because the display range chosen for the IR camera does not detect objects colder than 150°C.*

Emissivity values for each area were adjusted in each IR camera video sample thanks to the continuing presence of dots: according to position and time, the found values for ε fluctuated between a low of 0.76 and a high of 0.80. Areas subject to the most intense heat were seen to have slightly higher emissivity compared to peripheral ones, and all showed a slight upward trend as the test progressed, probably because of a change in the properties of the paint.
In order to account for a certain degree of arbitrariness inherent in this method of evaluation, it was decided to assign a reference temperature to the various areas into which the *E-Cat HT2* had been divided. This was obtained by assigning to all areas the most frequently found value for ε and associating a percentage error to it. This error is the result of the difference between two extreme values, namely the temperature obtained by assigning to all areas the lowest level of emissivity ever found in any one of them (= 0.76), and the temperature obtained assigning to all areas the highest value for ε ever found (= 0.80). Tables 7 and 8 summarize the results: the first refers to the average of temperatures in each of the five areas for different values of ε, whereas the second gives the average values of power emitted by radiation (*E*) and convection (Q) for different values of ε, while taking into account the sum performed on the five areas.

ε	**T 1 (°C)**	**T 2 (°C)**	**T 3 (°C)**	**T 4 (°C)**	**T 5 (°C)**	**Average**
Average ε	261.0	319.4	326.0	318.3	286.9	302.3
0.76	261.0	328.4	335.2	327.3	286.9	307.7
0.80	254.0	319.4	326.0	318.4	279.2	299.4

Table 7. Average temperatures relevant to the divisions into five areas of the E-Cat HT2*'s cylindrical body, calculated according to average values of emissivity (first row), absolute minimal values (second row), and absolute maximum values (third row), collated by taking into consideration all the areas and all the analyzed time intervals. The last column gives the averages of the previous values for each of the five areas.*

E	**E (W)**	**Q(W)**	**E(W) + Q(W)**
Average ε	459.8	281.5	741.3
0.76	463.8	288.2	752.0
0.80	458.6	277.9	736.6

*Table 8. Emitted power values by radiation (*E*) and by convection (Q) for different values of* ε*. The numbers are computed from the power average of all five areas, minus the* E_room *component arising from the contributing factor of ambient temperature.*

The error associable to the average value of emitted power may be got by taking into account the difference between what is obtained by attributing to each area the highest possible and the lowest possible value for ε. Thus:

$$(752.0-736.6)/741.3 = 2\% \quad (23)$$

As may be inferred from the last value above, the uncertainty regarding emissivity does not affect the results much, and should therefore be considered a parameter of lesser critical import than what was originally estimated.
The average temperature relevant to the breech, as well as its average emissivity, turned out to be extremely constant over time, with values of 224.8°C and 0.88, respectively. We can therefore associate them with a value of irradiated power *E-E*_room = 17 [W].
At this point, all the contributing factors relevant to the thermal power of the *E-Cat HT2* are available, i.e. the power emitted by the cylindrical body through radiation and convection, the power emitted by radiation by the breech, and the set of missing factors (conduction, breech convection, flange radiation and convection). It is now possible to obtain a complete estimate:

$$\textit{Emitted Power}_{E\text{-}Cat\ HT2} = (741.3 + 17 + 58)\ [W] = (816.3 \pm 2\%)\ [W] = (816 \pm 16)\ [W] \quad (24)$$

Ragone Chart

Upon completion of the test, the *E-Cat HT2* was opened, and the innermost cylinder, sealed by caps and containing the powder charges, was extracted. It was then weighed (1537.6 g) and subsequently cut open in the middle on a lathe. Before removal of the powder charges, the cylinder was weighed once again (1522.9 g), to compensate for the steel machine shavings lost. Lastly, the inner powders were extracted by the manufacturer (in separate premises we did not have access to), and the empty cylinder was weighed once again (1522.6 g). The weight that may be assigned to the powder charges is therefore on the order of 0.3 g; here it shall be conservatively assumed to have value of 1 g, in order to take into account any possible source of error linked to the measurement.
According to the data available from the PCE-830 analyzer, the overall power consumption of the *E-Cat HT2* and the control box combined was 37.58 kWh. The associated instantaneous power varied between 910 and 930 W during the test, so it may be averaged at 920±10 W. In order to determine the power consumption of the *E-Cat HT2* alone, one must subtract from this value the contributive factor of the control box power consumption. As it was not possible to measure the latter while the test on the *E-Cat HT2* was in progress, one may refer to the power consumption of the box measured during the dummy test. This value would in all likelihood be higher in the case of operative *E-Cat HT2*, due to the electronic circuits controlling the self-sustaining mode: so, as usual, we shall adopt the more conservative parameter.
If one assumes that the control box absorbed about 110 W, we can associate the *E-Cat HT2* with a consumption of:

$$\textit{Instantaneous Power Consumption}_{E\text{-}Cat\ HT2} = (920 - 110)\ [W] = 810\ [W] \quad (25)$$

Keeping in mind the fact that this consumption was not constant over time, but may be referred just to 35% of the total test hours, one may calculate the effective power consumption of the device as:

$$\textit{Effective Power Consumption}_{E\text{-}Cat\ HT2} = (810/100) \cdot 35 = 283.5\ [W] \quad (26)$$

Let us further assume an error of 10%, in order to include any possible unknown source. Errors of this extent are commonly accepted in calorimetric measurements, and in our case they would comprise various sources of uncertainty: those relevant to the consumption measurements of the *E-Cat HT2* and the control box, those inherent in the limited range of

frequencies upon which the IR cameras operate, and those linked to the calculation of average temperatures.
The energy produced by the *E-Cat HT2* during the 116 hours of the test is then:

$$Produced\ Energy_{E\text{-}Cat\ HT2} = (816\text{-}283.5) \cdot 116 = (6.2 \pm 0.6) \cdot 10^4\ [Wh] \quad (27)$$

From (27) one may gather the parameters necessary to evaluate the position held by the *ECat HT2* with respects to the Ragone Plot, where specific energy is represented as a function on a logarithmic scale of the specific power of the various energy storage technologies [see Ref. 8].

For power density we have:

$$(816\text{-}283.5)/0.001 = 532500\ [W/kg] \sim 5 \cdot 10^5\ [W/kg] \quad (28)$$

Thermal energy density is obtained by multiplying (28) by the number of test hours:

$$532500 \cdot 116 = (6.2 \pm 0.6) \cdot 10^7\ [Wh/kg] \sim 6 \cdot 10^7\ [Wh/kg] \quad (29)$$

It is easy to infer from the Ragone chart, another example of which may be seen below in fig. 15 below, that these values place the *E-Cat HT2* at about three orders of magnitude beyond any other conventional chemical energy source.

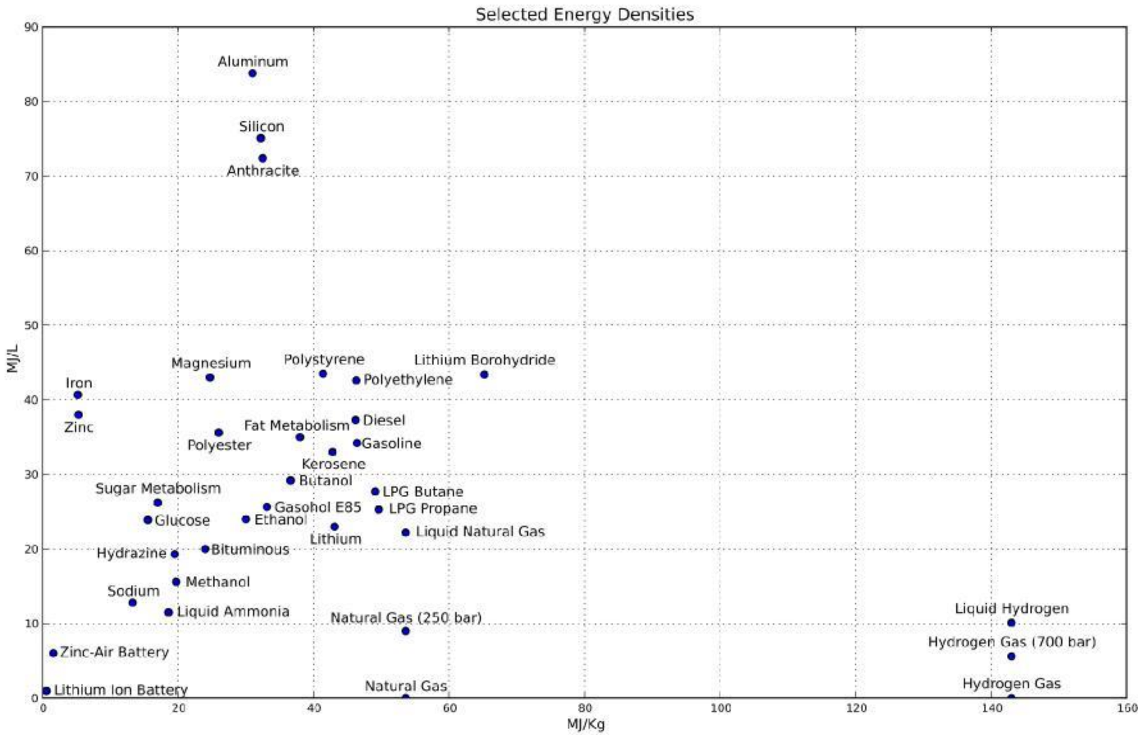


Fig. 15. Another version of the Ragone Plot of Energy Storage [Ref. 8]. In this plot, specific volumetric and gravimetric energy densities are presented for various sources. The ECatHT2, out of scale here, lies outside the region occupied by conventional chemical sources.

As it was not possible to inspect the inside of the control box, let us now repeat the last calculations supposing, as a precautionary measure, that all power consumption is assigned to the *E-Cat HT2*.
According to this logic, and assigning to the *E-Cat HT2* the maximum value of error given by (24), namely (816 - 16)W = 800 W, one gets:

$$Conservative\ Power\ Consumption_{E\text{-}Cat\ HT2} = (920/100) \cdot 35 = (322 \pm 32)\ [W] \quad (30)$$

whereas (28) and (29) become:

$(800\text{-}322)/0.001 = (4.7 \pm 0.5\ ) \cdot 10^5$ [W/kg] (31)

$478000 \cdot 116 = (5.5 \pm 0.6) \cdot 10^7$ [Wh/kg] (32)

The results thus obtained are still amply sufficient to rule out the possibility that the *E-Cat HT2* is a conventional source of energy.

Let us associate to this last value of conservative power consumption the worst-case scenario:

(322 + 32) [W] = 354 [W] (33)

Then the values of power density and energy density would then be:

$(800\text{-}354)/0.001 = (4.4 \pm 0.4) \cdot 10^5$ [W/kg] (34)

$446000 \cdot 116 = (5.1 \pm 0.5) \cdot 10^7$ [Wh/kg] (35)

Obviously, not even in this case do we have any substantial change as far as the position occupied by the *E-Cat HT2* in the Ragone plot is concerned.
For a further confirmation of the fact that the *E-Cat HT2*'s performance lies outside the known region of chemical energy densities, one can also calculate the volumetric energy density of the reactor, by referring to the whole volume occupied by the internal cylinder, namely $1.5^2 \cdot \pi$ 33 = 233 cm^3 = 0.233 l. This is the most conservative and "blind" approach possible.
Taking the figures from the worst case, we get a net power of 800-354=446 W; by multiplying this by (3600 · 116), we find that 185 MJ where produced. Thus, we have a volumetric energy density of 185/0.233 = $(7.93 \pm 0.8)10^2$ MJ/Liter, meaning that even by resorting to the most conservative and "worst case scenarios", where the total volume of the reactor is comprehensive of the 5-mm thick steel cylinder, we see that we are still at least one order of magnitude above the volumetric energy density of any known chemical source [Ref. 8].

***E-Cat HT2* performance calculation**

According to the engineering definition, COP is given by the ratio between the output power of a device and the power required by its operation, thereby including, in our case, the power consumed by the control electronics.
For the *E-Cat HT2* one would therefore have (assuming a 10% uncertainty in the powers):

$COP = 816/322 = 2.6 \pm 0.5$ (36)

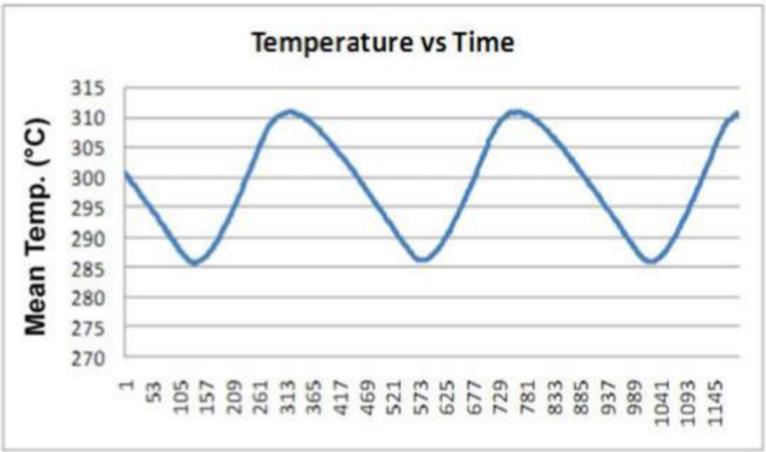
In order to compare this figure with the COP value obtained in the December test (5.6; see (19)), one must first of all consider that the two values were obtained in different experimental contexts: (19) gives the ratio between power emitted and power consumed by the *E-Cat HT* only, without the TRIAC power supply, whereas (36) includes power consumption by the *E-Cat HT2*'s control device instrumentation. The expression useful for such a comparison is therefore the following:

$COP = 816/283 = 2.9 \pm 0.3$ (37)

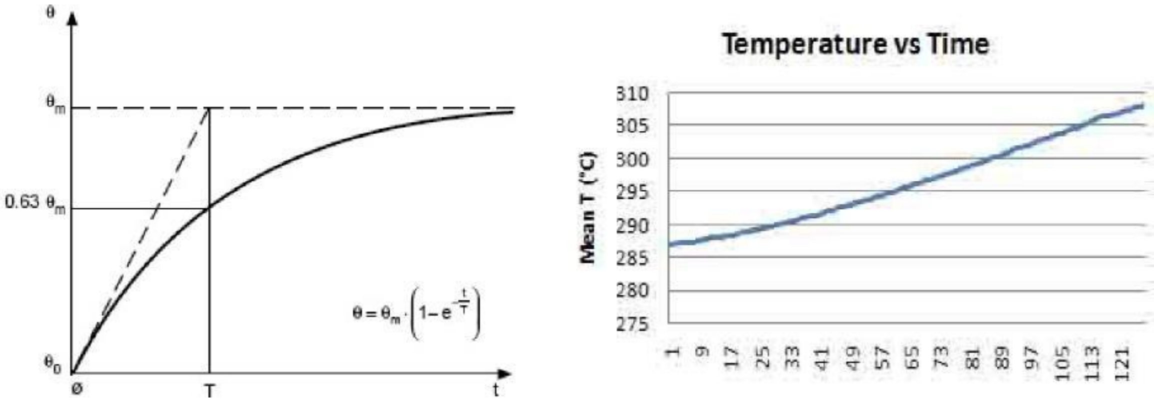
Thus, (19) and (37) give the performances specific to prototypes *E-Cat HT* and *E-Cat HT2*, respectively – regardless of the electronic circuits (also prototypes) used to control them. Since the main goal of the present paper is a specific investigation of E-Cats as physical systems, these are the most meaningful expressions for our purposes.

The reasons for the appreciable difference between the value obtained in December and the one found in March are probably to be sought in the tendency of the COP to increase with temperature, a fact which was noticed even in the November test. In that occasion, reaching a certain critical temperature threshold was enough to cause the reaction to diverge uncontrollably and destroy the device. Considering that, in December, the *E-Cat HT*'s average temperature was 438°C, vs an average of 302°C for the *E-Cat HT2* in March, a higher COP for the former device with respect to that found in the latter was by no means unexpected.
In any event, inasmuch as the quantity of the charge contained in the first device is not known, a comparison between the two tests is not strictly appropriate. It is possible that the two coefficients of performance differ only because the quantity of powder used in the two tests was different.

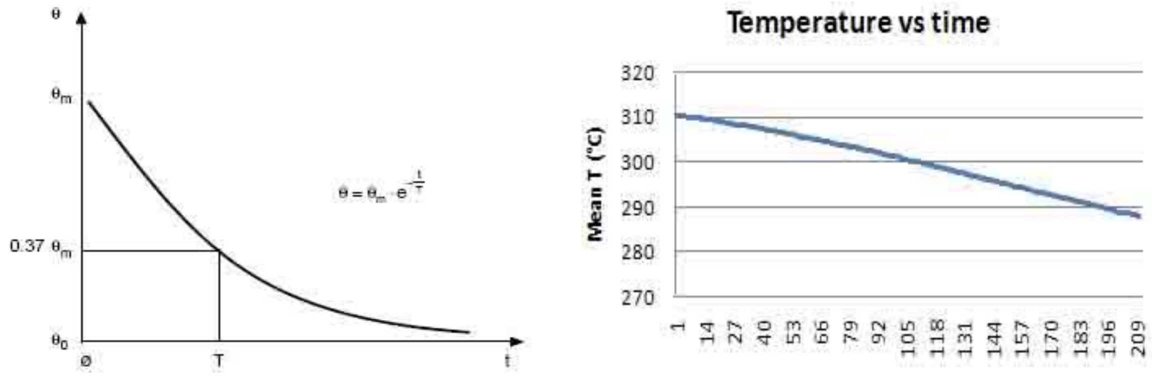
Remarks on the test
An interesting aspect of the *E-Cat HT2* is certainly its capacity to operate in self-sustaining mode. The values of temperature and production of energy which were obtained are the result of averages not merely gained through data capture performed at different times; they are also relevant to the resistor coils' ON/OFF cycle itself. By plotting the average temperature vs time for a few minutes of test (Plot 3) one can clearly see how it varies between a maximum and a minimum value with a fixed periodicity.



Plot 3. Average surface temperature trend of the E-Cat HT2 over several minutes of operation. Note the heating and cooling trends of the device, which appear to be different from the exponential characteristics of generic resistor.
Looking at Plot 3, the first feature one notices is the appearance taken by the curve in both the heating and cooling phases of the device. If we compare these in detail with the standard curves of a generic resistor (Plot 4 and Plot 5), we see that the former differ from the latter in that they are not exponential .

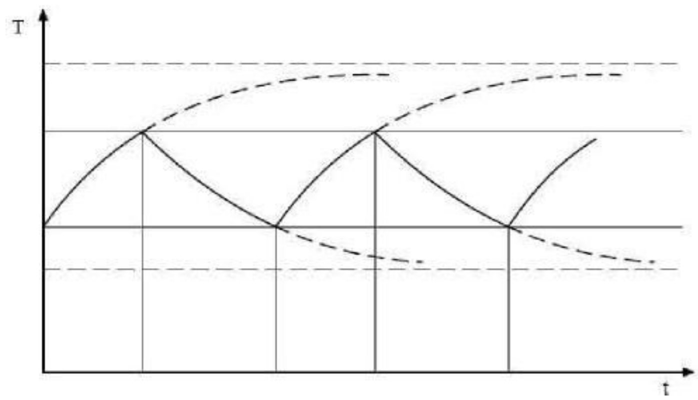


Plot 4. Comparing the typical heating curve of a generic resistor (left, [Ref. 9]) to the one relevant to one of the E-Cat HT2's ON states.



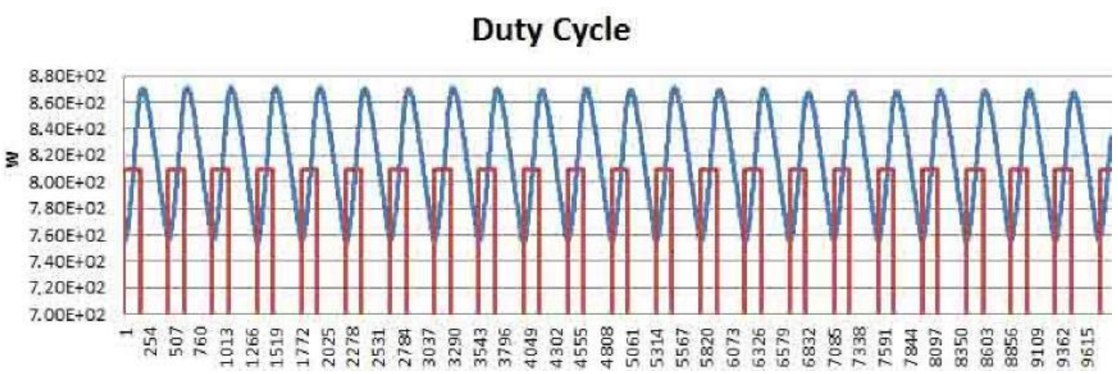
Plot 5. Comparing the typical cooling curve of a generic resistor (left, [Ref. 9]) to the one relevant to one of the E-Cat HT2's OFF states.

Finally, the complete ON/OFF cycle of the *E-Cat HT2*, as seen in Plot 3, may be compared with the typical heating-cooling cycle of a resistor, as displayed in Plot 6.



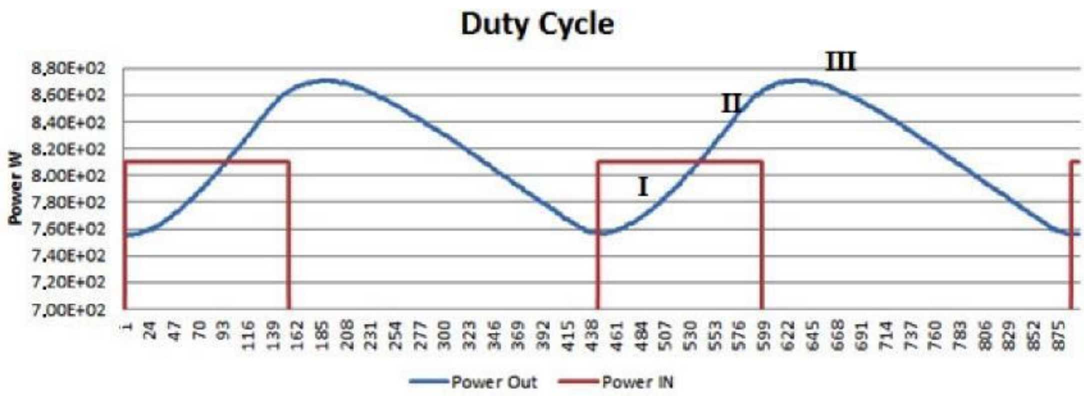
Plot 6. Heating and cooling cycle of a generic resistor [Ref. 9]. The trend is described by exponential type equations.

What appears indicated here is that the priming mechanism pertaining to some sort of reaction inside the device speeds up the rise in temperature, and keeps the temperatures higher during the cooling phase.
Another very interesting behavior is brought out by synchronically comparing another set of curves: power produced over time by the *E-Cat HT2*, and power consumed during the same time. An example of this may be seen in Plot 7, which refers to about three hours of test. The resistor coils ON/OFF cycle is plotted in red, while the power-emission trend of the device appears in blue.



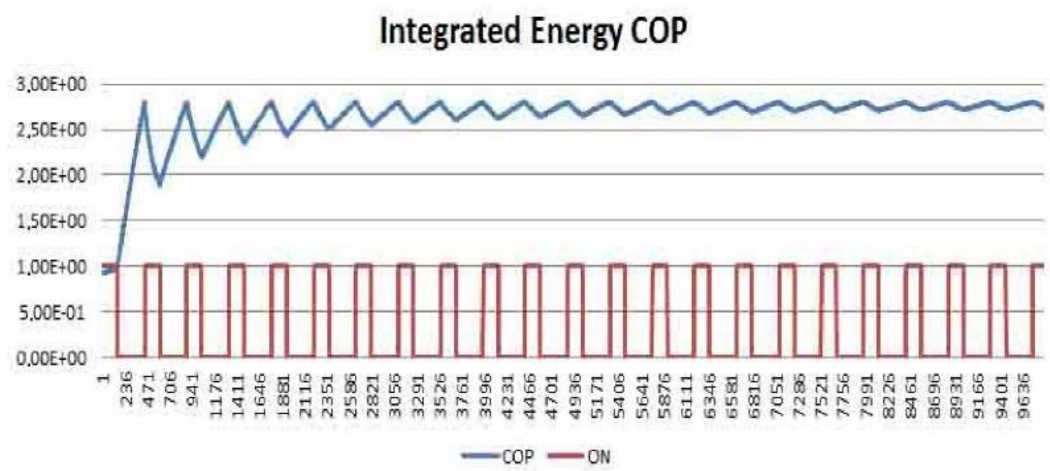
Plot 7. Chart showing emitted power (in blue) and consumed power (in red) vs time for the E-Cat HT2.

Starting from any lowest point of the blue curve, one can distinguish three distinctive time intervals. In the first, emitted power rises, while remaining below the red line representing consumed power. In the second, emitted power rises above consumed power, and approaches its peak while the resistors are still on. In the third, after the resistors have been turned off, emitted power reaches its peak and then begins to fall to a new minimum value, whereupon the resistors turn on again. In the first time interval, emitted power is less than consumed power; but already in the second the trend reverses, and continues as such into the beginning of the third. Plot 8, which gives an expanded view of Plot 7, the three intervals are visually enhanced for the sake of clarity.



Plot 8. Detail taken from Plot 7, reproducing the first two periods of the cycle. The three time intervals in which each period may be divided are labeled by Roman numerals.

Further food for thought may be found by analyzing the trend of the ratio between energy produced and energy consumed by the *E-Cat HT2*, during the time interval shown in Plot 7. The blue curve in Plot 9 is the result of the analysis, and is reproduced here together with the red curve of power consumption normalized to 1. Basically, for every second taken into account, the corresponding value of the blue curve is calculated as the ratio between the sum of the power per second emitted in all the previous seconds, and the sum of the power per second consumed in all the previous seconds.



Plot 9. The blue curve is the result of the ratio between energy produced and consumed by the E-Cat HT2, *with reference to the same time instants dealt with in Plot 7. The red curve represents the ON/OFF trend of the resistor coils normalized to 1.*

All the above trends are remarkable, and warrant further in-depth enquiry.

Conclusions

The two test measurements described in this text were conducted with the same methodology on two different devices: a first prototype, termed *E-Cat HT*, and a second one, resulting from technological improvements on the first, termed *E-Cat HT2*. Both gave indication of heat production from an unknown reaction primed by heat from resistor coils. The results obtained indicate that energy was produced in decidedly higher quantities than what may be gained from any conventional source. In the March test, about 62 net kWh were produced, with a consumption of about 33 kWh, a power density of about $5.3 \cdot 10^5$, and a density of thermal energy of about $6.1 \cdot 10^7$ Wh/kg. In the December test, about 160 net kWh were produced, with a consumption of 35 kWh, a power density of about $7 \cdot 10^3$ W/kg and a thermal energy density of about $6.8 \cdot 10^5$ Wh/kg. The difference in results between the two tests may be seen in the overestimation of the weight of the charge in the first test (which included the weight of the two metal caps sealing the cylinder), and in the manufacturer's choice of keeping temperatures under control in the second experiment to enhance the stability of the operating cycle. In any event, the results obtained place both devices several orders of magnitude outside the bounds of the Ragone plot region for chemical sources.

Even from the standpoint of a "blind" evaluation of volumetric energy density, if we consider the whole volume of the reactor core and the most conservative figures on energy production, we still get a value of $(7.93 \pm 0.8)\ 10^2$ MJ/Liter that is one order of magnitude higher than any conventional source.

Lastly, it must be remarked that both tests were terminated by a deliberate shutdown of the reactor, not by fuel exhaustion; thus, the energy densities that were measured should be considered as lower limits of real values.

The March test is to be considered an improvement over the one performed in December, in that various problems encountered in the first experiment were addressed and solved in the second one. In the next test experiment which is expected to start in the summer of 2013, and will last about six months, the long term performance of the *E-Cat HT2* will be tested. This test will be crucial for further attempts to unveil the origin of the heat phenomenon observed so far.

Acknowledgments

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We would especially like to thank Andrea Rossi, M.A., inventor of the E-Cat, for giving us the opportunity to independently test the apparatus, and Prof. Em. Sven Kullander and Prof. Björn Gålnander (Uppsala University) for their continued interest in and support for these investigations.

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APPENDIX

This Appendix seeks to shed light on some details regarding the electrical measurements which were performed during the March test.
Figure 1 shows the wiring diagram of the PCE-830.
All cables were checked before measurements began. The ground cable, the presence of which was necessary for safety reasons, was disconnected. The container holding the electronic control circuitry was lying on a wooden plank and was lifted off the surface it was resting on, and checked on all sides to make sure that there were no other connections.
We furthermore made sure that the frame supporting the *E-CAT HT2* was not fastened to the pavement and that there were no cables connected to it.
Therefore, apart from its connections to the control electronics, the *E-CAT HT2* appeared to be electrically insulated.

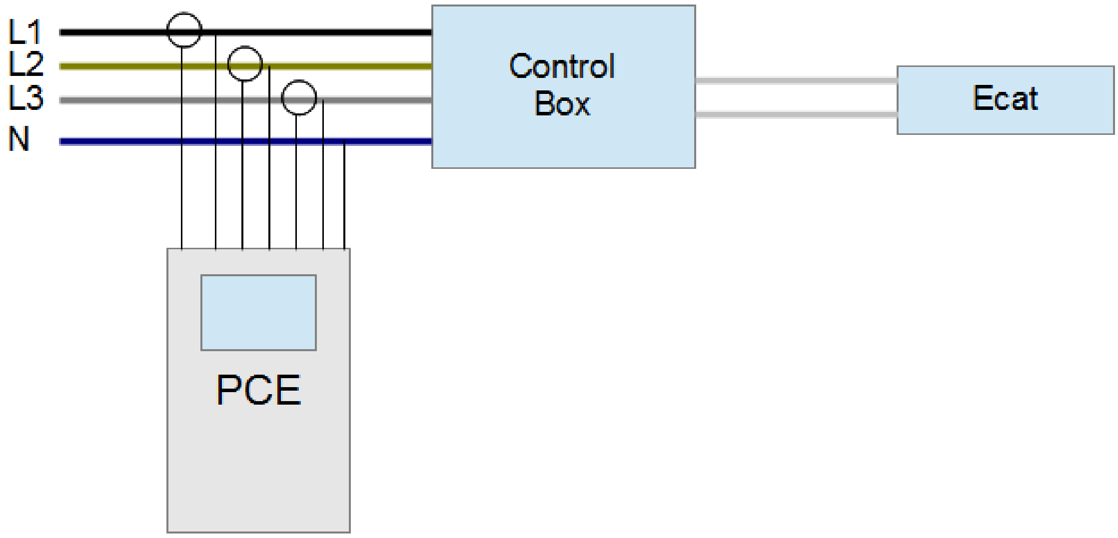


Fig. 1. Wiring diagram of the PCE-830 Power and Harmonics Analyzer. The three-phase power cables were checked and connected directly to the electrical outlet. It was established and verified that no other cable was present and that all connections were normal. The ground cable was disconnected before measurements began.

The PCE-830, in addition to providing voltage and current values for each phase, allows one to check both the waveform and its spectral composition in harmonics of the fundamental frequency (50 Hz).
As far as voltage is concerned, the figures, considering that peak values are shown, clearly show that the waveform was sinusoidal and symmetrical, and that there were no levels of DC voltage – having it been already established that there were no other electrical connections.

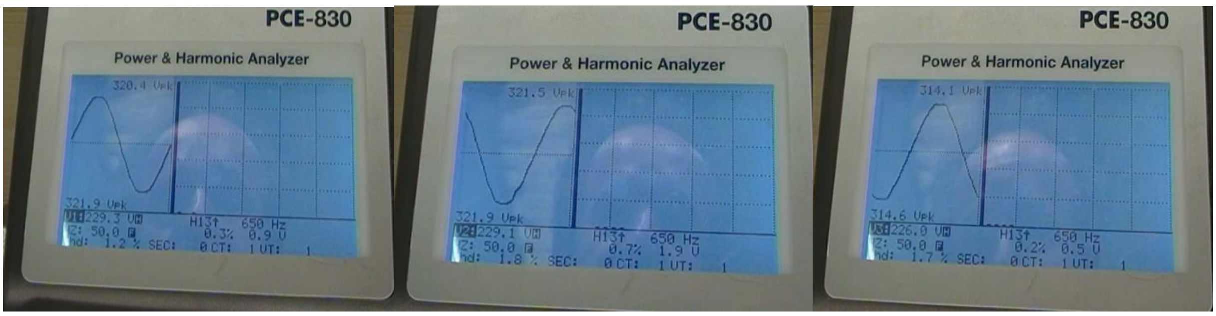


Fig. 2. Waveforms for voltages measured at control box input. Note the symmetrical sinusoids, with no indication of DC voltage levels. The spectral composition includes only the first harmonic at 50 Hz.

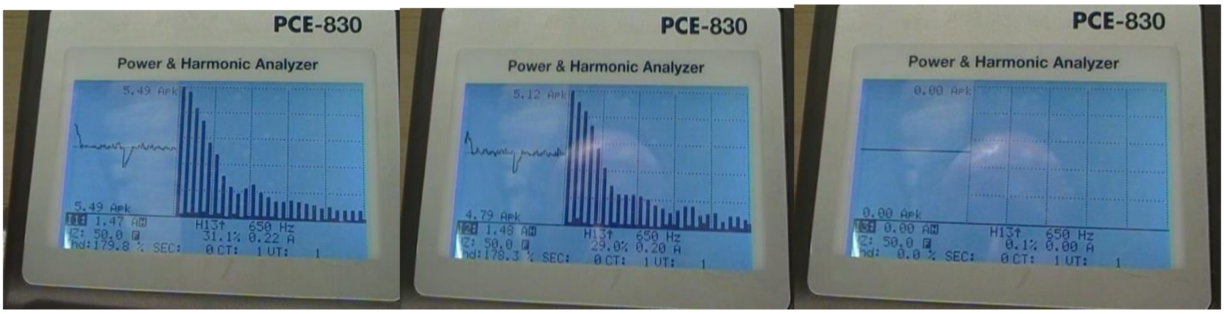


Fig. 3. Current waveform and harmonics spectrum. The waveform is typical of a sine wave cut by a TRIAC regulator. One may see that no current was present in the third phase. The first 50 harmonics are visualized. Note how the power is for the most part contained within the 30th harmonic.

The instrument's stated measurement error is 2% within the 20th harmonic, and 5% from harmonics 21 to 50. In our measurements, a margin of error of 10% was assumed.

As far as measurements of current are concerned, it was ascertained that no current was present in the third phase, and that, for the other two phases, the waveform harmonics spectrum, which appeared to be the one normally associated with a TRIAC regulator, was contained within the interval measurable by the instrument.

EXHIBIT 11

Technical Consulting Agreement

This Technical Consulting Agreement (this "Agreement") is entered into effective as of the 1st day of September 2013 by and between:

USQL United States Quantum Leap LLC, with an address at 1331 Lincoln Road Unit 601, Miami Beach, Florida 33139 U.S.A. ("USQL")

And

Industrial Heat, LLC, with an address at c/o Paracorp Incorporated 2140 South Dupont Highway Camden, DE 19934 USA ("Industrial Heat")

(each a "Party" and collectively the "Parties").

Preamble

1. Industrial Heat's affiliate is the sole and exclusive licensee for the Americas and other territories of all intellectual property rights pertinent to the following patent applications:

- IT MI2008A000629, patent granted in Italy on April 06 2011, Patent Certificate n. 1387256
- EP 08873805.9, patent pending
- US 12/736.193; patent pending

The above mentioned patent applications are pertinent to an invention that allows the production of energy plants based on an innovative and experimental technology,

2. USQL and its professional personnel not only have a great technical and scientific competence in electronics and electromechanics and computer science, but also have gained considerable experience in producing and assembling important components of such energy plants;

3. Industrial Heat desires to engage USQL to provide services related to the manufacture and development of the above mentioned energy plants, and USQL desires to accept such engagement;

Now, therefore, in consideration of the mutual covenants and agreements set forth herein, and for other good and valuable consideration, the receipt and sufficiency of which are hereby acknowledged, the Parties hereby agree as follows:

1.Recitals/ Exhibits

The foregoing recitals, as well as all exhibits and schedules that are attached to this Agreement are hereby included in and are made a part of this Agreement.

2. Technical consulting and assistance.

USQL will supply Industrial Heat with technical consulting and assistance in order to manufacture and develop the electrical equipment and the electronic system of the above mentioned energy plants. Such services will be provided on behalf of USQL by Fulvio Fabiani, the sole member and the sole manager of USQL.

Industrial Heat, as it deems appropriate, will supply USQL with all the drawings, projects, information and knowledge about products and the production process, with the exception of the information and knowledge considered as industrial or trade secrets by Industrial Heat, in order to allow USQL to carry on its activity of technical consulting and assistance. USQL is not allowed to use any of the received information and documents for purposes not concerning this Agreement, without Industrial Heat's written authorization, and all such information and documents shall remain the sole property of Industrial Heat.

3. Independent Contractor

USQL is and shall remain an independent contractor in rendering services to Industrial Heat pursuant to this Agreement. USQL shall not be deemed an employee, partner, or a joint venturer with Industrial Heat or any of its affiliates for any purpose. USQL shall perform the services described in this Agreement in good faith and in a manner reasonably believed by USQL to be in or not opposed to the best interests of Industrial Heat. Neither USQL nor anyone acting on its behalf shall be authorized to enter into any contract on behalf of Industrial Heat. USQL or any of its affiliates shall not bind Industrial Heat or any of its affiliates in any way without prior approval by Industrial Heat. USQL and its employees, agents or other personnel shall have no claim against Industrial Heat or any of its affiliates hereunder or otherwise for employee benefits of any kind, including, without limitation, vacation pay or sick leave, health or disability benefits, unemployment insurance benefits, retirement benefits, or workers' compensation. USQL and its principal shall be solely responsible for its own income or other taxes with respect to its compensation hereunder, and Industrial Heat shall not be responsible for withholding taxes or any other amounts with respect to USQL's compensation.

4. Personnel Training.

USQL agrees to instruct and train Industrial Heat's personnel about the production systems, exercise, and maintenance of the plants. Any out of pocket expenses incurred by USQL with the prior approval of Industrial Heat and relating to such training will be reimbursed or paid for by Industrial Heat.

5. Industrial secrets. Confidentiality.

USQL acknowledges that during the term of its engagement by Industrial Heat, it will have access to confidential and valuable information relating to the business and affairs

of Industrial Heat and its affiliates. USQL understands that its engagement with Industrial Heat creates a relationship of confidence and trust with respect to all such confidential information, and that it is a condition of its engagement or continued engagement by Industrial Heat, and to its working on matters involving confidential information of Industrial Heat and its affiliates, that USQL enter into this Agreement. For purposes of this Agreement, the term "affiliate" shall mean, with respect to any person or entity, any other person or entity that controls, is controlled by, or is under common control with such person or entity.

During the term of its engagement by Industrial Heat and at all times thereafter, USQL agrees that it will not, and its employees and principals will not, except as permitted by the terms of this Agreement, disclose or use, either for itself or for the benefit of any third party, any confidential information relating in any way to the business and affairs of Industrial Heat or any of its affiliates. Information in any form, including any oral, written or electronically maintained information, that is not generally available to the public shall be constituted "Confidential Information" for purposes of this Agreement, which information shall include, without limitation, the fact that USQL is performing the services described in this Agreement for Industrial Heat, the location of any premises occupied by Industrial Heat, the substance of this Agreement, information relating to the business, technical, financial or other affairs of Industrial Heat or its affiliates, including, without limitation, the fact that this Agreement or any subsequent agreement exists or the terms thereof, all information relating to intellectual property, trade secrets and products of Industrial Heat or its affiliates, all information relating to pricing, financing, business structure, transactions and parties to transactions, investors, and the internal affairs and relationships of Industrial Heat or its affiliates with third parties, and all information disclosed to or received by USQL that is specifically and reasonably identified to it by Industrial Heat or any affiliate, either orally, in writing or electronically, as constituting Confidential Information hereunder or that from all relevant circumstances reasonably should be assumed by USQL to constitute confidential information , and any information that constitutes a "trade secret" of Industrial Heat or its affiliates. The provisions of this paragraph, however, shall not prevent USQL from use or disclosure of information (i) as necessary in the ordinary course of USQL's engagement by Industrial Heat, provided that USQL will not be allowed to communicate Confidential Information to third parties (including without limitation any suppliers) without Industrial Heat's prior written authorization, (ii) that is in the public domain (other than information in the public domain as a result of a violation of this Agreement by USQL), (iii) that USQL can demonstrate was acquired outside of its affiliation with Industrial Heat from a third party in rightful possession of such information and that is not prohibited from disclosing such information, or (iv) that USQL is required to disclose or produce by law or court order or pursuant to compulsory oral questions, interrogatories, requests for information or documents, deposition, subpoena, civil investigative demand or similar legal process, in which event USQL shall provide Industrial Heat with prompt notice of any request for such disclosure or production so that Industrial Heat may seek a protective order or other

appropriate remedy and/or waive USQL's compliance with the provisions of this Agreement.

6.Rights to Materials.

All Confidential Information, records, files, memoranda, reports, drawings, plans, designs, specifications, tests and results, recordings, documents and the like (together with all copies thereof), including any of the foregoing that are electronically maintained, relating to the business of Industrial Heat or the engagement of USQL pursuant to this Agreement that USQL shall use or prepare or come in contact with in the course of, or as a result of, the engagement of USQL under this Agreement shall remain the sole property of Industrial Heat or shall be deemed contracted for as a part of the services provided hereunder, as the case may be, and none of such items or materials may be reproduced or used by USQL for the benefit of any party other than Industrial Heat or one of its affiliates or for any purpose other than this Agreement. Upon termination of this Agreement or upon the prior demand of Industrial Heat, USQL shall immediately return all such items and materials (and all copies thereof, including any electronically maintained copies) to Industrial Heat and shall not thereafter cause removal thereof from Industrial Heat's premises. USQL further agrees that upon termination of its engagement or upon the prior demand of Industrial Heat, it will promptly return to Industrial Heat all items of equipment or any other property of Industrial Heat or any of its affiliates then in USQL's possession or control.

7. New Developments.

USQL further agrees that during the term of its engagement by Industrial Heat it will promptly disclose to Industrial Heat any and all improvements, inventions, developments, discoveries, innovations, systems, techniques, processes, formulas, programs and other things that may be of assistance to Industrial Heat or its affiliates, whether patentable or unpatentable, that (i) relate to the actual or demonstrably anticipated research or development by Industrial Heat or any of its affiliates, or (ii) result from any work performed by USQL for or at the request of Industrial Heat, or (iii) are developed on Industrial Heat's time or using the equipment, supplies or facilities or any Confidential Information or trade secret information of Industrial Heat, or any of its affiliates; and that are made or conceived by USQL, alone or with others, while engaged by Industrial Heat (collectively referred to herein as the "New Developments"). USQL agrees that all New Developments shall be and remain the sole and exclusive property of Industrial Heat and that it shall, upon the request of Industrial Heat, and without further compensation, but at the cost and expense of Industrial Heat, do all things reasonably necessary to insure Industrial Heat's or its affiliate's ownership of such New Developments, including without limitation the execution of any necessary documents assigning and transferring to Industrial Heat and its assigns all of USQL's rights, title and interest in and to such New Developments, and the execution of all necessary documents required to enable Industrial Heat to file and obtain patents in the United States and foreign countries on any of such New Developments. USQL agrees that its obligations pursuant to this paragraph shall

continue beyond the termination or expiration of its engagement by Industrial Heat. In the event that USQL is unable or unavailable or shall unreasonably refuse to sign any lawful or necessary documents required in order for Industrial Heat to apply for and obtain a patent or patents or other intellectual property rights with respect to a New Development (including applications therefor or renewals, extensions, divisions or continuations thereof), USQL hereby irrevocably designates and appoints Industrial Heat and its duly authorized officers and agents as USQL's agents and attorneys-in-fact to act for and in USQL's behalf, and in its place and stead, to execute and file any such applications and other instruments, and to do all other lawfully permitted acts, to further the prosecution and issuance of patents or other intellectual property rights with respect to such New Developments and to vest ownership of such patents or other rights in Industrial Heat, with the same legal force and effect as if executed by USQL.

8.Duration of the Agreement.

This Agreement shall commence as of September 1, 2013 and shall continue in effect for an initial term through and including August 31, 2014 (the "Initial Term"). This Agreement shall terminate upon expiration of the Initial Term unless the parties agree in writing to extend it. Notwithstanding the foregoing, Industrial Heat may terminate this Agreement for "cause" during the Initial Term or at any time thereafter (i) immediately upon notice to USQL should USQL engage or be determined to have engaged in fraud or any act of material dishonesty, willful or criminal misconduct, or (ii) upon ten days prior notice to USQL that USQL has materially breached the Agreement, which failure or breach is not cured within the ten day notice period. Further, Industrial Heat may terminate this Agreement without "cause" during the Initial Term, provided that Industrial Heat shall pay the Contractor the balance of the Consultant Fee (as defined herein) due during the Initial Term, with such payment to be made at such times as it would have otherwise been due in accordance with the terms of this Agreement. If USQL terminates this Agreement at any time or if Industrial Heat terminates this Agreement for "cause" during the Initial Term , USQL shall, to the extent requested by Industrial Heat, promptly conclude all work then in process and Industrial Heat shall pay USQL for the balance of work performed to the date of termination in accordance with the compensation provisions hereof. Except as set forth in this paragraph, Industrial Heat shall not be obligated under this Agreement nor otherwise liable to USQL for any further payments following termination of this Agreement or for any costs, expenses, losses or damages arising out of or relating to a termination of this Agreement; as well as USQL shall not be obligated under this Agreement nor otherwise liable to Industrial Heat for any further payments following termination of this Agreement or for any costs, expenses, losses or damages arising out of or relating to a termination of this Agreement; provided, however, that nothing shall limit the liabilities or obligations of either party following termination of this Agreement that arise out of any breach of this Agreement by such party.

9. Compensation.

Industrial Heat will pay to USQL as compensation for the technical assistance and

consulting services provided during the Initial Term and in consideration of the terms of this Agreement, a sum equal to USD 126,000.00 (one hundred twenty six thousand/00 USD)(the "Consultant Fee"). Such Consultant Fee will be paid in monthly payments as provided in paragraph 8 below until expiration of the Initial Term or until the earlier termination of this Agreement as provided by paragraph 6. In addition to payment of the Consultant Fee, Industrial Heat will reimburse USQL for reasonable rent expenses incurred by USQL in connection with the rental of an apartment in the Raleigh, North Carolina area for Fulvio Fabiani, provided that Industrial Heat shall have the right to approve, in its sole discretion, any lease or rental agreement that binds USQL and requires the payments of any rents that USQL will be requesting be reimbursed by Industrial Heat.

10. Payment. Term and conditions

USQL, at the end of each month, will issue an invoice equal to USD 10,500.00 (ten thousand five hundred/00 USD), plus the monthly rent amount. The invoice will be sent by email to Industrial Heat. Industrial Heat will pay the above invoice within 15 days from reciept.

11. Nature of Engagement.

It is understood that USQL is engaged on a non-exclusive basis and that USQL shall remain free to provide services to other parties during the term hereof, provided that such other services by USQL do not unreasonably interfere with or impair USQL's ability to provide services as contemplated hereunder on a timely basis and are not competitive in any way with the activities of Industrial Heat and its affiliates, and further provided that Fulvio Fabiani shall devote substantially all of his business time to providing the services to the extent that such time is requested by Industrial Heat.

12. Notices.

Any kind of communications and notices concerning this Agreement shall be considered valid if they are transmitted by fax with confirmation of receipt, email with confirmation of receipt, or by registered post letter with confirmed delivery or by personal hand delivery with delivery confirmation signature.

The reference personnel and address for USQL are:

Fulvio Fabiani c/o USQL LLC 1331 Lincoln Road Unit 601, Miami Beach, FL 33139 USA - fulvio.fabiani@mail.com - +39 346 2440000

The reference personnel and address for Industrial Heat are:

Thomas F. Darden c/o Industrial Heat 111 East Hargett Street Ste 300, Raleigh NC 27601 USA – tdarden@industrialheat.co - + 1 919 7432506
JT Vaughn jvaughn@industrialheat.co 919-649-5299

Any change regarding the personnel referenced above, or to the address or to the fax

number or to the email address must be immediately communicated to the other Party and it will be considered valid on the date it is received.

13.Entire Agreement

This Agreement contains the entire agreement of the parties with respect to the subject matter contained in this Agreement and supersedes all agreements, documents or other understandings or communications heretofore made between USQL and Industrial Heat regarding the subject matter hereof.

14. Language and Applicable Law.

This Agreement has been made in the English language. All documents and communications delivered in connection therewith between the Parties shall be in the English language. This agreement shall be construed and enforced in accordance with and governed by the laws of the State of North Carolina.

15. Rights and Remedies.

The duties, obligations, rights and remedies in this Agreement shall be cumulative, and in addition to, and not in limitation of, any duties, obligations, rights and remedies otherwise imposed or available by law. No action or failure to act by Industrial Heat or USQL shall constitute a waiver of any right or duty afforded either party under this Agreement, nor shall any such action or failure to act constitute an approval of, or acquiescence in, any breach of this Agreement, except as may be specifically agreed in writing or specified herein.

16. Injunctive Relief.

USQL recognizes and agrees that its breach of the provisions of this Agreement relating to confidentiality and rights to materials may result in irreparable damage to Industrial Heat and/or its affiliates. Accordingly, should USQL at any time violate or threaten to violate any of the provisions of this Agreement relating to confidentiality or return of materials, Industrial Heat shall be entitled to all remedies available as a matter of law or equity, including, without limitation, specific performance and/or injunctive relief, to prevent or otherwise restrain a breach of such provisions.

17. Assignment.

USQL agrees that it will not assign or transfer its interest in this Agreement without the prior written consent of Industrial Heat.

[Signature page follows]

IN WITNESS WHEREOF, the parties have executed this Technical Consulting Agreement as of the day and year first above written.

Dated:

Signed, sealed and delivered by

USQL United States Quantum Leap LLC

By: ______________________

Fulvio Fabiani – Manager

Industrial Heat LLC

By: ______________________

~~Thomas F. Darden - Manager~~
JT Vaughn, Vice President

JOINDER

The undersigned, Fulvio Fabiani, the sole member and the sole manager of USQL United States Quantum Leap LLC ("USQL"), hereby joins in the foregoing Agreement for the purpose of agreeing to be bound by the provisions thereof relating to confidentiality, rights to materials, and new developments to the same extent as USQL is bound by such provisions. Further, the undersigned acknowledges that USQL is an independent contractor for purposes of this Agreement and that neither USQL nor the undersigned shall be deemed an employee of USQL for any purpose.

Date: 9/9/13

____
Fulvio Fabiani

EXHIBIT 12

From: **eon333@libero.it** <eon333@libero.it>
Date: Monday, September 10, 2012
Subject: I: Fwd: Fw: Our latest on the E-cat: 'Swedish investment in E-cat halted after test'
To: tdarden@cherokeefund.com, jvaughn@cherokeefund.com

Dear Tom,
mission accomplished.
With this company Hydrofusion we had agreed upon a draft to sell them IP, know how and manufacturing license for Europe but Germany, France and Italy. By our law, if you send a proposal you are engaged to accept if the proposee accepts all the conditions of the proposal. After receiving your last text at the end of August I decided to go ahead with you, therefore I had to get rid of this engagement . The only way out was to invite them to a test, ask them to bring with them their consultant. I made the test abort, maintaining the temperatures below the starting limit. Then I made up some discussions, I said they made a wrong test, they escaped, I am free.
We did not have damages of image, because, knowing what was on the road, I had made before their test a disclaimer, saying that the Hot temperature E-Cat was just a prototype, still under test and validation and subject to modification, thing that I am repeating everywhere. Now I am publishing that I am surprised of all this ado for nothing, since I already said that for the Hot Cat we needed more tests before saying it is a product ready for the market.
At this point we can organize with Cherokee a world strategy, since all the other licensees are just commercial: for example in Africa we will have just to pay a roialty to the local agent upon our sale price , but they all are very good and they can sell either energy or plants. Nobody has rights upon the IP, know how, manufacturing and so on.
Warmest Regards,
Andrea

EXHIBIT 13

From: **eon333@libero.it** <eon333@libero.it>
Date: Mon, Sep 10, 2012 at 6:50 PM
Subject: R: Re: Andrea Rossi
To: tdarden@cherokeefund.com, jimcompton@mindspring.com, rickbauman14u@yahoo.com, jvaughn@cherokeefund.com
Cc: ccassarino@lti-global.com

Thank you, Tom: on the 23rd I will return with the agreement signed by me, probably the same text you sent me, we will just adjust some particulars.

I got rid of the European big clicense I had to sign. I made a masterpiece making them go voluntarily...I will explain personally.

About the commercial licensees: Cherokee will direct them , I made up a very good organization that can be useful.

Enjoy Paris!

Warmest Regards,

Andrea

----Messaggio originale----
Da: tdarden@cherokeefund.com
Data: 10/09/2012 23.37
A: <eon333@libero.it>, <jimcompton@mindspring.com>, <rickbauman14u@yahoo.com
>, <jvaughn@cherokeefund.com>
Cc: <ccassarino@lti-global.com>
Ogg: Re: Andrea Rossi

Good to hear from you. I am in France, but I would prefer to be in Bologna right now talking business, that's for sure.

I am glad JT Vaughn was able to come to your conference. I have not seen the online reports but will try to get an internet connection to do so.

I look forward to hearing more and to seeing you when you return. We look forward to the growth and development of your great technology.
Thomas F Darden
Cherokee
www.cherokeefund.com
919 743 2506 w
919 522 4095 c

From: eon333@libero.it <eon333@libero.it>
To: tdarden@cherokeefund.com <tdarden@cherokeefund.com>; jimcompton@mindspring.com <jimcompton@mindspring.com>; rickbauman14u@yahoo.com <rickbauman14u@yahoo.com>; jvaughn@cherokeefund.com <jvaughn@cherokeefund.com>
Cc: ccassarino@lti-global.com <ccassarino@lti-global.com>
Sent: Mon Sep 10 13:36:58 2012
Subject: Andrea Rossi

Dear Tom:
I am back from Zurich.
Before contacting your attorneys we want to complete the study of the document you sent . I want to tell you that so far we have not changements to make. It is good.
For this reason I have put on hold everything else and I am downplaying all the talks here.

I explained well to John in Zurich what I am doing.
On the 22nd I will be in Miami, so that we could make a meeting immediately after to initial a final draft.
The first plant could be put in Africa do desalinate water: wecould put it there to work for free, making good making well: millions of units could be sold after that. We have a new technology to desalinate very cheap using the 1 MW E-Cat.
Warmest Regards,
Andrea
p.s. did you see Zurich on the Internet?

EXHIBIT 14

Observation of abundant heat production from a reactor device and of isotopic changes in the fuel

Giuseppe Levi
Bologna University, Bologna, Italy

Evelyn Foschi
Bologna, Italy

Bo Höistad, Roland Pettersson and Lars Tegnér
Uppsala University, Uppsala, Sweden

Hanno Essén
Royal Institute of Technology, Stockholm, Sweden

ABSTRACT

New results are presented from an extended experimental investigation of anomalous heat production in a special type of reactor tube operating at high temperatures. The reactor, named E-Cat, is charged with a small amount of hydrogen-loaded nickel powder plus some additives, mainly Lithium. The reaction is primarily initiated by heat from resistor coils around the reactor tube. Measurements of the radiated power from the reactor were performed with high-resolution thermal imaging cameras. The measurements of electrical power input were performed with a large bandwidth three-phase power analyzer. Data were collected during 32 days of running in March 2014. The reactor operating point was set to about 1260 ºC in the first half of the run, and at about 1400 °C in the second half. The measured energy balance between input and output heat yielded a COP factor of about 3.2 and 3.6 for the 1260 ºC and 1400 ºC runs, respectively. The total net energy obtained during the 32 days run was about 1.5 MWh. This amount of energy is far more than can be obtained from any known chemical sources in the small reactor volume.

A sample of the fuel was carefully examined with respect to its isotopic composition before the run and after the run, using several standard methods: XPS, EDS, SIMS, ICP-MS and ICP-AES. The isotope composition in Lithium and Nickel was found to agree with the natural composition before the run, while after the run it was found to have changed substantially. Nuclear reactions are therefore indicated to be present in the run process, which however is hard to reconcile with the fact that no radioactivity was detected outside the reactor during the run.

1. Introduction

This paper presents the results from a new extended study carried out on the "E-Cat" reactor, a device invented by Andrea Rossi. Various tests of this reactor have indicated that an excessive amount of heat is generated from a fuel consisting of hydrogen-loaded nickel powder plus some additives. The heat generating process is initiated by heat from resistor coils around the reactor tube. In addition, the resistor coils are fed with some specific electromagnetic pulses. The E-Cat reactor was tested in March 2013 by the same collaboration performing the present test and a report is given in ref. [1]. The March 2013 test showed indeed a clear indication that abnormal heat was generated, i.e. that the amount of heat could not be explained by any chemical processes in the limited volume of the reactor tube. This striking result prompted us to investigate this phenomenon further. Therefore a second test has now been performed, this time over a much longer period of time (32 days). Also, additional instrumentation was employed to further improve and secure the experimental conditions during the run. A longer test was also motivated to investigate the long term stability of the E-Cat operation, as well as running it at two different operational settings for comparison. Furthermore, and more importantly, we wanted to investigate if the nuclear composition of the fuel had changed due to the heat generating process. Such an investigation is indispensable in order to find out if the heat generating process has its origin in transformations at the nuclear level. A careful analysis of the fuel

isotope composition has therefore been performed on samples taken by us before and after the experimental run using the standard methods of SIMS, XPS, EDS and the chemical element analysis ICP-MS and ICP-AES.

In the course of the year following the previous tests, the E-Cat's technology was transferred to Industrial Heat LLC, United States, where it was replicated and improved. The present E-Cat reactor is therefore an improved version running at higher temperature than the one used in the March 2013 experiment. The general experimental procedure in the present test was the same as in the March test, i.e. the input power was carefully monitored with appropriate instruments, and the output power was determined by measuring the emitted radiation as well as calculating the heat dissipation from convection. The test started with a run with no fuel in the reactor in order to make sure that our experimental set-up gave a perfect balance between the measured input and output power.

Since we required that our measurements be carried out in an independent laboratory with our own equipment, the experiment was purposely set-up and hosted within an industrial establishment which was not in any way connected with Andrea Rossi's businesses or those of his partners. The test was thus performed in Barbengo (Lugano), Switzerland, in a laboratory placed at our disposal by Officine Ghidoni SA.

2. Reactor characteristics and experimental setup

The reactor investigated on this occasion is outwardly quite different from the ones used in the tests held in the past years. Its external appearance is that of an alumina cylinder, 2 cm in diameter and 20 cm in length, ending on both sides with two cylindrical alumina blocks (4 cm in diameter, 4 cm in length), non-detachable from the body of the reactor, which henceforth will be referred to as "caps". An image of the reactor is given in Figure1. Whereas the surface of the caps is smooth, the outer surface of the body of the E-Cat is molded in triangular ridges, 2.3 mm high and 3.2 mm wide at the base, covering the entire surface and designed to improve convective thermal exchange (cylinder diameter is calculated from the bases of the ridges). In this way, the current model of E-Cat is capable of attaining higher temperatures than the earlier models, avoiding internal melting, a previously fairly frequent occurrence [1].

Figure 1. Weighing the E-Cat after the test (452 g). The ridges along the body of the reactor increase the dissipation surface for natural heat convection. The power supply cables run through the two cylindrical extremities (termed "caps"), and were cut prior to weighing.

Three braided high-temperature grade Inconel cables exit from each of the two caps: these are the resistors wound in parallel non-overlapping coils inside the reactor. A thermocouple probe, inserted into one of the caps, allows the control system to manage power supply to the resistors by measuring the internal temperature of the reactor. The hole for the thermocouple probe is also the only access point for the fuel charge. The thermocouple probe cable is inserted in an alumina cement cylinder, which acts as a bushing and perfectly fits the hole, about 4 mm in diameter. When charging the reactor, the bushing is pulled out, and the charge is inserted. After the thermocouple probe has been lodged back in place, the bushing is sealed and secured with alumina cement. To extract the charge, pliers are used to open the seal.

The resistors and the copper cables of the three-phase power supply are connected outside the caps, in the classic delta configuration. For 50 cm from the reactor, the power cables are contained in hollow alumina rods (three per side), 3 cm in diameter (Figure 2). The purpose of the rods is to insulate the cables and protect the connections.

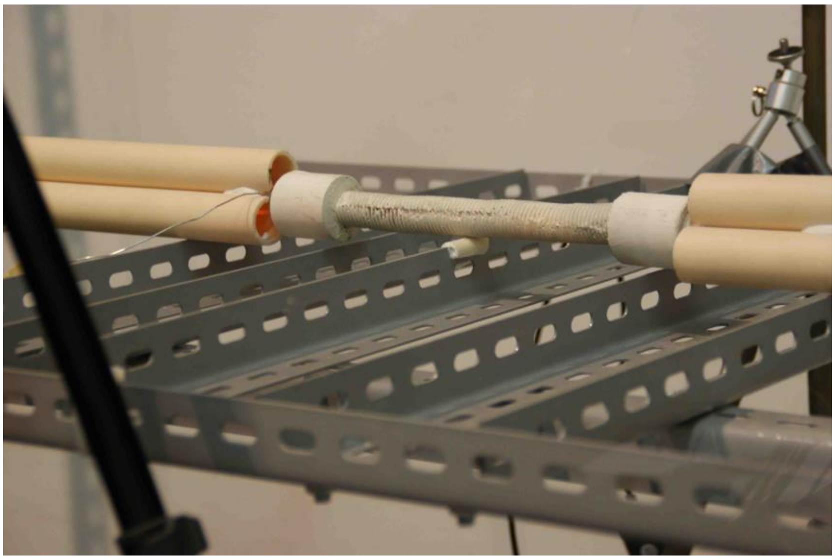


Figure 2.The E-Cat, installed on its metal frame. Note the two sets of three alumina rods (one per side) thermally and electrically insulating the supply cables that run through them. On the left, the cable connecting to the K-type probe may be seen. The strut under the center of the reactor has been covered with alumina cement, which provides thermal insulation of the reactor from the strut.

The E-Cat's control apparatus consists of a three-phase TRIAC power regulator, driven by a programmable microcontroller; its maximum nominal power consumption is 360 W. The regulator is driven by a potentiometer used to set the operating point (i.e. the current through the resistor coils, normally 40-50 Amps), and by the temperature read by the reactor's thermocouple.

Both the reactor and the rods lie on a metal frame, the points of contact with the frame being thermally insulated with alumina cement. The whole frame lies on an insulating rubber mat on the floor (Figure 3).

Figure 3. Experiment setup for the measurements. Foreground: reactor control system, the two PCEs for electric power measurements, and one of the multimeters used to verify that no DC components were present. Background: reactor, the two thermal imagery cameras. Note the 6 dosimeters (pairs of red and blue rectangles: 2 on wall, two to the left of reactor, and two to the right, on the far ends of the metal frame) for radiation emission measurements.

As in the previous tests, the calculation of the E-Cat's average power and energy production was performed by evaluating the power emitted both by radiation and convection. Our instruments consisted of two thermal imaging cameras to measure average surface temperatures, two power and harmonics analyzers for electrical consumption measurements, and three digital multimeters to measure any possible DC component in the power supply.

The cameras used were two Optris PI 160 Thermal Imagers, one provided with a 30° × 23° lens and 160 × 120 pixel UFPA sensors, capable of reading temperatures up to 900°C, the other with a 48° ×37° lens, capable of measuring temperatures up to 1500°C. The spectral range for both cameras is from 7.5 to 13 µm. The power analyzers were two PCE 830 units from PCE Instruments, capable of measuring, and displaying on an LCD display, electric current, voltage and power values, as well as the corresponding waveforms. These instruments are capable of reading voltage and AC current values up to 5 kHz.

The choice of instruments was warranted both by the straightforwardness of the experimental setup and the precision of the instruments themselves. Designing a calorimetric measurement by means of a cooling fluid would have been more complex, especially in the light of the high temperatures reached by the E-Cat.

All the instruments used during the test are property of the authors of the present paper, and were calibrated in their respective manufacturers' laboratories. Moreover, once in Lugano, a further check was made to ensure that the PCEs and the IR cameras were not yielding anomalous readings. For this purpose, before the official commencement of the test, both PCEs were individually connected to the power mains selected for powering the reactor. For each of the three phases, readings returned a value of 230 ± 2V, which is appropriate for an industrial establishment power network. The IR cameras, on the other hand, were focused on circular tabs of adhesive material of certified emissivity (henceforth referred to as "dots"). The relevant readings were compared to those obtained from a thermocouple used to measure ambient temperature, and were found to be consistent with the latter, the differences being < 1°C.

Throughout the test, all the above instruments were connected to the same computer, wherein all the acquired data was saved. For both the PCEs and the IR cameras, data acquisition frequency was set at 0.5 Hz.

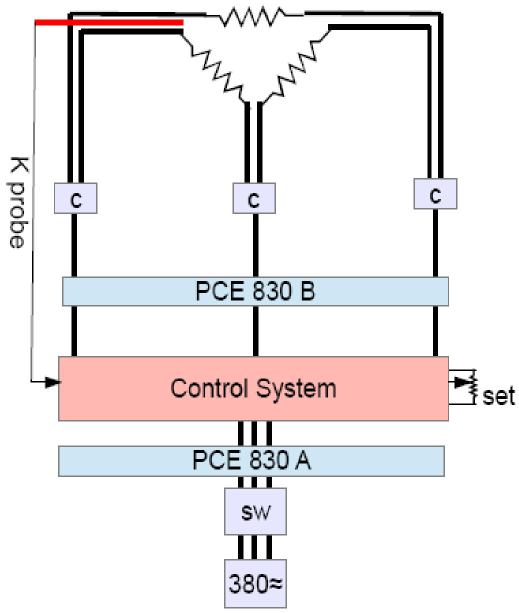


Figure 4.Wiring diagram. The two PCEs are located one upstream and one downstream from the control instruments, a TRIAC three-phase power regulator driven by a potentiometer and by the temperature read by the K-probe. The resistors are connected in delta configuration (SW = Switch, C = Connection Box). Note that, in the text, the three cables running from the control system to C are termed C_1, whereas the six cables running from C to the reactor are termed C_2.

Figure 4 details the electrical connections of all elements of the experimental setup. The two PCEs were inserted one upstream and one downstream of the control unit: the first allowed us to measure the current, voltage and power supplied to the system by the power mains; the second measured these same quantities as input to the reactor. Readings were consistent, showing the same current waveform; furthermore, they enabled us to measure the power consumption of the control system, which, at full capacity, was seen to be the same as the nominal value declared by the manufacturer.

Special attention was given to measuring the current and voltage input to the system: the absence of any DC component in the power supply was verified in various occasions in the course of the test, by means of digital multimeters and supplementary clamp ammeters. We also verified that all the harmonics of the waveforms input to the system were amply included in the range measurable by the PCEs (Figure 5). The three-phase current line supplying all the energy used for the test came from an electrical panel belonging to the establishment hosting our laboratory, to which further unrelated three-phase current equipment was connected.

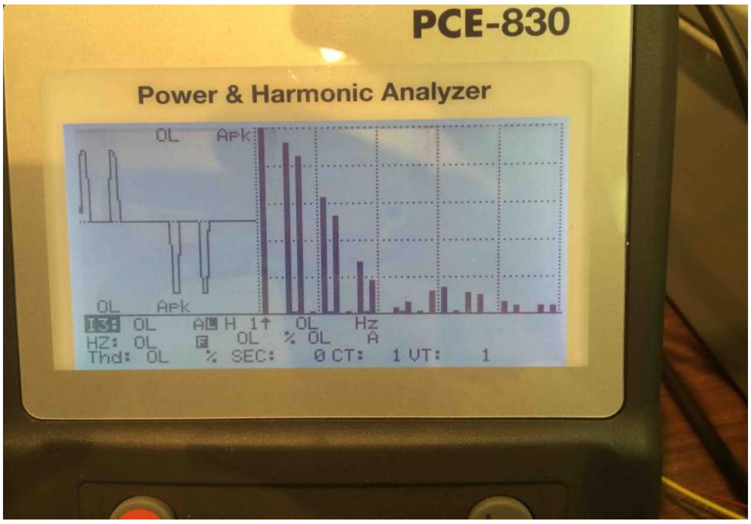


Figure 5.The PCE display downstream from the control unit. On the left, one can see the current's waveshape (identical in both PCEs), on the right its harmonics analysis. Note that the PCE is capable of correctly measuring up to 100 harmonics, though with diminishing precision. The figure reveals that all the most important harmonics are contained within the 20th harmonic, and, therefore, that all the wave shape harmonics input to the system lie within the PCE's measuring range.

David Bianchini, MSc and expert in radiation detection, was in charge of assessing possible ionizing radiation and neutrons emitted by the reactor charge, before, during and after operation. For this purpose, he provided the following instruments: a scintillation probe, a neutron radiation detector, a Geiger probe and various thermo luminescent dosimeters. For all types of radiation taken into consideration, background radiation was measured beforehand, both inside the laboratory where the test took place, and in various premises belonging to the establishment hosting us. Subsequently, Bianchini evaluated the possible presence of alpha, beta and gamma radiation by applying his instruments directly to the powder that was subsequently inserted into the reactor. The same operation was repeated after the end of the test on the powder extracted from the reactor. In both cases, no signs of activity were found. Similar readings were performed on the E-Cat, both during the dummy run without charge powder, and during normal operation. Several dosimeters located in the vicinity of the reactor were in operation during the entire 32 days of the test, for detecting neutron radiation. A detailed report on these operations and the results thereof is supplied as Appendix 1 to the present paper.

3. Experimental procedure

The first phase of the test was dedicated to measuring the "dummy reactor", i.e. the E-Cat operating without its internal charge. Conservation of energy dictates that all power supplied to the dummy reactor from the electric power line be dissipated as thermal energy to the environment by means of radiation and convection. Therefore, by comparing power input, as measured by the two power analyzers, to power output as measured by us, we were able to ascertain that no overestimation had occurred. In other words, the data relevant to the dummy reactor served the purpose of checking the method used. However, it was not meant to compare the operation of the loaded reactor to the dummy run. In fact, such a procedure would have required that the same amount of power be supplied to the dummy and to the reactor. Moreover, at the start of the measurements, there was no way of knowing what input power the loaded reactor would have absorbed. In fact, it is well known that some Inconel cables have a crystalline structure that is modified by temperature, and are capable of withstanding high currents only if they are operated at the appropriate temperature. If these conditions are not met, microscopic melt spots are liable to occur in the cables. So, there was some fear of fracturing the ceramic body, due to the lower temperature of the thermal generators

with respect to the loaded reactor. For these reasons, power to the dummy reactor was held at below 500 W, in order to avoid any possible damage to the apparatus.

The dummy reactor was switched on at 12:20 PM of 24 February 2014 by Andrea Rossi who gradually brought it to the power level requested by us. Rossi later intervened to switch off the dummy, and in the following subsequent operations on the E-Cat: charge insertion, reactor startup, reactor shutdown and powder charge extraction. Throughout the test, no further intervention or interference on his part occurred; moreover, all phases of the test were monitored directly by the collaboration.

"Dots" of known emissivity, necessary to subsequent data acquisition, were placed in various places on the cable rods. It was not possible to perform this operation on the dummy reactor itself (and *a fortiori* on the E-Cat), because the temperatures attained by the reactor were much greater than those sustainable by the dots. We also found that the ridges made thermal contact with any thermocouple probe placed on the outer surface of the reactor extremely critical, making any direct temperature measurement with the required precision impossible. Therefore, in the course of the test, we set the camera software to emissivity values valid for several alumina thermal ranges. However, in order to acquire from the literature a more adequate emissivity vs. temperature trend, it was necessary to know some of the characteristics of the material the reactor was made of, such as its composition and degree of purity. For this purpose, upon completion of the test, we took a sample of the material constituting the reactor; subsequently, Prof. Ennio Bonetti (Bologna) subjected it to X-Ray spectroscopy. The results confirmed that it was indeed alumina, with a purity of at least 99%. Details of this analysis will be found in Appendix 2.

After 23 hours' operation, the dummy reactor was switched off and disconnected from the power cables, to allow for one of the caps to be opened and the powder to be inserted. The powder had been previously placed in a small envelope, weighed (about 1 g), and then transferred to a test tube so that Bianchini could perform radioactivity measurements on it, after placing it in a low background lead well. Lastly, the contents of the test tube were poured inside the reactor, in the presence of a member of the experimental team. The leads were reconnected and the cap sealed with a mixture of water and alumina powder cement. The E-Cat was placed once again on its metal frame, and power was fed to it, the voltage being increased in progressive steps.

Upon completion of the gradual startup process procedure, the thermal camera indicated an average temperature for the body of the reactor of 1260°C, while the PCE recorded an electric power input to the E-Cat fluctuating at around 810 W. Although we had been informed that the E-Cat was capable of operating at higher power values, we had previously decided to keep to the lower value, and for almost 10 days no adjustments to the apparatus were made.

After this initial period, we noticed that the feedback system had gradually cut back the input current, which was yielding about 790 W. We therefore decided to increase the power, and set it slightly above 900 W. Thereby, we also obtained an important second measurement point. In a few minutes, the reactor body reached a temperature close to 1400°C. Subsequent calculation proved that increasing the input by roughly 100 watts had caused an increase of about 700 watts in power emitted. The speed with which the temperature had risen persuaded us to desist from any further attempt to increase the power input to the reactor. As we had no way of substituting the device in case of breakage or melting of internal parts, we decided to exercise caution and continue operating the reactor at ca. 900 W.

We also chose not to induce the ON/OFF power input mode used in the March 2013 test, despite the fact that we had been informed that the reactor was capable of operating under such conditions for as long a time as necessary. That power input mode, however, would have caused significant temperature increases during the brief intervals of time in which power was fed to the reactor. Moreover, the emissivity of alumina is temperature-dependent: this would have made all calculations troublesome and rendered analysis of the acquired data difficult.

In all the days that followed, no alterations were made to the instrumental apparatus or to the supply voltage. The dummy run was filmed and saved to a single thermography file; likewise, only one relevant file was produced by the PCE. But for the test on the E-Cat, we decided to save the data – both from the thermal camera constantly focused on the reactor body and from the PCE – on two-day intervals, yielding a total of 16 files from each instrument. This was done to avoid creating very large files, the accidental loss of which would have been inconvenient; moreover, it allowed us to perform preliminary analyses on the earliest data recorded. The other IR camera was primarily used to frame the hollow rods containing the power cables, and its position was changed often in the course of the test. When experimental conditions were seen to be constant, it would be pointed towards various parts of the reactor as well as of the rods, in order to verify the symmetry of heat emission and thus yield a more comprehensive picture of the thermal behavior of the system.

About 32 days from startup, on the 29 March 2014, at 11:40, the E-Cat was shut down, after gradually reducing its input power. The shutdown date had already been decided when organizing the test, and had nothing to do with the potential of the reactor, which was running normally. Therefore, no assumption may be made on the life of the powder charge, nor, consequently, on the total energy density of the reactor charge ,which means that the values found are only indicative of lower limits.

After cooling, the E-Cat was again opened by breaking one of the caps, and the powder was collected and put in a test tube. After Bianchini's readings, performed in a matter similar to those in the first phase, the test tube was handed back to us for further analysis, the results of which will presented in paragraph 8.

4. Data analysis method

4.1 Radiant power

Radiant power emitted both by the dummy reactor and by the E-Cat was calculated by means of the Stefan-Boltzmann formula:

$$M = \varepsilon\sigma T^4 \text{ [W/m}^2\text{]} \quad (1)$$

where ε is a parameter that assumes values ranging from 0 to 1, and represents the emissivity of a body, whereas σ is the Stefan-Boltzmann constant, the value of which is $5.67 \cdot 10^{-8}$ [W/m^2K^4].

Knowing the value of ε is of prime importance, both for the calculation of power emitted, and for reading temperatures with an IR camera, an instrument which does not measure the relevant parameter directly, but deduces it by means of a formula having several variables which must be supplied. Every thermal camera contains a detector where sensitive components generate an electric signal proportional to the IR radiation received. This signal is then amplified and processed by the device’s electronics, and converted into an output signal proportional to the temperature of the object. This proportionality is expressed by an algorithm dependent on several parameters, such as the internal temperature of the detector (read directly by the camera sensors), ambient temperature, and the emissivity of the radiant body. The user sets the last two parameters before acquiring the data, but they may be also modified in the course of the analysis, because the camera software is capable of re-elaborating stored results and re-adapting them to new settings. For an in-depth description on how the cameras used by us work, see [2].

From the analyses performed on the sample taken from the reactor, we determined that the material constituting the outer shell is 99% pure alumina (Appendix 2); better yet, that impurities, if present, are below the experimental limit of measurement. We therefore retrieved from the literature [3] a discrete-point plot of the emissivity of said material as a function of temperature (Figure 6), and extracted from it the values necessary to reproduce the trend as a continuous line (Plot 1).

The error associated with the plot's trend has been measured at ± 0.01 for each value of emissivity: this uncertainty has been taken into account when calculating radiant energy.

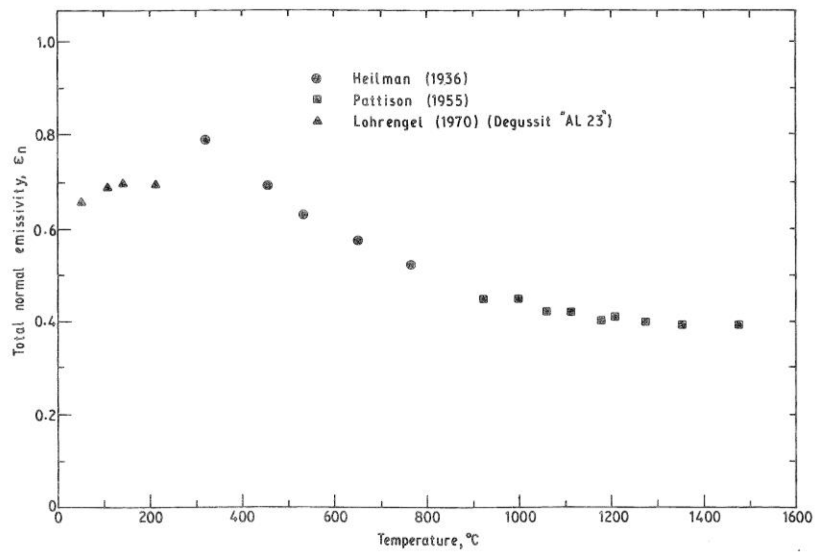
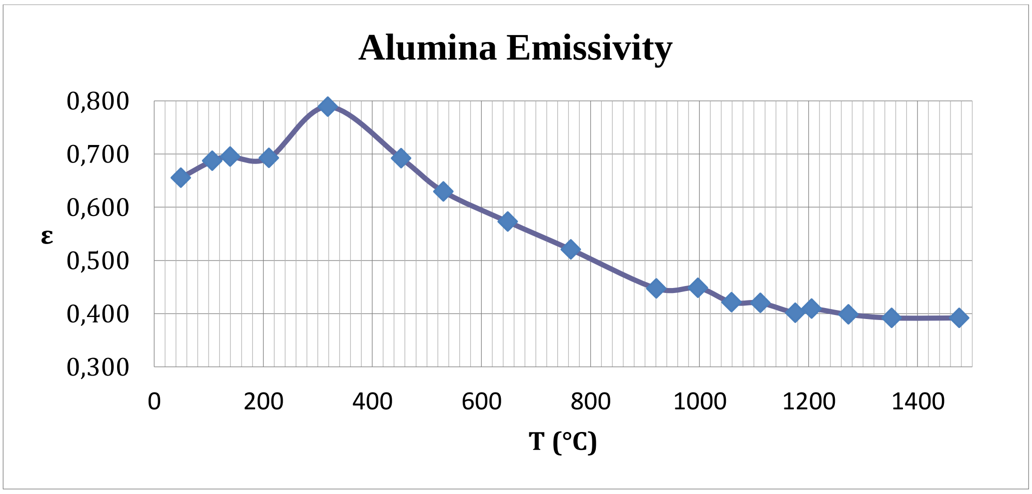


Figure 6.Trend of alumina emissivity vs. temperature; from [3].



Plot 1. Alumina emissivity trend as a function of temperature, reproduced from data extracted from the plot in Figure 6 [3].

During the data analysis, in order to account for the several values of ε and the, at times, uneven distribution of heat, each thermography file was divided in an appropriate number of areas, to which the Stefan-Boltzmann formula was applied. The values for ε relevant to each area were assigned recursively, by correcting the settings until the same matching between temperature and emissivity indicated by Plot 1 was achieved. Iterative methods for determining the emissivity of an observed object are well known in the literature: some examples may be found in [4], [5].

It was not possible to extract any sample of the material constituting the rods, as this is firmer than that of the reactor. The rods were made of pure alumina, crystallized however with a different degree of fineness due to the industrial origin of their manufacture.

We therefore took the same emissivity trend found in the literature as reference; but, by applying emissivity reference dots along the rods, we were able to adapt that curve to this specific type of alumina, by directly measuring local emissivity in places close to the reference dots (Figure 7).

An example of all these procedures will be given in detail only for the dummy reactor, in paragraph 5.

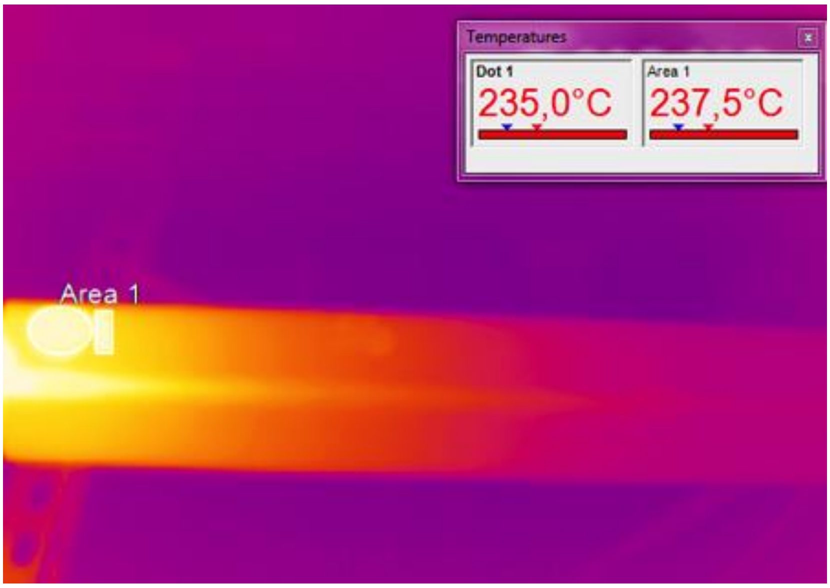


Figure 7. Detail of a thermography image of the rods to the right of the E-Cat. The circular bright spot is a reference "dot" (TiO_2 on Kapton film) which has higher emissivity (0.95) than that of alumina, and thus appears to be hotter. The temperature read on this dot (235°C) is the actual temperature of the tube. The temperature at the rectangle next to the circle (237.5 °C) is obtained by setting an emissivity value for alumina found in the literature [3.] The difference lies within the errors associated to the measurements.

4.2 Convection

In order to calculate the heat dissipated by convection, two different kinds of surfaces must be taken into consideration, the smooth cylindrical surfaces of the rods and reactor caps, and the ridged cylinder of the reactor body.

If one identifies both the rods and the reactor caps as cylinders immersed in air, one may, for each of them, calculate the heat Q emitted by convection per time unit by means of Newton's relation. If T_a indicates air temperature, A the surface area of a cylinder, and T_s the cylinder's temperature, we have:

$$Q = hA(T_s – T_a) = hA\Delta T \text{ [W]} \quad (2)$$

where h defines the thermal exchange coefficient [W/m²K].

Calculating h is the fundamental problem of thermal convection calculation, and has been tackled by various authors more or less empirically (See f.i. [6], [7], and [8]). In the specific case of cylindrical surfaces, one of the more commonly used expressions is the following one:

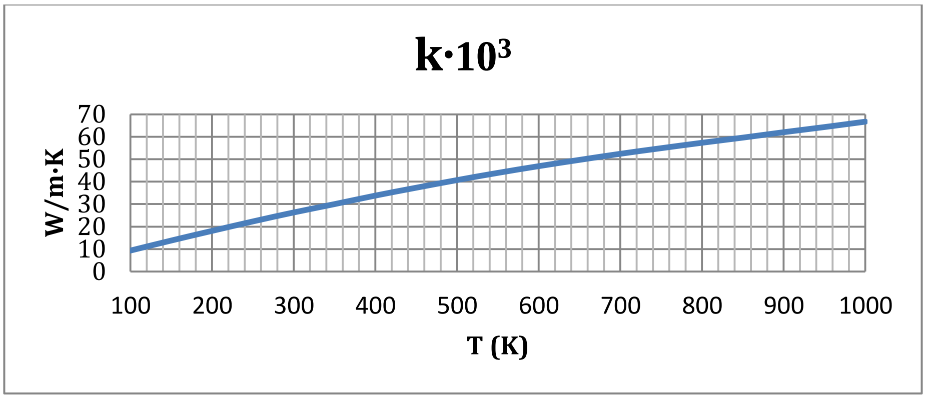
$$h = (kCRa^n) / D \text{ [W/m}^2\text{K]} \quad (3)$$

where k indicates the coefficient of thermal conductivity of air [W/mK], C and n are two constants, Ra is Rayleigh's number, and D the diameter of the cylinder. Rayleigh's number is a dimensionless parameter given by the following expression:

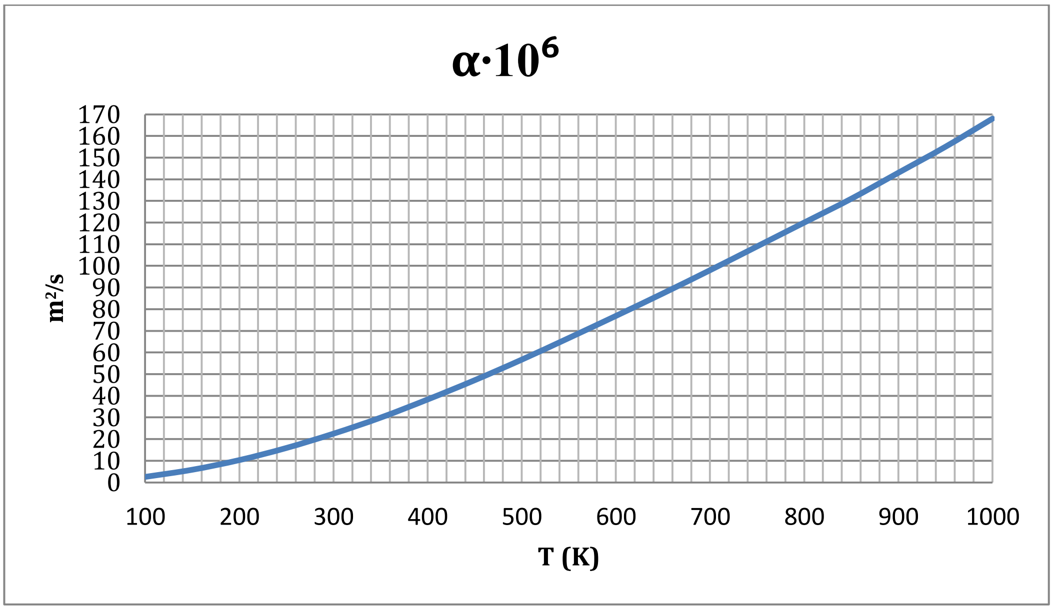
$$Ra = (g\beta(T_s – T_a)D^3) / \nu\alpha \quad (4)$$

where g [m/s^2] is gravitational acceleration, β[K^{-1}] is the volumetric thermal expansion coefficient, which, for an ideal gas (applied here to air for simplicity) is= 1/T; next, ν [m²/s] is kinematic viscosity, and α [m²/s] is thermal diffusivity. Coefficients β, k, α, and ν are all temperature-dependent, and must be calculated at the so-called "film temperature" $T_f = (T_s + T_a) / 2$. Plots 2, 3, and 4 express these trends for a range of temperatures from 100 to 1000 K and have been taken from the data reported in Appendix A of [9].

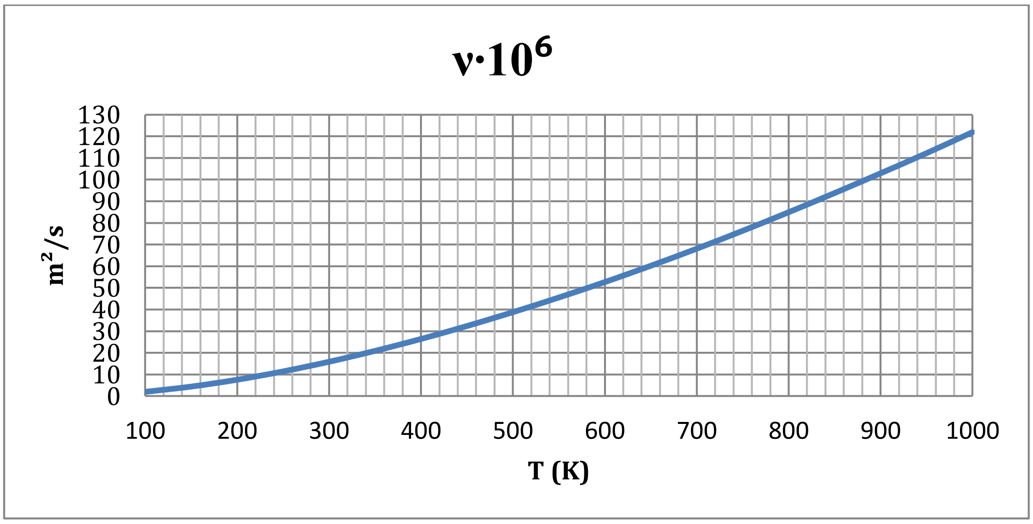
Plot 2.



Plot 3.



Plot 4.



Plots 2, 3, and 4. Trends of thermal conductivity k [W/mK], kinematic viscosity ν [m²/s], and thermal diffusivity α [m²/s] of air in function of temperature, reproduced from data found in the literature [9]. The convention used to present numerical values of the properties is illustrated by this example: for T = 300 [K] we have $k \cdot 10^3$= 26.3 [W/mK],$\nu \cdot 10^6$= 15.9 [m²/s], and $\alpha \cdot 10^6$= 22.5 [m²/s]; therefore k = 0.026 [W/mK], ν = 0.000016 and α = 0.000023.

The Rayleigh number expresses the ratio of buoyancy forces to viscous forces, and its value is indicative of the laminar-turbulent transition, which occurs when Ra >10^9. Constants C and n are dependent on the value of Ra, according to what is expressed by Table 1 [9].

Ra	C	n
10^{-10}-10^{-2}	0.675	0.058
10^{-2}-10^{2}	1.020	0.148
10^{2}-10^{4}	0.850	0.188
10^{4}-10^{7}	0.480	0.250
10^{7}-10^{12}	0.125	0.333

Table 1. Values of the constants C and n corresponding to variations of the Rayleigh number.

Thermal flow emitted by the body of the reactor by natural convection may be in turn calculated by an expression suitable to objects having circular fins, to which our ridges may be compared for simplicity's sake. Figure 8 shows a single circular fin, triangular in profile. This shape is the closest possible to the reactor's ridges, and is appropriate to represent them.

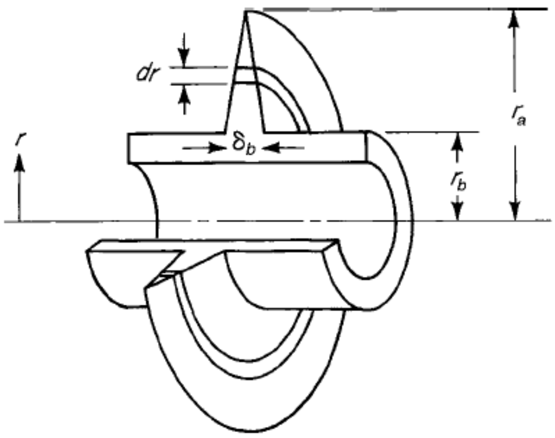


Figure 8. Representation of a circular fin having triangular profile. Its shape is very similar to that of the reactor ridges, and was used as a model to calculate natural convection.

Let us then approximate the body of the reactor to that of a cylinder having N fins, each one having surface A_f. If we take A_t as the its total surface, we have:

$A_t = NA_f$ (5)

The length of the reactor body is given by L = 200 mm, and that of the base of each ridge is given by δ_b = 3.25 mm. If we compare this to a finned cylinder having no space between fins, the number of ridges/fins along it is = N = L / $\delta_b \approx$ 61. For the area of each fin, we have:

$A_f= 2\pi(r_a^2 – r_b^2) = 3.22 \cdot 10^{-4}[m^2]$ (6)

where r_a is the distance between the axis of the cylinder and the tip of a fin, = $1.23 \cdot 10^{-2}$[m], while r_b is the radius of the cylinder = $1.0\cdot10^{-2}$[m] (Figure 8). Note how this formula for the area is actually fit for fins

having a rectangular, not triangular, profile; this approximation is however commonly used, as one may see f.i.in [10].

We may calculate the total thermal power emitted by convection by the reactor body in the following manner [9]:

$Q = N\eta h A_f(T_s - T_a)$ [W] (7)

assuming that coefficient h is equivalent of what one would have for a finless surface.

This coefficient is therefore calculated as in (3), referring to a cylinder having the size of the reactor but completely devoid of fins (see here [9]). Parameter η represents here the efficiency of each fin, and is an index of its thermal performance. Since the driving potential for convection is expressed by the difference in temperatures between a body and its exchange fluid, it is obvious that the maximum thermal flow for a fin would be had if its entire surface were at the same temperature as its base. However, as each fin is characterized by a finite resistance to thermal conduction, there will always be a thermal gradient along it, and the condition given above is a mere idealization. Therefore, the efficiency for a fin is defined as the ratio of heat actually exchanged with air to its the maximum ideal amount. In the case of a fin having triangular profile, one may calculate the trend of η as a function of a dimensionless parameter m, equal to:

$m = b(2h / k\delta_b)^{0.5}$ with $b = r_a - r_b = 2.3 \cdot 10^{-3}$ [m]; k [W/mK]: thermal conductivity of the cylinder (8)

This trend may be seen in Figure 9; for calculation details see [10].

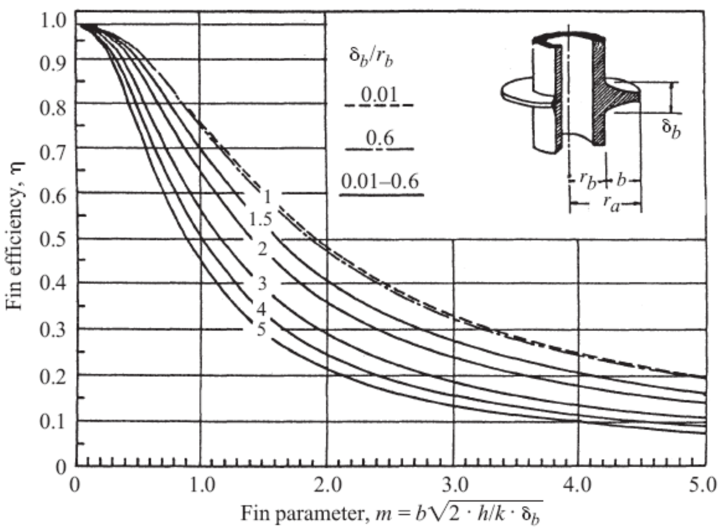


Figure 9. A plot showing the efficiency of a circular fin having triangular profile. From [10].

4.3 Joule heating in the cables

The cables supplying power to the reactor are made of copper and are several meters long. In the present run of the E-Cat the current flow may actually be higher than 40 A. For this reason, it is expedient to evaluate what portion of the current, fed to the system by the power mains, is dissipated by the cables as Joule heat. Figure 4 shows the cable layout from mains to load: three copper cables exit the power regulator, one for each phase, three meters in length each, with a cross-profile of 12.00 mm^2. In order to allow the delta configuration connection of the resistors, each of these cables is connected to another two cables, 2 m in length each, having a cross-section of 12.45 mm^2.

Given that the resistivity of copper is = 0.0175 Ω / m mm^2, one may easily deduce that the electrical resistance of the three cables exiting the regulator (Circuit 1, C_1) is = $R_1 = 4.375 \cdot 10^{-3}$ Ω, whereas that of the cables splitting off from these (Circuit 2, C_2) is = $R_2 = 2.811 \cdot 10^{-3}$Ω.

We may calculate the dissipated heat to the limited extent of the dummy reactor: the results relevant to the E-Cat will be given in Table 7, due to the fact that the average current values changed from day to day.

Measurements performed during the dummy run with the PCE and ammeter clamps allowed us to measure an average current, for each of the three C_1 cables, of I_1 = 19.7A, and, for each C_2 cable, a current of $I_1 / 2 = I_2$ = 9.85 A. The evaluation of heat dissipated by the first circuit is:

$$W_{C1} = 3(R_1 I_1^2) = 3(4.375 \cdot 10^{-3} \cdot (19.7)^2) = 5.1 \text{ [W]} \tag{9}$$

For the second circuit we have:

$$W_{C2} = 6(R_2 I_2^2) = 6(2.811 \cdot 10^{-3} \cdot (9.85)^2) = 1.6 \text{ [W]} \tag{10}$$

By adding the results, we have the total thermal power dissipated by the entire wiring of the dummy.

$$W_{tot.dummy} = 5.1 + 1.6 = 6.7 \approx 7\text{[W]} \tag{11}$$

In the calculations that follow, relevant to the dummy reactor and the E-Cat's power production and consumption, the watts dissipated by Joule heating will be subtracted from the power supply values.

Note that the copper cables, 12.45 mm^2 in cross section, run through most of the six alumina rods, inside of which they are joined by a connecting terminal to the Inconel cables coming from the reactor. The length of Inconel cable inside the rods is but a few centimeters long. Therefore, if one considers that the copper cables run through almost the whole length of the rods (50 cm), it is possible to calculate what fraction of the 7 W given by (11) is emitted within the six rods themselves. For each of the six 50 cm lengths of copper cable, the relevant resistance is $7.028 \cdot 10^{-4}$Ω. From (10) we see that the heat dissipated inside the rods by the copper cables is = $6 \cdot (7.028 \cdot 10^{-4} \cdot (9.85)^2) = 0.4$ W, that is to say, about 6% of the heat emitted by all the copper cables together. It is obvious that the heat emitted by the rods (which shall be calculated in detail in the next paragraph) is only in the least part generated by the cables running through them: on the contrary, that heat originates almost exclusively from the reactor, which, by conduction through the short lengths of Inconel cables coming from the caps, transmits it to the rods.

5. Analysis of data obtained from the dummy reactor

In order to determine the radiated and convection heat emitted by the dummy reactor, one must first of all find its surface temperature.

Figure 10 shows an image taken from the dummy's thermography file, processed for data analysis. Each cap has been divided into three parts, while the central body of the reactor has been divided into 10 parts. For each part, the measurements are as follows:

$$\text{Caps: } (2\pi \cdot R_{cap} \cdot L_{cap}) / 3 = 1.67 \cdot 10^{-3} m^2 \tag{12}$$

$$\text{Dummy reactor body: } (2\pi \cdot R_{reactor} \cdot L_{reactor}) / 10 = 1.25 \cdot 10^{-3} m^2 \tag{13}$$

where R indicates tap radius in (12) and reactor body radius in (13). L indicates the relevant lengths; for the reactor, the radius is that of the body without the ridges.

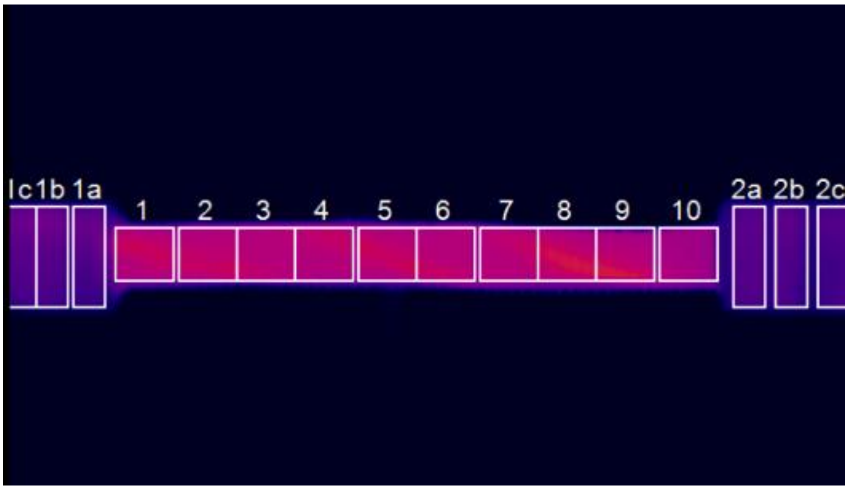


Figure 10. Detail of a thermography image from the dummy reactor run. The image was divided into several areas; the most appropriate emissivity settings were applied to each area.

An emissivity value has been assigned to each area, recursively calculated on the basis of the trend in Plot 1. The method applied for assigning the values is set forth in Tables 2a and 2b, by using as an example the results of a randomly chosen area, in our case Area No. 5, at a randomly chosen instant.

Table 2a

ε assigned	T obtained (°C)	ε for T obtained
1.00 →	366.6 →	0.76
0.76 →	426.6 →	0.71
0.71 →	443.1 →	0.69
0.69 →	450.3 →	0.69

Table 2b

ε assigned	T obtained (°C)	ε for T obtained
0.5 →	541.2 →	0.62
0.62 →	478.3 →	0.68
0.68 →	454.0 →	0.69
0.69 →	450.3 →	0.69

Tables 2a, 2b. Examples of values recursively assigned to emissivity. In the first table, the initial value is set at 1.00, whereas in the second table it is set at 0.5. In both cases, one sees that the correct emissivity assigned to Area 5 is 0.69. This proves that the method adopted here is independent of the starting value assigned to ε.

The IR camera was recording past the initial moments during which the dummy reactor was heating up, and up to a point at which it was operating at normal capacity. The file run was then stopped, and an emissivity reference value of 1 was set for each area. As one may see in the first table, for the instant chosen, the mean temperature of Area 5 indicated by the thermal camera's software is = 366.6°C for ε = 1. From the curve (ε vs. T), one can see that, for that mean temperature, the correct emissivity value would be 0.76; the next step is therefore changing the emissivity of area 5 according to this new value. We thus get a new estimate for the mean temperature of the area as 426.6°C, for which, according to the emissivity curve, one should have ε = 0.71. This procedure is continued until one gets a correct matching between emissivity and temperature, which — in the above case of area 5 —yields ε = 0.69 and T = 450.3°C. In order to prove that this method does not depend on the initial emissivity value chosen, Table 2b shows what happens when the initial value of ε has been nominally set at 0.5. As one may see, after a certain number of iterations, the same final result is found. After establishing what emissivity value settings were to be used for each area, we extracted the

temperatures relevant to all the 23 hours of the dummy run, and averaged them, obtaining a single final value for each one of them (for Area 5, this was = 450.3°C). This method was applied to all the areas of the dummy reactor, as well as to the rods and to the E-Cat, as we shall see.

A possible source of error in the calculation of the mean temperatures (and, consequently, in that of emitted power) must be seen in the uncertainty with which one reads the values of curve (ε vs. T). This uncertainty, valued at ± 0.01, was used to calculate the error to be associated with each result. In the case of area 5, for instance, all calculations were first performed for $\varepsilon = 0.69$, then for $\varepsilon = 0.68$ (i.e. $\varepsilon = 0.69 - 0.01$), and finally for $\varepsilon = 0.70$ (i.e. $\varepsilon = 0.69 + 0.01$). The difference between the results obtained in the last two cases, compared to the first result, is the percentage error sought. In this manner, temperature fluctuations in each area with time, for which one would have to constantly reset emissivity, are also taken into account.

The maximum value reached by area 5 during the whole measurement was equal to 469°C, which would correspond to $\varepsilon = 0.68$, whereas the minimum value was equal to 443°C, which would warrant $\varepsilon = 0.69$.

After reckoning the average temperatures for each area, we calculated the watts emitted by radiation and convection for each area, and upon adding these, arrived at the total power dissipated by the dummy reactor. More specifically, for each area of the cap and of the reactor body, radiation values were obtained by applying equation (1) and subtracting from the result the contribution due to ambient temperature, which during the dummy test was 21°C ($\varepsilon = 0.64$). Using once again Area 5 as an example and expressing all temperatures in degrees Kelvin, as the formulas require, we get, for radiation:

$(\varepsilon \cdot T^4 - \varepsilon_{amb} \cdot T_{amb}{}^4) \cdot \sigma \cdot \text{Area} =$

$$= (0.69 \cdot (454.3 + 273.16)^4 - 0.64 \cdot (21 + 273.16)^4) \cdot 5.67 \cdot 10^{-8} \cdot 1.25 \cdot 10^{-3} = 13.4 \text{ [W]} \quad (14)$$

For convection, we applied (2) to each area relevant to the reactor caps, and (7) to each area attributed to the reactor body. Taking Area 5 as an example, we must first calculate the heat exchange coefficient h, starting from the value assumed in this case by the Rayleigh number:

$$Ra = (g\beta(T_s - T_a)D^3) / \nu\alpha = 28184.32 \quad (15)$$

($g = 9.8$ [m/s²], $\beta = 1 / T_f = 19 \cdot 10^{-4}$ [K^{-1}], $T_s = 727.19$[K], $T_a = 294$[K], $D = 0.02$[m], $\nu = 40 \cdot 10^{-6}$ [m²/s], $\alpha =$
$= 59 \cdot 10^{-6}$ [m²/s])

From Table 1 we can see that, for this value of Ra, we have: C = 0.48 and n = 0.25.

By (3) we then have:

$$h = (kCRa^n) / D = 12.75 \text{ [W/mK]} \quad (16)$$

where the thermal conductivity of air k is $= 41 \cdot 10^{-3}$ [W/mK].

Coefficients k, ν, and α were calculated by means of Plots 2, 3, and 4, at a film temperature $T_f = 510.60$ K.

Furthermore, for each area of the body we know that the length L is 0.02 [m], that the number of fins is N ≈ 6, whereas r_b and δ_b (Figure 10) keep their previously established values (10^{-2} [m] and $3.2 \cdot 10^{-3}$ [m]).

In order to get the watts emitted by Area 5, one more parameter is lacking, namely fin/ridge efficiency, for which we need another parameter, m, given by (8). This last parameter depends on the thermal conductivity of alumina, which is, in turn, a function of its temperature. From [3] we learn that at the average temperature of Area 5 ($T_s = 727.19$[K]), *k* is ca. 10 [W/mK], therefore:

$$m = b(2h / k\delta_b)^{0.5} = 0.065 \quad (17)$$

From Figure 9 we can see that for this value of m, the value of η is very close to 1 (≈ 0.98), which is to be expected, given the definition of efficiency and how it relates to the fairly small size of the ridges.

Now we can finally substitute all the values found in (7) and calculate heat emitted by convection by Area 5:

$$Q = N\eta hA_f(T_s - T_a) = 10.46 \text{ [W]} \quad (18)$$

For each cap, we applied (2), to each of the three areas attributed to each cap ($A = 16.7 \cdot 10^{-4}$ [m²], D = 0.04 [m]). For instance, for cap Area 1a, by consulting Plots 2, 3, and 4, and taking into account $T_f = 453.05$ [K], we get the following values: $k = 37 \cdot 10^{-3}$ [W/mK], $\nu = 32 \cdot 10^{-6}$ [m²/s] and $\alpha = 47 \cdot 10^{-6}$ [m²/s]. In this case, the Rayleigh number and coefficient h become:

$$Ra = (g\beta(T_s - T_a)D^3) / \nu\alpha = 292803.67 \quad (19)$$

$$h = (kCRa^n) / D = 10.33 \text{ [W/m}^2\text{K]} \quad (20)$$

Heat emitted by convection by cap Area 1a alone is thus:

$$Q = hA(T_s - T_a) = 5.50 \text{ [W]} \quad (21)$$

Table 3 below shows, for each area, the values obtained for average temperature, power emitted by radiation, and power emitted by convection, when the appropriate emissivity is assigned; the last four columns give only the results relevant to the sum total of watts emitted by radiation and convection when emissivity is made higher or lower by uncertainty.

	ε	Average T (°C)	Radiation (W)	Convection (W)	TOT. (W)	ε – 0.01	TOT. (W)	ε + 0.01	TOT. (W)
Area 1	0.69	451.00	13.18	10.37	23.55	0.68	23.73	0.70	23.37
Area 2	0.69	449.93	13.10	10.34	23.44	0.68	23.62	0.70	23.27
Area 3	0.71	436.14	12.46	9.96	22.43	0.70	22.59	0.72	22.39
Area 4	0.71	435.88	12.44	9.96	22.40	0.70	22.57	0.72	22.36
Area 5	0.69	454.03	13.41	10.46	23.86	0.68	24.05	0.70	23.68
Area 6	0.71	443.31	12.99	10.16	23.15	0.70	23.32	0.72	22.98
Area 7	0.71	437.98	12.60	10.01	22.61	0.70	22.78	0.72	22.45
Area 8	0.69	461.64	13.99	10.67	24.66	0.68	24.85	0.70	24.47
Area 9	0.69	452.66	13.30	10.42	23.72	0.68	23.91	0.70	23.54
Area 10	0.73	412.90	11.18	9.44	20.62	0.72	20.77	0.74	20.48
Cap 1a	0.79	338.94	10.07	5.50	15.57	0.78	15.64	0.80	15.50
Cap 1b	0.79	323.63	9.05	5.20	14.25	0.78	14.31	0.80	14.18
Cap 1c	0.79	330.38	9.49	5.33	14.82	0.78	14.89	0.80	14.75
Cap 2a	0.79	319.85	8.81	5.12	13.93	0.78	14.00	0.80	13.87
Cap 2b	0.79	323.57	9.05	5.19	14.24	0.78	14.31	0.80	14.18
Cap 2c	0.79	311.31	8.29	4.95	13.24	0.78	13.30	0.80	13.18
TOTAL			183.41	133.09	316.50		318.65		314.67

Table 3. For each one of the areas that the caps and the body of the dummy reactor have been divided into, the table shows, subsequently: actual emissivity value, average temperature, power emitted by radiation, power emitted by convection, the sum of the last two values, emissivity minus uncertainty, the sum total of watts emitted if one sets “emissivity minus uncertainty”, emissivity plus uncertainty, and the sum total of watts if one sets “emissivity plus uncertainty”.

The total power emitted by the dummy reactor is 316.50 W, and the percentage error to be associated to this value is:

$$(318.65 - 314.67) / 316.50 = 0.0126 = 1.26\% \approx 1.3\% \quad (22)$$

The very same process used for the dummy reactor body was used to calculate the power emitted through radiation and convection by the rods. During the test, the rods were heated by conduction, from their being in contact with the reactor, and from the heat yielded to them by the lengths of Inconel cable external to the caps. Not only do the cables dissipate heat by Joule heating, they also subtract it from the reactor by conduction. Here too, the thermal images of each rod were divided into 10 areas. Because the rods were placed in overlapping positions, each one of them was capable of dissipating heat to the environment for only 2/3 of its surface; moreover, whereas the temperature of the two lower rods was more or less the same, the upper rod always indicated higher temperatures. For this reason, we decided to perform calculations on a thermography file corresponding to a side view, in which only one upper and one lower rod were visible, and to attribute to the third rod which was not framed by the camera the same values of the lower visible rod (Figure 11). Lastly, we found that the three rods connected to the cap on the right of the dummy reactor indicated slightly higher temperatures than those connected to the cap on the left, and that this difference was within the associated error margin. We therefore decided to perform the calculations for only one set of three rods (the cooler ones) and multiply the result by a factor of 2.

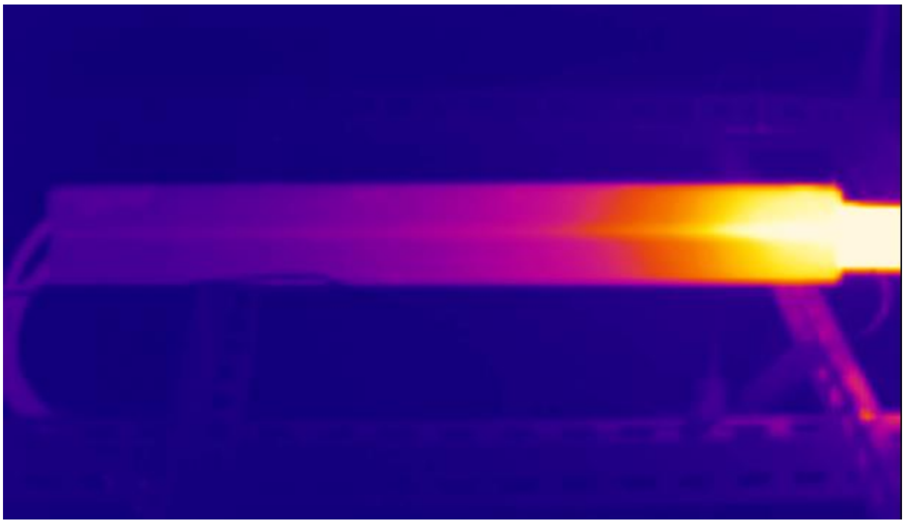


Figure 11.Thermography image of the set of three rods on the left of the reactor. To the third rod hidden behind the other two, we attributed the temperatures appropriate to the lower rod.

The dimensions of each area are given by:

$$(2\pi \cdot R_{rod} \cdot L_{rod}) / 10 = 4.71 \cdot 10^{-3} m^2 \quad (23)$$

where R and L are the radius and the length of each rod, respectively.

To each area, formulas (14) for calculating radiation and formula (18) convection were applied, substituting the appropriate values.

Table 4 shows all the results obtained for the areas of the upper rod (indicated by $_u$) and one of the lower rods (indicated by $_d$) of a set of three rods. In the columns from left to right, the first values found are relevant to the upper rod (subsequently: emissivity, average temperature, radiation power, convection power, and the sum of the last two values), followed by the values relevant to the lower rod. The sum of the results obtained for each area appears in the last line. Finally, the bottom cell of the last column of the table records

the watts emitted by one entire set of three rods, a value obtained by adding the total watts produced by the upper rod, to the total watts, multiplied by two, produced by the lower rod.

Area	ε_u	$T_{\cdot u}$(°C)	$Rad._u$ (W)	$Conv._u$(W)	$Tot._u$ (W)	ε_d	$T_{\cdot d}$ (°C)	$Rad._d$ (W)	$Conv._d$ (W)	$Tot._d$ (W)	Tot. 3 rods (W)
1	0.69	151.52	4.71	5.84	10.55	0.69	147.98	4.52	5.65	10.17	
2	0.69	125.13	3.36	4.45	7.81	0.69	118.89	3.07	4.13	7.20	
3	0.68	90.85	1.91	2.81	4.72	0.68	87.71	1.80	2.66	4.46	
4	0.67	68.17	1.15	1.72	2.87	0.67	68.15	1.15	1.72	2.87	
5	0.66	58.26	0.85	1.28	2.13	0.66	58.21	0.85	1.28	2.13	
6	0.66	54.12	0.74	1.11	1.85	0.66	52.82	0.71	1.06	1.77	
7	0.66	46.33	0.56	0.80	1.36	0.66	45.06	0.53	0.75	1.28	
8	0.66	40.02	0.42	0.56	0.98	0.66	38.89	0.39	0.52	0.91	
9	0.66	35.34	0.32	0.40	0.72	0.66	34.30	0.30	0.36	0.66	
10	0.66	31.82	0.25	0.28	0.53	0.66	31.09	0.23	0.26	0.49	
TOT.					33.52					31.94	97.4

Table 4. The values in the table refer to one of the two sets of three dummy reactor rods. Subscript "u" refers to the uppermost rod of the set, subscript "d" to one of the two lower rods (the same results apply to the second lower rod). Each rod has been divided into 10 areas. For each area, the table indicates, subsequently: assigned emissivity, average temperature, power emitted by radiation, power emitted by convection, the sum of the last two values. The last cell of the table gives the total watts emitted by one whole set of three rods, reckoned by multiplying the results relevant to the lower rod by 2, and adding them to those of the upper rod.

We can now calculate the total heat emitted from both sets of three rods, bearing in mind how much of their surface is actually emitting heat, and the associated error percentage (estimated at ca. 5%):

$$(97.40\cdot 2/3)\cdot 2 = 129.86 \pm 5\% \text{ [W]} \quad (24)$$

In the previous paragraph, we have seen that the copper cables running through the rods emit a total of 0.4 W through Joule heating. This value should be subtracted from (24) because, contrary to the power calculated with that equation, it does not derive from heat generated by the reactor and transmitted to the rods by conduction, but from electric power supplied by the mains. However, as it is a very small value, it may be considered part of the error associated to (24).

Note also that part of the power produced by the rods is also due to Joule heat emitted by the short lengths of Inconel resistors connected to the copper cables inside the rods after leaving the caps. All the characteristics of these resistors, however, such as their geometric dimensions and the exact makeup of the alloy they are made of, are covered by trade secret. Though we are unable to furnish an exact calculation of their contribution to the heat emitted by the rods, the short lengths of Inconel cable inside the rods allow us to reasonably consider it as lying within the error percentage associated to the measurements.

By adding the watts emitted directly by the dummy reactor to watts released by conduction to the rods, we get the dummy's thermal power output:

$$(316.50 \pm 4.11) + (129.86 \pm 6.49) = 446.36 \pm 10.60 = 446 \pm 2.4\% \text{ [W]} \quad (25)$$

Let us now compare this dissipated power with the power supply, the average of which over 23 hours of test is = (486 ± 24) W (uncertainty here is 5% of average, calculated as standard deviation). Keeping in mind the Joule heating of the power cables discussed in paragraph 4.3, we have the following results:

Power supply (W)	Joule heating (W)	Actual input (W)	Output (W)
486 ± 24	7	486 – 7 = 479 ± 24	446 ± 10

If we take error percentages into account, we will see that where input is at minimum possible value (455 W) and output at maximum possible value (456 W), our method overestimates by about 1 W, i.e. 0.2%. Vice versa, where input is at maximum possible value (503 W) and output at minimum possible value (436 W) our method underestimates the power supplied to the reactor by about 67 W, i.e. 14%.

We can therefore rely on the fact that applying the very same procedure to data gathered from the E-Cat test does not lead to any significant overestimation; rather, there is a good chance that the power actually generated by the reactor is underestimated.

6. Analysis of data obtained from the E-Cat

Using the same procedure employed for the dummy reactor, we analyzed the 16 files relevant to the active E-Cat test. For each file, we calculated average power emitted by radiation and convection by the reactor, cable dissipation through Joule heating, and power transmitted to the hollow rods. For the rods, we do not have 16 thermography files corresponding to those saved for the reactor, because, as mentioned above, the IR camera's position was changed frequently. We therefore analyzed several thermography files relevant to different days and positions, from which the two most representative ones for length of time and average temperatures were singled out. The first file refers to the days of the test before the 6th of March (the day in which power supply to the reactor was increased), the second to the following days. This choice was justified by the fact that the thermal variations on the rods obtained by analyzing the file data were significant only in the comparison between the two above-mentioned stages, and lay in any case within the percentage error associated to the result (± 5%). Once again, as in the case of the dummy reactor, the rods' symmetric geometry allowed us to perform calculations for only one set of three rods, and multiply the result by a factor of two. Here, from the power value obtained for the rods, one should once again subtract the small contribution of heat emitted by the cables that run through them; but this value is included in the percentage error associated to the result.

The results obtained are as follows:

	Radiation (W)	Convection (W)	Total for 1 set of three (W)	Total for 2 sets (W)
Rods, 1st period	72.15	81.84	153.99	307.98
Rods, 2nd period	88.47	87.94	176.41	352.82

Table 5. Power emitted by radiation and convection by a set of three E-Cat rods (column 4) and by both sets (column 5). The values are averaged over two different periods of time: the upper row refers to the days before March 6 – the day when the power supply was raised by ca. 100 watts – the lower row refers to the following days.

Tables 6 and 7 report all the E-Cat test results relevant to the days of testing, approximately two days for each file.

The first table shows the average temperature of each cap and of the entire body of the E-Cat for each of the 16 files analyzed. It should be mentioned that, as in the case of the dummy reactor, analysis on the E-Cat was again performed by dividing the thermal images into 10 areas along the length of the reactor, and into three

areas for each cap. In the table, however, the results relevant to each area are further averaged out, in order to facilitate reading.

In the second table, mean power consumption, watts produced and watts dissipated by Joule heating are shown for each file. Uncertainty associated to the result is on average 5% for power consumption and 3% for watts emitted. The last two columns record COP and net production. COP is the ratio of the sum of the mean power, emitted by radiation and convection by both the E-Cat and the rods, to mean power consumption of the reactor minus watts dissipated by the cables through Joule heating. It therefore gives an indicative parameter of the reactor's performance. Net production, on the other hand, is given by the difference between the total watts produced by the reactor and those consumed by it, and shows what portion of emitted power is entirely due the internal reaction of the E-Cat. By way of example, using the data of file No. 1 in the table, we have:

COP = (2128.32 + 307.98) / (815.86 –37.77) = 3.13 ± (3% + 5%) = 3.13 ± 8% (26)

Net Production = (2128.32 + 307.98) – (815.86 – 37.77) =

= (2436.30 – 778.09) ± (73.09 + 38.90) = 1658.21 ± 111.99 = 1658 ± 7% [W] (27)

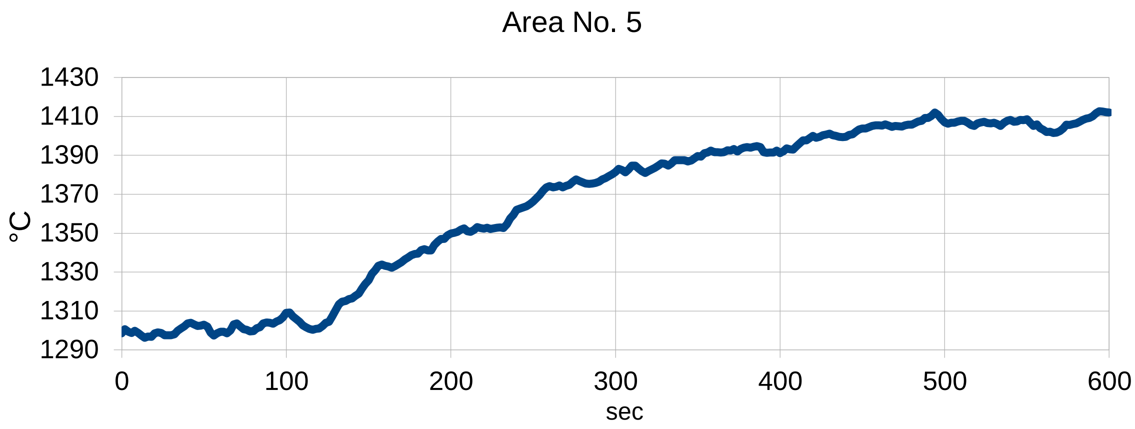
File No.	E-Cat body average T (°C)	Cap 1 average T (°C)	Cap 2 average T (°C)
1	1260.00	548.59	539.30
2	1257.77	550.71	541.93
3	1256.09	548.67	540.58
4	1257.21	549.02	539.22
5	1243.40	551.51	543.74
6	1398.99	609.24	589.93
7	1405.58	609.16	590.17
8	1404.04	607.84	589.06
9	1401.46	606.11	588.00
10	1392.26	600.51	601.34
11	1396.49	608.23	602.23
12	1400.86	610.10	604.65
13	1401.59	608.58	604.70
14	1400.56	607.45	604.62
15	1410.27	614.53	605.81
16	1412.31	611.09	595.15

Table 6. Average temperatures of E-Cat body and caps calculated for each of the 16 thermography files recorded during the test. One file corresponds to ca. two days of data logged.

File No.	Consumption (W)	Radiation (W)	Convection (W)	TOT. (W)	Rods (W)	Joule heating (W)	COP	Net Production (W)
1	815.86	1740.98	387.34	2128.32	307.98	37.77	3.13	1658.21
2	799.84	1733.30	386.46	2119.76	307.98	36.98	3.18	1664.88
3	791.48	1724.95	385.23	2110.18	307.98	36.49	3.20	1663.17
4	790.69	1729.30	385.49	2114.79	307.98	36.41	3.21	1668.49
5	785.79	1676.89	381.43	2058.32	307.98	36.13	3.16	1616.64
6	923.71	2381.64	427.64	2809.28	352.82	42.43	3.59	2280.82
7	921.91	2416.68	429.64	2846.32	352.82	42.18	3.64	2319.41
8	918.24	2407.26	429.16	2836.42	352.82	41.89	3.64	2312.89
9	917.90	2392.29	427.82	2820.11	352.82	41.75	3.62	2296.78
10	913.40	2348.43	425.64	2774.07	352.82	41.93	3.59	2255.42
11	904.77	2373.08	427.23	2800.31	352.82	41.52	3.65	2289.88
12	906.98	2397.95	428.56	2826.51	352.82	41.60	3.67	2313.95
13	910.47	2401.80	429.87	2831.67	352.82	41.62	3.67	2315.64
14	908.13	2394.93	428.70	2823.63	352.82	41.55	3.67	2309.87
15	905.01	2451.10	432.02	2883.12	352.82	41.46	3.75	2372.39
16	906.31	2454.71	431.47	2886.18	352.82	41.25	3.74	2373.94

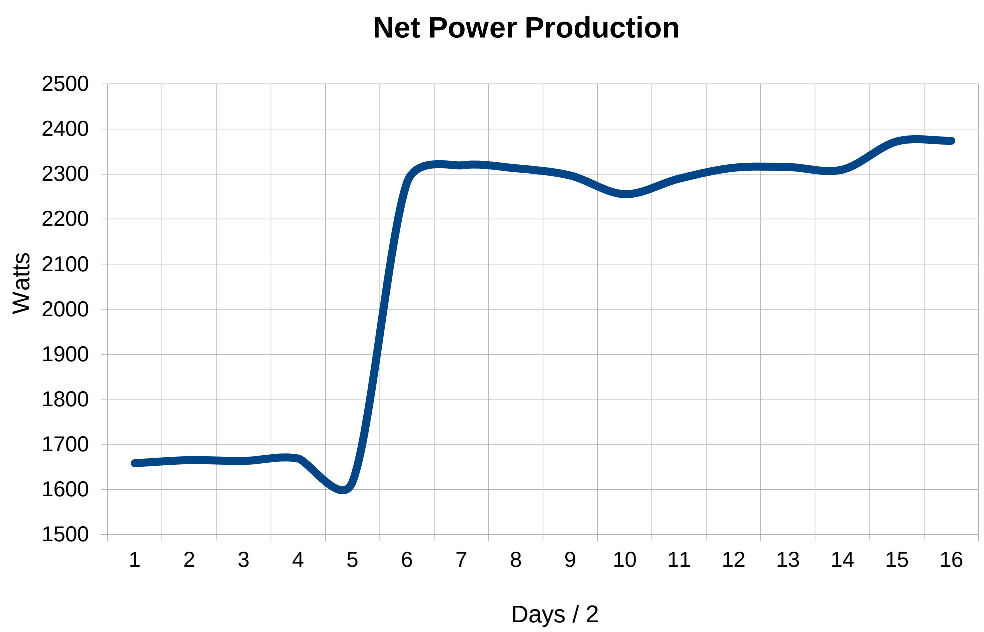
Table 7. For each of the 16 thermography files recorded (ca. two days of test) we have, subsequently: average power consumption of the E-Cat, power emitted by the E-Cat by radiation, power emitted by convection, sum total of the last two values, sum total of watts emitted by both sets of rods by radiation and convection, power dissipated by Joule heating, COP, and net production.

What immediately stands out in Table 7 is the sharp difference between values obtained in the first ten days of the test (files 1 to 5 included), when power input to the reactor was kept at lower levels, and those obtained in the second period, in which power supply was increased by slightly more than 100 W. The effect of raising power input was an increase in power emission of about 700 W. Plot5 shows the trend of average temperature for one of the areas in which the thermography file of the E-Cat was divided (Area No. 5), when power input was increased. All values have been calculated by setting only one emissivity value, so as to make displaying on a continuous line possible, but the choice of ε is appropriate here only for the final temperatures reached after power increase. For this reason, the plot is not entirely reliable as far as the values on the *y*-axis are concerned: its purpose is merely that of showing how long it took the E-Cat to stabilize after input current was increased. As one can see, this amounts to about 400 seconds, slightly more than six minutes.

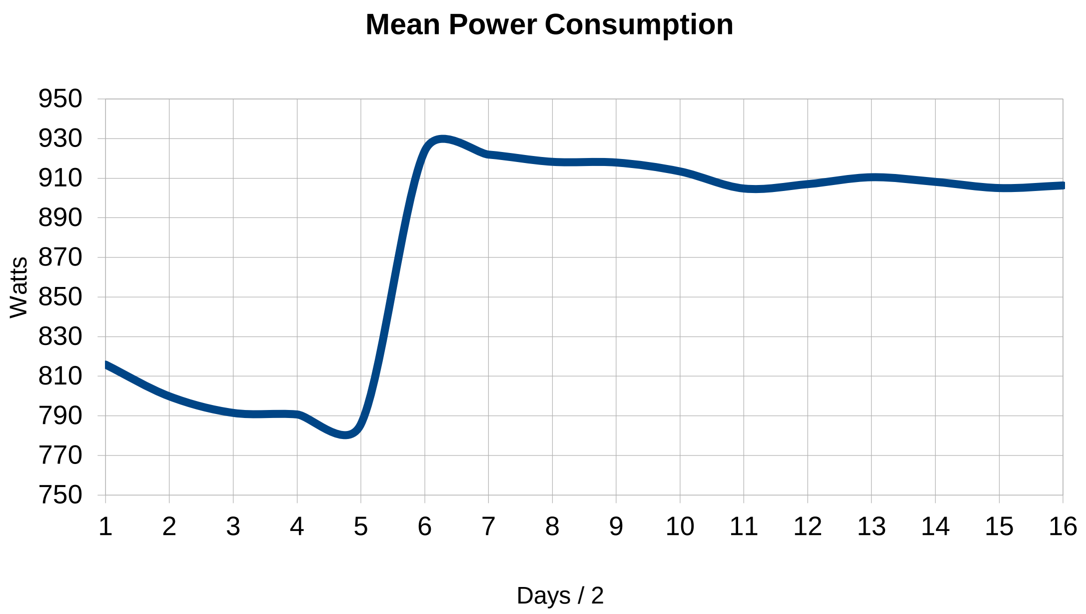


Plot 5. Average temperatures of Area 5 at the time of power supply increase. All values seen here are calculated assuming the same emissivity, in order to allow visualization on a continuous line. Thus, the *y*-axis is an arbitrary scale by which one can determine how long it took the E-Cat to reach a stable state (about 400 seconds) when input current was increased.

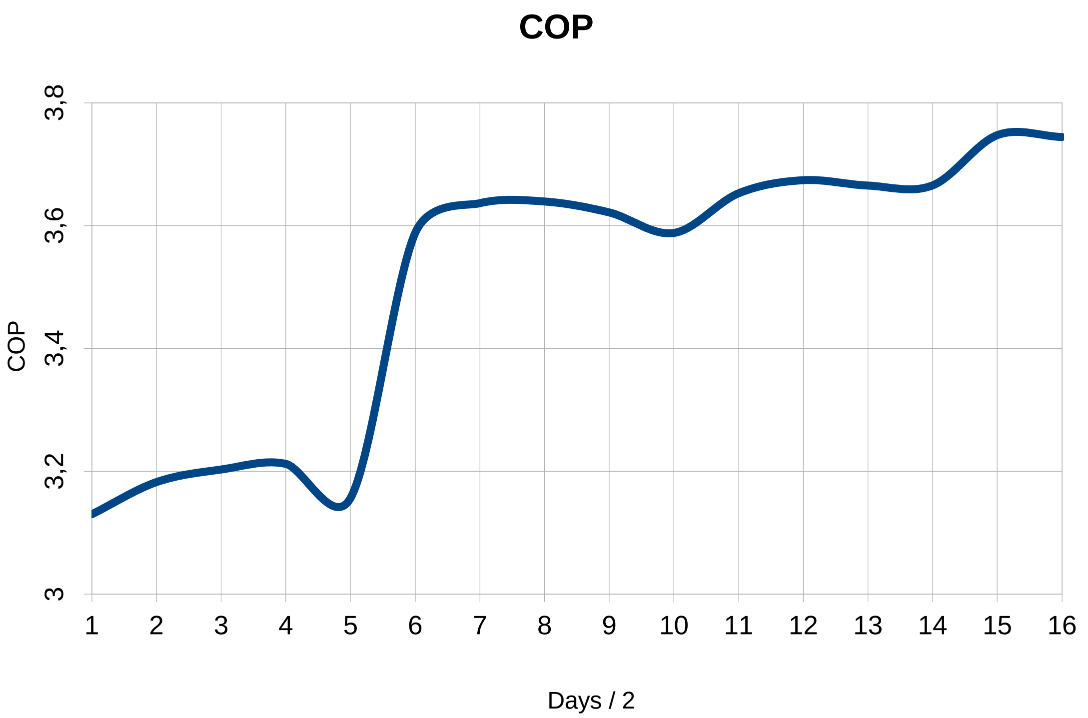
Another matter for consideration that stands out from the analysis of the results regards the trend of net production vs. that of consumption. There seems to be an anticorrelation between the two behaviors, which stands out as a decrease in average consumption values corresponding to increases in production averages, and vice versa. This behavior is probably due to a feedback effect driving the resistor power supply, raising it or lowering it according to the internal temperatures read by the thermocouple. The values of Table 7, relevant to net production, average consumption, and COP, are reproduced in Plots 6, 7, and 8.



Plot 6. E-Cat Net power production trend throughout the test. Each interval on the *x*-axis represents a time span of about two days. Net power production is given by the difference between the total watts produced by the reactor and the watts consumed by it. It shows how much emitted power is exclusively due to the E-Cat's internal reaction.

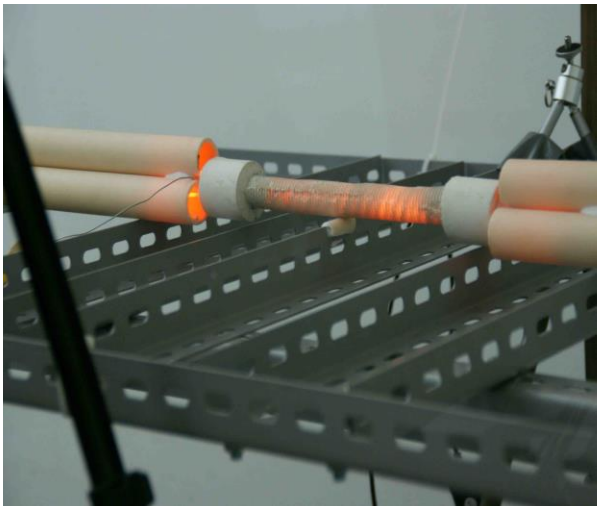


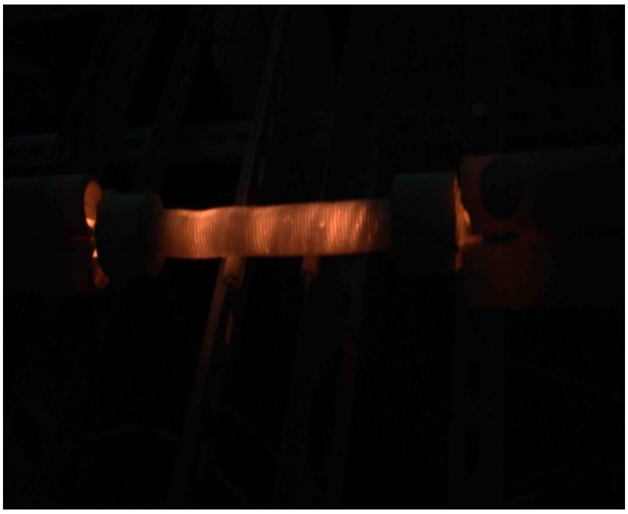
Plot 7. Mean power consumption of the E-Cat throughout the test. Each interval on the *x*-axis represents a time span of about two days.



Plot 8. COP trend throughout the test. Each interval on the *x*-axis represents a time span of about two days. COP is the ratio of the sum of mean power emitted by radiation and convection by the E-Cat and by the rods, to the mean power consumption of the reactor minus power dissipated by Joule heating. It gives an indication of the E-Cat's performance.

It must be remarked that the COP values quoted here refer only to the performance of the reactor running at the capacity selected by us, not at its maximum potential, any evaluation of which lies beyond the purposes for which this test was designed. Awareness of the fact that the test would have lasted a considerable length of time prompted us to keep the reactor running at a level of operation capable of warranting both the stability and the safety of the test. Therefore, we do not know what the limits of the current technology are, in terms of performance and life span of the charges.





Figures 12a, 12b. E-Cat operating during the test. Note the Inconel resistors leaving the caps and entering the rods, where they are connected to the copper cables of the power supply. The resistors appear to glow intensely in the parts lying outside the caps, whereas inside the reactor body they seem to shade an underlying emission of light. This may be explained if we consider that the main source of energy inside the reactor body is actually the charge, and that it is emitting more light than the resistors. These are not visible through the caps, which are thicker than the reactor body. Upon leaving the reactor, however, the resistors emit heat almost exclusively by radiation (convection is negligible here, as they are inside the rods): there are no brighter sources of light which can "outshine" them, nor masses of alumina that can cool them. Their temperature is moreover fairly high, on account of the current they carry and the heat extracted by conduction from the reactor. Figure 12b was taken in the dark, from the opposite side to that of 12a. One of the three sets of hollow rods is visible, and another patch of insulating alumina cement on the second metal strut in the middle, added without modifying the setup.

7. Ragone Plot

The net production of the E-Cat, the values of which may be seen in the last column of table 7, allows us to calculate the total energy produced by the reactor during its ca. 768 hours of operation.

By multiplying the value of each file by the length of time that the file refers to (48 hours) and adding the results, we get:

$(1658.21 \cdot 48) + (1664.88 \cdot 48) + \ldots + (2373.94 \cdot 48) = (1618194 \pm 10\%)$ [Wh] =

$= (5825 \pm 10\%)$ [MJ] (28)

Next, we may calculate the specific gravimetric energy and the power density associated to the E-Cat and try to place it within the Ragone plot (Figure 13), a diagram comparing the power and energy densities of several conventional sources [11].

If one considers the weight of the charge = 1 g, one gets the following values relevant to thermal energy density and power density:

$(1618194 / 0.001) = (1618194000 \pm 10\%)$ [Wh/kg] $= (1.6 \cdot 10^9 \pm 10\%)$ [Wh/kg] =

$= (5.8 \cdot 10^6 \pm 1\ 0\%)$[MJ/kg] (29)

$(1618194000 / 768) = (2107023 \pm 10\%)$ [W/kg] $= (2.1 \cdot 10^6 \pm 10\%)$ [W/kg] (30)

These results place the E-Cat beyond any conventional source of energy, as may be clearly seen from the plot in Figure13. Our values, though close to the energy densities of nuclear sources, such as U235, are however lower than the latter by at least one order of magnitude [12].

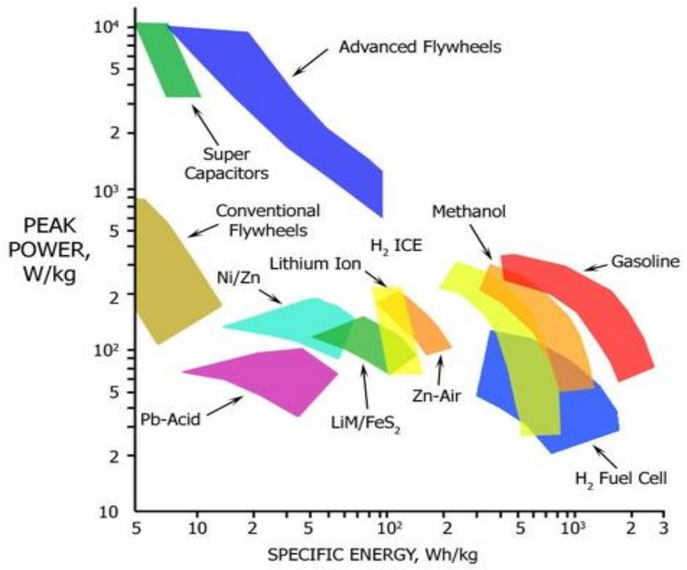


Figure 13. "Ragone plot of energy storage"[11]. The plot shows specific gravimetric energy and power densities relevant to various sources. The E-Cat, which would be far off the scale here, lies outside the region occupied by conventional sources.

Considering that we do not know the internal structure of the reactor, and therefore cannot completely rule out that there were other charges inside it besides the one weighed and inserted by us, we may repeat the above calculations taking the weight of the entire reactor (452 ± 1 g) into consideration:

$(1618194 / 0.452) = (3580075 \pm 10\%)$ [Wh/kg] $= (3.6\cdot 10^6 \pm 10\%)$ [Wh/kg] =

$= (1.3\cdot 10^4 \pm 10\%)$ [MJ/kg] (31)

$(3580075 / 768) = (4661 \pm 10\%)$ [W/kg] $= (4.7\cdot 10^3 \pm 10\%)$ [W/kg] (32)

Even if taken from this extremely conservative point of view, the reactor lies beyond the limits of the above Ragone plot.

Lastly, by way of further enquiry, we may consider another kind of Ragone plot, where volumetric densities instead of gravimetric densities are expressed (Figure 14), and calculate the reactor's position with respects to it [13].

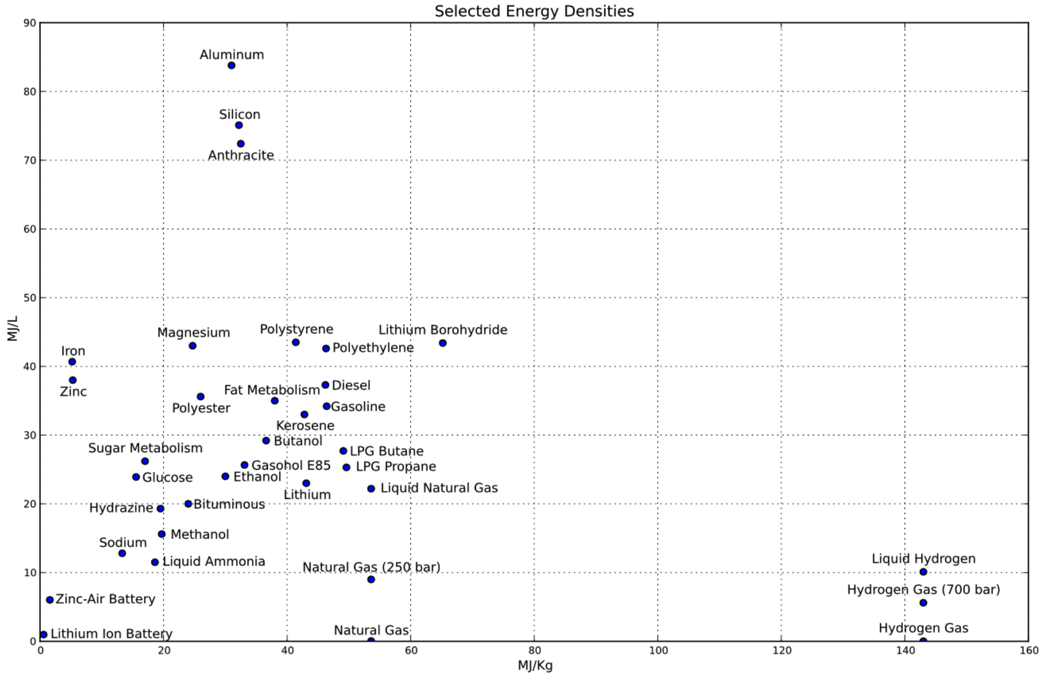


Figure 14. Another version of the Ragone Plot of Energy Storage [13]. In this plot, specific volumetric and gravimetric energy densities are given for various sources. The E-Cat, far off the scale here, lies outside the region occupied by conventional chemical sources.

Given that we do not know the exact internal volume of the E-Cat, we may conservatively take into account the whole external volume of the object. The results are:

E-Cat Volume = $20\pi + 2 \cdot 16\pi = (163 \pm 2\%)\ cm^3 = (0.163 \pm 2\%)$ l (33)

$(5825 / 0.163) = (35736 \pm 12\%)$ [MJ/l] $= (3.6 \cdot 10^4 \pm 12\%)$ [MJ/l] (34)

Once again, even in the most conservative scenarios, we have values that allow us to conclude that the reactor studied here may not be considered a conventional source of energy.

8. Fuel analysis

The result from the heat measurement is remarkable by giving such a large amount of heat from the very small quantity of fuel powder used confined in the small volume of the reactor. This large amount of heat is, as pointed out above, way beyond what can be expected from chemical burning, which only involves rearrangements of the fuel material at the atomic scale, i.e. by transforming atomic binding energies to kinetic energy. Very large energy transformations can only take place when binding energies at the nuclear level are exploited, as in fusion reactions for light elements and fission reactions for heavy elements. However fusion reactions between free charged particles are extremely unlikely at low energies due to the Coulomb barrier. The conditions for fusion reactions between particles imbedded in a specific metal compound are not expected to be very much different from those of free particles, but this is not known in all details. It is therefore not possible to categorically reject the occurrence of fusion reactions in a metal compound having specific properties, by referring to our knowledge of the fusion process between free particles. In fact, as an example, the d(d,p)t fusion reaction cross sections have been observed [14] to depend on the temperature in deuterated metals at sub-Coulomb energies. This is an effect of screening from the electron cloud surrounding the interacting nuclei. In Astrophysics it is also well known that low energy cross sections are higher than expected [see e.g. 14,15].Whether fusion reactions can be induced at a large scale in a metal compound under specific conditions is an open question.

In order to get information on wheter any rearrangement at the nuclear level takes place in the fuel during the burning process in the E-Cat, we studied the isotopic composition of the fuel before and after the burning. Any change in the isotopic composition of the fuel in E-Cat is expected to have its origin in a nuclear reaction. The element analyses were performed by three different external groups, each specialized in the different techniques employed. The work begun with an electron microscopy (SEM) scan to study the surface morphology of the fuel powder. The analyzing methods employed were X-ray Photoelectron Spectroscopy (XPS), Dispersive X-ray Spectroscopy (EDS), Secondary Ion Mass Spectrometry (SIMS) and chemical analysis from Inductively Coupled Plasma Mass Spectrometry (ICP-MS) as well as atomic emission spectroscopy (ICP-AES). The full report from these analyses is presented in detail in the Appendices 3 and 4.

The XPS gives information on which elements are present in the fuel, while the SIMS and ICP-MS analyzing methods also give the isotopic composition of the nuclear species. The ICP-AES analysis also gives the masses percentage of the found elements. Both XPS and SIMS give information on which elements are present at the surface of a sample granule down to a depth of a few nanometers. The ICP-MS is an integrating method giving the average isotopic composition of the whole fuel/ash sample being analyzed. The ICP-AES also gives the mass values in the whole sample. It is thus quite plausible that the four methods give rather different results depending on the sample granule chosen as well as in the case where the whole sample is used, provided that the burning process in the fuel is not even but varies locally as observed. However, qualitatively the methods should yield the same results. It should also be noted that our total sample was about 10 mg, i.e. only a small part of the total fuel weight of 1 g used in the reactor. The sample was taken by us at random from the fuel and ash, observing utmost care to avoid any contamination.

An arbitrary sample of different granules is chosen for the analysis, but the same samples are used for both EDS and SIMS. The fuel contains natural nickel powder with a grain size of a few microns. The existence of natural Nickel content is confirmed by all four analyzing methods being used. In addition the fuel is found to be mixed with a component containing hydrogen, i.e. probably a chemical hydride. From all combined analysis methods of the fuel we find that there are significant quantities of Li, Al, Fe and H in addition to Ni. Moreover from the EDS and XPS analysis one finds large amounts of C and O. It should be stressed, that the quantities of most elements differ substantially depending on which granule is analyzed. In addition to these elements there are small quantities of several other elements, but these can probably be considered as impurities.

It is plausible that the fuel is mixed with the standard Lithium Aluminum Hydride, $LiAlH_4$. Further evidence of that is obtained from the ICP-AES analysis which shows that the mass ratio between Li and Al is compatible with a $LiAlH_4$ molecule. This compound can be used to produce free hydrogen by heating. We remark in particular that hydrogen but no deuterium was seen by SIMS. The other methods are insensitive to both hydrogen and deuterium.

The ash has a different texture than the powder-like fuel by having grains of different sizes, probably developed from the heat. The grains differ in element composition, and we would certainly have liked to analyze several more grains with SIMS, but the limited amount of ash being available to us didn't make that possible. The main result from our sample is nevertheless clear, that the isotopic composition deviates dramatically from the natural composition for both Li and Ni.

The Lithium content in the fuel is found to have the natural composition, i.e. ^{6}Li 7 % and ^{7}Li 93 %. However at the end of the run a depletion of ^{7}Li in the ash was revealed by both the SIMS and the ICP-MS methods. In the SIMS analysis the ^{7}Li content was only 7.9% and in the ICP-MS analysis it was 42.5 %. This result is remarkable since it shows that the burning process in E-Cat indeed changes the fuel at the nuclear level, i.e. nuclear reactions have taken place. It is notable, but maybe only a coincidence, that also in Astrophysics a ^{7}Li depletion is observed [see e.g. 17].

One can speculate about the nature of such reactions. Considering Li and disregarding for a moment from the problem with the Coulomb barrier the depletion of ^{7}Li might be due to the reaction $p + {}^{7}Li \rightarrow {}^{8}Be \rightarrow {}^{4}He + {}^{4}He$. The momentum mismatch in the first step before ^{8}Be decays can be picked up by any other particle in the vicinity. In this case the large kinetic energy of the ^{4}He (distributed between 7 and 10 MeV) is transferred to heat in the reactor via multiple Coulomb scattering in the usual stopping process. One can then estimate how much this reaction contributes to the total heat being produced in our test run. From the ICP-AES analysis we find that there is about 0.011 gram of ^{7}Li in the 1 gram fuel. If each ^{7}Li nucleus releases about 17 MeV we find then that the total energy available becomes 0.72 MWh. This is less than the 1.5 MWh actually produced in our 32 days run, so more energy has to come from other reactions, judging from this very rough and speculative estimate.

Another remarkable change in the ash as compared to the unused fuel is the identified change in the isotope composition of Ni. The unused fuel shows the natural isotope composition from both SIMS and ICP-MS, i.e. ^{58}Ni (68.1%), ^{60}Ni (26.2%), ^{61}Ni (1.1%), ^{62}Ni (3.6%), and ^{64}Ni (0.9%), whereas the ash composition from SIMS is: ^{58}Ni (0.8.%), ^{60}Ni (0.5%), ^{61}Ni (0%), ^{62}Ni (98.7%), ^{64}Ni (0%), and from ICP-MS: ^{58}Ni (0.8%), ^{60}Ni (0.3%), ^{61}Ni (0%), ^{62}Ni (99.3%), ^{64}Ni (0%). We note that the SIMS and ICP-MS give the same values within the estimated 3% error in the given percentages.

Evidently, there is also an isotope shift in Nickel. There is a depletion of the ^{58}Ni and ^{60}Ni isotopes and a buildup of the ^{62}Ni isotopes in the burning process. We note that ^{62}Ni is the nucleus with the largest binding energy per nucleon. The origin of this shift cannot be understood from single nuclear reactions involving protons. With alpha particles colliding with Ni one can in principle raise the atomic mass number by 4 via exciting ^{58}Ni to ^{62}Zn, which then via positron emission decays back to ^{62}Cu and ^{62}Ni, but that is hardly believable to occur due to an enormous Coulomb barrier to merge ^{4}He and Ni. Besides, with this reaction one can also go to stable Zn isotopes, which are not found in the ash.

It should be pointed out that the fusion towards heavier isotopes of Nickel releases energy. For example the reaction $p + {}^{58}Ni \rightarrow {}^{59}Cu + \gamma$ and ^{59}Cu decaying back to ^{59}Ni via β^{+} emission releases 3.4 MeV. Even if that particular reaction is excluded, since no gammas are observed, we can tentatively use this number for each step towards ^{62}Ni, and the information from ICP-AES that there is about 0.55 gram Ni in the fuel. We find then that there is about 2.2MWh available from the Nickel transformations. Accordingly, from Nickel and Lithium together there is about 3 MWh available, which is twice the amount given away in the test run. Consequently we can conclude that the amount of fuel is probably compatible with the energy release being measured, although a quantitative statement requires detailed knowledge of the prevailing reactions.

However, as discussed above, it is of course very hard to comprehend how these fusion processes can take place in the fuel compound at low energies. Presently we should therefore restrict ourselves to merely state that an isotope shift has occurred in Lithium and Nickel. We refrain from speculations in any dynamic scenario making this reaction possible at low energies. The reaction speculation above should only be considered as an example of reasoning and not a serious conjecture.

If nuclear transitions are prevalent in the burning process it is expected that radiation is emitted. It is remarkable that neither neutrons, charged particles nor gammas are observed from the E-cat reactor. Furthermore, the spent fuel was found inactive right after the E-Cat run was stopped. All imaginable nuclear reactions in the reactor should be followed by some radiation, and at least some of that radiation should penetrate the reactor wall and be possible to detect. Even in the case discussed above with two rather high energy helium nuclei in the final state, which all stop in the reactor, one can expect that some helium nuclei during the stopping process undergo some nuclear reaction, e.g. inelastic scattering of ^{4}He on Li, Al or Ni which then subsequently decays to their ground state respectively via gamma emission. To get free neutron is however not kinematically possible with the 10 MeV alpha available. The absence of any nuclear radiation from the burning process is presently an open question, and has to be understood.

9. Summary and concluding remarks

A 32-day test was performed on a reactor termed E-Cat, capable of producing heat by exploiting an unknown reaction primed by heating and some electro-magnetic stimulation. In the past years, the same collaboration has performed similar measurements on reactors operating in like manner, but differing both in shape and construction materials from the one studied here. Those tests have indicated an anomalous production of heat, which prompted us to attempt a new, longer test. The purpose of this longer measurement was to verify whether the production of heat is reproducible in a new improved test set-up, and can go on for a significant amount of time. In order to assure that the reactor would operate for a prolonged length of time, we chose to supply power to the E-Cat in such a way as to keep it working in a stable and controlled manner. For this reason, the performances obtained do not reflect the maximum potential of the reactor, which was not an object of study here.

Our measurement, based on calculating the power emitted by the reactor through radiation and convection, gave the following results: the net production of the reactor after 32 days' operation was (5825 ± 10%) [MJ], the density of thermal energy (if referred to an internal charge weighing 1 g) was ($5.8 \cdot 10^6$ ± 10%) [MJ/kg], while the density of power was equal to ($2.1 \cdot 10^6$ ± 10%) [W/kg]. These values place the E-Cat beyond any other known conventional source of energy. Even if one conservatively repeats the same calculations with reference to the weight of the whole reactor rather than that of its internal charge, one gets results confirming the non-conventional nature of the form of energy generated by the E-Cat, namely ($1.3 \cdot 10^4$ ± 10%) [MJ/kg] for thermal energy density, and ($4.7 \cdot 10^3$ ± 10%) [W/kg] for power density.

The quantity of heat emitted constantly by the reactor and the length of time during which the reactor was operating rule out, beyond any reasonable doubt, a chemical reaction as underlying its operation. This is emphasized by the fact that we stand considerably more than two order of magnitudes from the region of the Ragone plot occupied by conventional energy sources.

The fuel generating the excessive heat was analyzed with several methods before and after the experimental run. It was found that the Lithium and Nickel content in the fuel had the natural isotopic composition before the run, but after the 32 days run the isotopic composition has changed dramatically both for Lithium and Nickel. Such a change can only take place via nuclear reactions. It is thus clear that nuclear reactions have taken place in the burning process. This is also what can be suspected from the excessive heat being generated in the process.

Although we have good knowledge of the composition of the fuel we presently lack detailed information on the internal components of the reactor, and of the methods by which the reaction is primed. Since we are presently not in possession of this information, we think that any attempt to explain the E-Cat heating process would be too much hampered by the lack of this information, and thus we refrain from such discussions.

In summary, the performance of the E-Cat reactor is remarkable. We have a device giving heat energy compatible with nuclear transformations, but it operates at low energy and gives neither nuclear radioactive waste nor emits radiation. From basic general knowledge in nuclear physics this should not be possible. Nevertheless we have to relate to the fact that the experimental results from our test show heat production beyond chemical burning, and that the E-Cat fuel undergoes nuclear transformations. It is certainly most unsatisfying that these results so far have no convincing theoretical explanation, but the experimental results cannot be dismissed or ignored just because of lack of theoretical understanding. Moreover, the E-Cat results are too conspicuous not to be followed up in detail. In addition, if proven sustainable in further tests the E-Cat invention has a large potential to become an important energy source. Further investigations are required to guide the interpretational work, and one needs in particular as a first step detailed knowledge of all parameters affecting the E-Cat operation. Our work will continue in that direction.

Acknowledgments

By this work the authors would like to deeply and at heart honor the late Sven Kullander, who initiated this independent test experiment. He was a great source of inspiration and knowledge throughout the course of this work.

The authors gratefully acknowledge Andrea Rossi and Industrial Heat LLC for providing us with the E-cat reactor to perform an independent test measurement. The authors would like to thank Prof. Ennio Bonetti (University of Bologna) and Prof. Alessandro Passi (University of Bologna [ret.]) for critical reading of the manuscript.

All authors of the appendices are gratefully acknowledged for their valuable contribution to this work.

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Lastly, our thanks to Industrial Heat LLC (USA) for providing financial support for the measurements performed for radiation protection purposes.

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Radiation measurements during the long-term test of the E-Cat prototype.

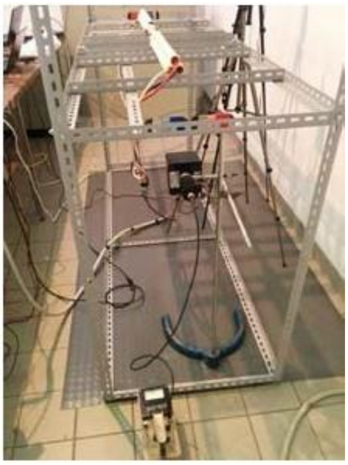
D. Bianchini, Bologna

PREFACE

Between the 24/02/14 and the 29/03/14 in Lugano (CH) I performed the radiation field measurements for radiation protection purposes as per Andrea Rossi request on the 30/01/14.

As in previous evaluation on the same type of prototype, the process, the geometry and the materials are unknown. The industrial plant manager declared the absence of using both of charge particle acceleration systems and intentionally added radioisotopes of any type. This statement excludes the presence of a field of ionizing radiation except for a new and unknown form of radiation source .The radiation measurements are made on the materials used before and after the test and on the ambient around the prototype in use during the test. The measuring positions are conservative with respect to the position and the occupation time of the operators involved.

The present evaluation based on the radiation measurements cannot be related to criteria of functionality of the system and cannot be used for comparison in systems different from this one, in the process, in the geometry or in the construction materials used.



Figl: Picture of the neutron probe and tennoluminescent detectors around the prototype

MATERIALS AND METHODS

In order to avoid potential source or risk for the operators and the population around the prototype during the long duration test the commissioner ask me to measure different kind of radiation in wide range of energy. The hypothesis that the prototype can produce a radiation field is due to the unconventional energy that the inventor has produced with it. To ensure that this process do not involve ionizing radiation I perform the evaluations on different type of radiation in wide spectrum and wide energy. The measurements are divided temporally in before, during and after the using of the prototype. In the "before" and "after" evaluation the gamma and alpha/beta field evaluation are made on the material used inside the prototype. In the "during" evaluations the gamma and neutron field are performed around the system.

The measure does not take into account in any way the interaction of the photons, charged particles or neutron produced by the materials inside the apparatus during the using and cannot in any way be traced back to the production of ionizing radiation from the inside of the prototype.
The radiation measurement protocol is structured as follows:

- The comparison of the CPM collected during the test with the CPM referred to the background in laboratory is an index of low flounce radiation field.

- The active probes and the TLD positions was chosen to be at the closest position.
- accessible by operators around the support frame.

- The radioisotope presence in the material used before and after the experiment is
- evaluated with a Geiger scanner in ratemeter mode.

- The background radiation, for all kind of radiation, has been measured both in the plant and in laboratory, at a distances d>30m from the room where the test took place.

The measurements were performed with the following instrumentation:

1. LUDLUM 2241 Scaler-Ratemeter (sin 214522):

- Scintillation probe (2.5 x 2.5 cm) (Dia x L) (Nal)TI Ludlum 44-2 (PR-227268);
- Energy range: 50 keV -2 MeV;
- Exposure sensitivity: 19.9 CPM/nSv/hr ^{137}'Cs gamma);
- Integration time: 2s.
- Rate meter Alarm and Alert: 0.2 µSv/h
- Calibration factors on ^{137}Cs supplied by the factory (04/2012)
- Constancy evaluation of gamma response factor with ^{137}Cs radiation source before and after the test
- The rate meter has a serial RS-232 blue-tooth connection to a pc logger.

2. LUDLUM 2221 Sealer/Ratemeter SCA (sin202347):

- Neutron Radiation Detector (neutron recoil scintillator) Prescila 42-4 l (PR256816)
- Sensitivity declared : 350 cpm per mrem/h;
- Calibrations at ENEA calibration service:
  14/06/2012 (N°03N12) wi1h AmBe source (E.,.-, =4.4 MeV)
  F =0.028µS'vl h/ CPM I equivalent to 36 cpm per µSv/h
  28/0112008 wi1h Pu-Li source ($E_{neutrons}$ =0.54 MeV)
  F =0.067µS'vl h/ CPM equivalent to 15 cpm per µSv/h
- Angular dependence and temperature dependence as in Figure 2

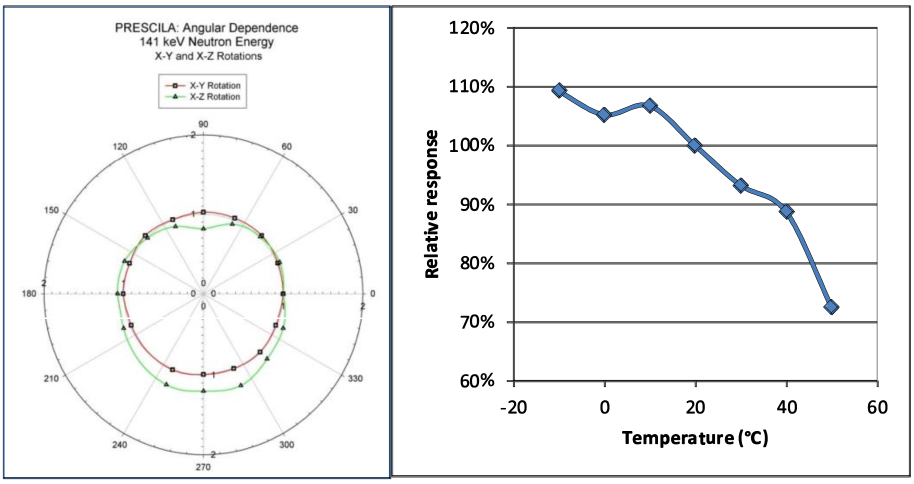


Figure 2: Angular and energy dependence of the Ludlum 44-41 neutron probe.

Appendix 1

3. LUDLUM 2241 Sealer-Ratemeter (sin214522):

- Geiger Probe Ludlum 44-9 (PR- 226527);
- Energy range: energy dependent
- Exposure sensitivity: 3300 cpm/mR/hr (^{137}Cs gamma);
- Integration time: 2s.
- Background (typical): 60CPM
- Rate meter Alarm aod Alert: 0.3 µSv/h
- Calibration factors on ^{137}Cs supplied by the factory (0412012)
- Constancy evaluation of gamma response factor with ^{137}Cs before and after the test.

4. TERMOLUMINESCENT DOSIMETERS LiF:V

- TDL Reader: Vinteen Toledo 654
- Calibration field: IEC 61267 – Code RQR5 – 2.45 mm A1 HVL
- Calibration dose :0.050±0.005 mGy
- Calibration factor: individual for each TDL
  Mean counts of the sample: 1613 cou
  Mean F value of the sample 0.031 µC
- Extended error on the dose measure at 0.050n
- 2 TDL for each position of measurement
- Calibration made before and after the measurement

RESULTS

Evaluation of radionuclides presence:

The material that compound the prototype, include the material inside, are controlled before and after the test in order to avoid the presence of radioisotope contamination. These measurements are performed with the Geiger probe in rate meter configuration on at least 20 points:

	CPM (mean values)	
	BEFORE	AFTER
Backsuound radiation in laboratory	51 (σ =Il)	53 (σ =IO)
Background radiation in plant	47 (σ = 13)	48 (σ=13)
Naked "Hot-Cat"	53 (σ = 11)	51 σr = 12)
Sample of inside reactor material	55 (σ = 14)	52 (σ= 15)

The reactor's inside material has been scanned in a low background container (5cmPB) with the Nal probe and this measure didn't shows any γ/X activity of the sample.

Gamma/X monitoring during the test:

The monitoring of the photonic dose field is made with passive and active dosimeters. During the 34 days of running 16 TLD dosimeters recorded the dose (4 for each side) and 4TLD are used as control placed at d > 50cm (Figure 3).

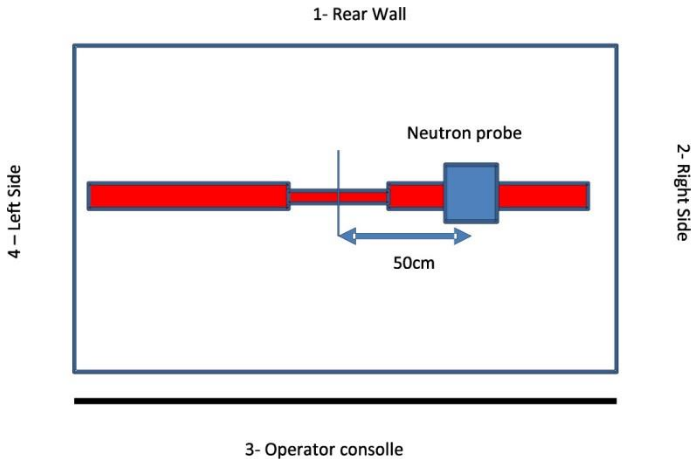


Figure 3. Relative position of the detector with respect to the prototype

The term luminescent reading values and relative doses are presented in table:

Position	*Counts*	*Dose (mGvl*
1 -Rear wall	2539	0.079±0.024
2 -Right side	2477	0.077±0.023
3 -Operator consolle	2411	0.075±0.022
4 -Left side	2553	0.079±0.024
Control	2385	0.074±0.022

The comparison of the absolute dose to the control dosimeters (background) shows that the increment dose due the test is less than 0.03±0.0lmGy for all the positions considered.

<u>Neutron field monitoring during the test:</u>

The neutron dose field evaluation is made on 5 hours interval. This interval is considered representative of the rest of the test. The measurements are performed in scaler mode on 60s integration time on the detailed number of runs.

	Number of runs	Mean Counts	Standard deviation
Background radiation in the laboratory	20	14.1	σ =4.3
Background radiation in plant	45	13.8	σ =3.9
50cm from the center of the prototype	95	16.9	σ =4.1

Bologna 09/04/2014

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Alumina sample analysis

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In order to determine the nature of the material covering the reactor, a sample from one of the ridges was analyzed. To prevent contamination, the fragments were placed on an X-Ray crystallography slide and attached with high vacuum grease, avoiding further handling.

Figure shows slide with fragments attached.

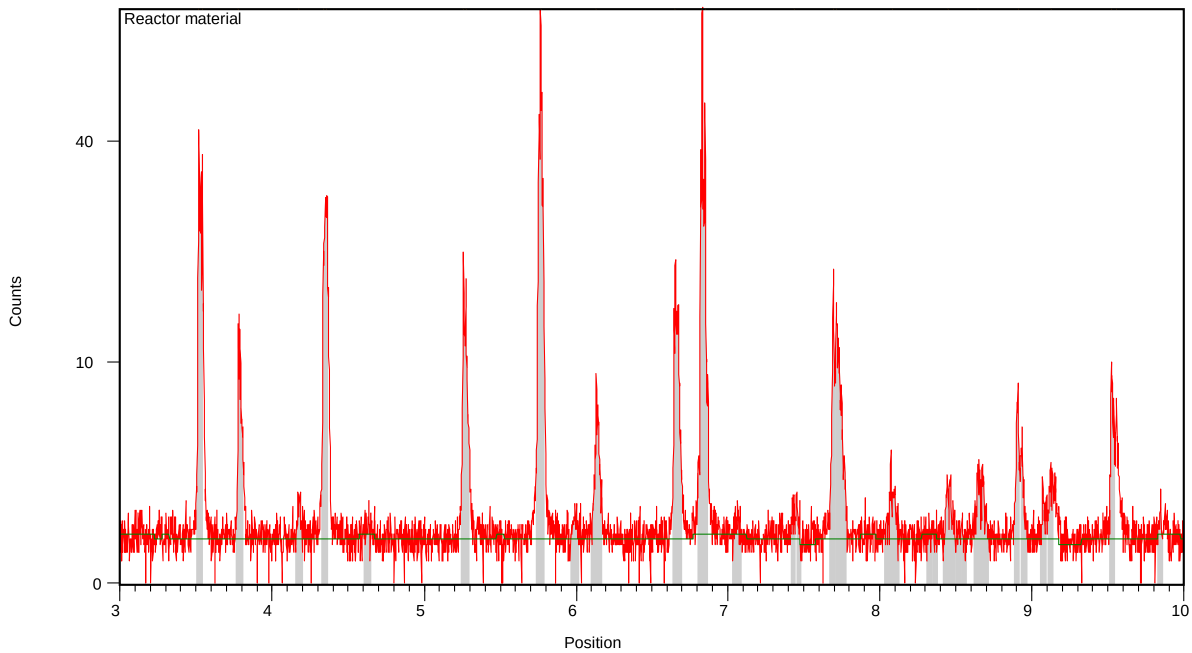
A table of the measurements parameters used follows.

Anchor Scan Parameters:

Scan Axis	Gonio	Start Position [°2Th.]	30.0000
End Position [°2Th.]	100.0000	Step Size [°2Th.]	0.0200
Scan Step Time [s]	4.0000	Scan Type	Continuous
Offset [°2Th.]	0.0000	Divergence Slit Type	Fixed
Divergence Slit Size [°]	1.0000	Specimen Length [mm]	10,00
Receiving Slit Size [mm]	0.1000	Measurement Temperature [°C]	25.00
Anode Material	Cu	K-Alpha1 [Å]	1.54060
K-Alpha2 [Å]	1.54443	K-Beta [Å]	1.39225
K-A2 / K-A1 Ratio	0.50000	Generator Settings	45 mA, 45 kV
Diffractometer Type	Rigaku	Diffractometer Number	1
DMAX-IIIC			
Goniometer Radius [mm]	240.00	Dist. Focus-Diverg. Slit [mm]	91.00
Incident Beam Monochromator	No	Spinning	No

Appendix 2

Graphics: (Bookmark 2)



Analysis software automatically identified the following peak list from its database:

Peak List:

Pos. [°2Th.]	Height [cts]	FWHM [°2Th.]	d-spacing [Å]	Rel. Int. [%]	Tip width [°2Th.]	Matched by
35.1845	338.49	0.0787	2.55074	47.87	0.0945	00-042-1468; 01-071-1127
35.4333	331.09	0.0590	2.53340	46.83	0.0708	01-071-1127
37.7784	134.95	0.0590	2.38136	19.09	0.0708	00-042-1468
41.7685	9.88	0.2362	2.16263	1.40	0.2834	00-042-1468; 01-071-1127
43.3784	220.16	0.0960	2.08430	31.14	0.1152	00-042-1468
43.5753	280.81	0.2362	2.07706	39.72	0.2834	01-071-1127
52.5804	221.39	0.0960	1.73915	31.31	0.1152	00-042-1468
52.7386	185.66	0.0720	1.73862	26.26	0.0864	
57.6591	634.55	0.1200	1.59745	89.74	0.1440	01-071-1127
61.3068	71.69	0.1440	1.51086	10.14	0.1728	00-042-1468; 01-071-1127
66.5421	186.63	0.1920	1.40412	26.40	0.2304	00-042-1468
68.3309	707.06	0.0720	1.37165	100.00	0.0864	00-042-1468
68.5276	456.75	0.0720	1.37160	64.60	0.0864	
74.3991	5.84	0.5760	1.27408	0.83	0.6912	00-042-1468
76.9444	185.35	0.0960	1.23816	26.21	0.1152	00-042-1468
77.1776	144.63	0.1920	1.23500	20.46	0.2304	00-042-1468; 01-071-1127
80.8221	12.13	0.3840	1.18825	1.72	0.4608	00-042-1468; 01-071-1127
84.4963	10.90	0.3840	1.14570	1.54	0.4608	00-042-1468
86.4385	18.75	0.4800	1.12487	2.65	0.5760	00-042-1468
89.0923	77.91	0.1680	1.09810	11.02	0.2016	00-042-1468
91.2842	17.82	0.6720	1.07736	2.52	0.8064	00-042-1468
95.2206	96.29	0.1200	1.04295	13.62	0.1440	00-042-1468
95.5698	57.60	0.1440	1.04006	8.15	0.1728	

Peak configuration allowed the identification of the following components:

Identified Patterns List:

Visible	Ref. Code	Score	Compound Name	Displacement [°2Th.]	Scale Factor	Chemical Formula
*	00-042-1468	75	Alumina	0,000	0,357	Al2 O3
*	01-071-1127	54	Corundum	0,000	0,211	Al2 O3

Plot of Identified Phases.

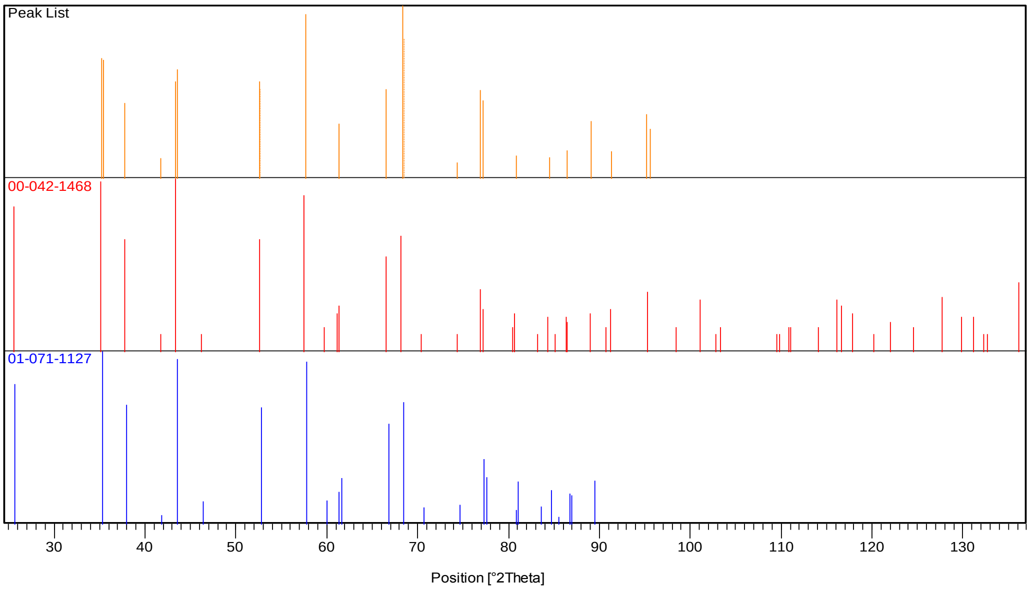


Figure shows peaks found (blue) compared to the two materials identified through the database (red).

Conclusion: within the limits of the instrument's sensitivity range, the sample appears to be constituted of aluminum dioxide, Al_2O_3.

Appendix 3

Investigation of a fuel and its reaction product using SEM/EDS and ToF-SIMS

Ulf Bexell and Josefin Hall

Materialvetenskap, Högskolan Dalarna

Background

Powder samples were investigated before and after an experiment performed in Lugano, Switzerland. The purpose of the present investigation is to study which elements that mainly occur in the samples.

Experimental

Material

Two types of powder samples were investigated. The first sample, called fuel, is declared to mainly contain Ni and probably some additions of H and Li. The second sample, called ash, is the reaction product of the fuel powder from an experiment performed in Lugano. The powder samples were mounted on a carbon adhesive sticker before analysis. The samples analyzed with SEM/EDS and ToF-SIMS were received mounted and analyzed as-received.

Surface characterization techniques

SEM/EDS

Scanning electron microscopy (SEM) was used to study the surface morphology of the samples. The SEM analyses were performed with a Zeiss Ultra 55 field emission gun scanning electron microscope (FEG-SEM) equipped with an Oxford Instruments Inca energy dispersive X-ray spectroscopy (EDS). Imaging was performed by using the secondary electron detector (SEI-mode). All EDS analyses where performed by using an accelerating voltage of 20 kV of the primary electrons.

ToF-SIMS

All time-of-flight secondary ion mass spectrometry (ToF-SIMS) analyses were performed with a PHI TRIFT II instrument using a 15 keV pulsed liquid metal ion source isotopically enriched in ^{69}Ga. In this system, the secondary ions are accelerated up to ~3 keV before being deflected by 270° by three electrostatic hemispherical analyzers. Both positive and negative spectra were obtained using a 600 pA d.c. primary ion beam pulsed with a frequency of 8 kHz (m/z=0.5–1850 amu), a pulse width of 18 ns (~1 ns bunched) and rastered over a surface area of 100×100 μm^2. The mass resolution at mass +28 amu (Si^+) was around m/Δm=1900. All spectra were carefully calibrated using the exact masses of peaks of known composition such as $^7Li^+$ (7.0160 amu), Na^+ (22.9898 amu), Al^+ (26.9815 amu), $^{58}Ni^+$ (57.9353 amu) etc. Peak identification was done on the basis of the exact mass of the secondary ions.

Appendix 3

Results and discussion

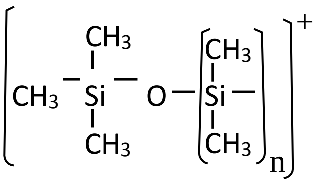
SEM/EDS

Figures 1 and 2 show that there exist different types of particles in the fuel and ash powders. The SEM images show that all particle types have different surface morphology and the EDS spectra, Figs 3 and 4, show that the chemistry also differs between the particles. Thus, it can be expected that the results from the ToF-SIMS measurements can vary depending on which type of particle that is analyzed. Note that Li cannot be detected using EDS.

ToF-SIMS

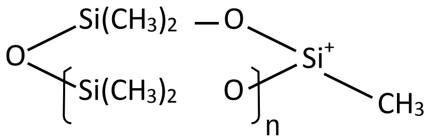
The positive ToF-SIMS spectrum in Fig. 5 shows the mass spectrum from the surface of the carbon adhesive sticker that the powder is mounted on. The most abundant peaks are characteristic of a dimethyl siloxane type of polymer. Some of the characteristic peaks are due to a linear or cyclic structure:

Linear type:



n	0	1	2	3
m/z	73	147	221	295

Cyclic type:



n	0	1	2	3
m/z	133	207	281	355

In Fig. 6 is the positive mass spectrum from a fuel powder particle shown. Except from peaks from elements such as Li (m/z = 7) and Ni (m/z = 58) it can be seen that the characteristic peaks from a siloxane is present in the mass spectra. To remove the siloxane that has diffused over the particle surface the area being analyzed is sputtered. Figure 7 show the positive mass spectrum from a particle surface sputter cleaned for 180 seconds. As can be seen, the characteristic peaks from the siloxane are more or less removed. The presence of a small Si peak, not seen in the figure, is the only remains of the siloxane. It should be noted that it cannot be excluded that the Si signal is due to an element coming from the fuel material itself. To prove that the siloxane is coming from the siloxane in the carbon adhesive sticker the sample were left for 16 hours in the vacuum chamber and analyzed at the same position that previously were sputter cleaned. The positive mass spectrum from this experiment is shown in Fig. 8 and the presence of the characteristic peaks from a siloxane is obvious, i.e. surface diffusion of the siloxane has occurred. Thus, all spectrum presented henceforth is acquired from sputter cleaned areas.

In Fig. 9 is the positive mass spectrum from the fuel and the ash presented. The main ion peaks are Li^+ (m/z = 6 and 7), Na^+ (m/z = 23), Ni^+ (m/z = 58 and 60 in the fuel and m/z = 62 in the ash) and 69^+ (m/z = 69). The Na^+ ion signal comes from the primary ions. The origin of Na^+ is either from some contamination, the carbon adhesive sticker or the material itself. Anyway, the probability for generating Na^+ as secondary ions is extremely high and the importance of the signal can be overestimated. The most interesting features is seen in the spectra from the ash where there seem to be a change in abundance of the isotopes for Li and Ni. In the fuel the abundance is close to what is naturally expected, see Table 1. In the ash the abundance of Li and Ni is altered, see table 1.

Appendix 3

Table 1. Measured and natural occurring abundances for Li and Ni ions in fuel and ash, respectively.

Ion	Fuel		Ash		
	Counts in peak	Measured abundance [%]	Counts in peak	Measured abundance [%]	Natural abundance [%]
$^{6}Li^{+}$	15804	8.6	569302	92.1	7.5
$^{7}Li^{+}$	168919	91.4	48687	7.9	92.5
$^{58}Ni^{+}$	93392	67	1128	0.8	68.1
$^{60}Ni^{+}$	36690	26.3	635	0.5	26.2
$^{61}Ni^{+}$	2606	1.9	~0	0	1.8
$^{62}Ni^{+}$	5379	3.9	133272	98.7	3.6
$^{64}Ni^{+}$	1331	1	~0	0	0.9

Figure 10 and 11 shows the positive mass spectra from different types of fuel and ash powder grains, respectively. Thus, as expected from the EDS analysis the appearance of the ToF-SIMS spectra will differ depending on particle analyzed.

Conclusions

The main conclusion that can be drawn from this SEM/EDS and ToF-SIMS study of powder samples from a fuel and a reaction product of the fuel, called ash, are:

- there are different types of powder particles in both samples.
- in the fuel sample, the detected ions has a natural abundance.
- In the ash sample, some ions, i.e. Li and Ni have an abundance deviating from the natural abundance.

Appendix 3

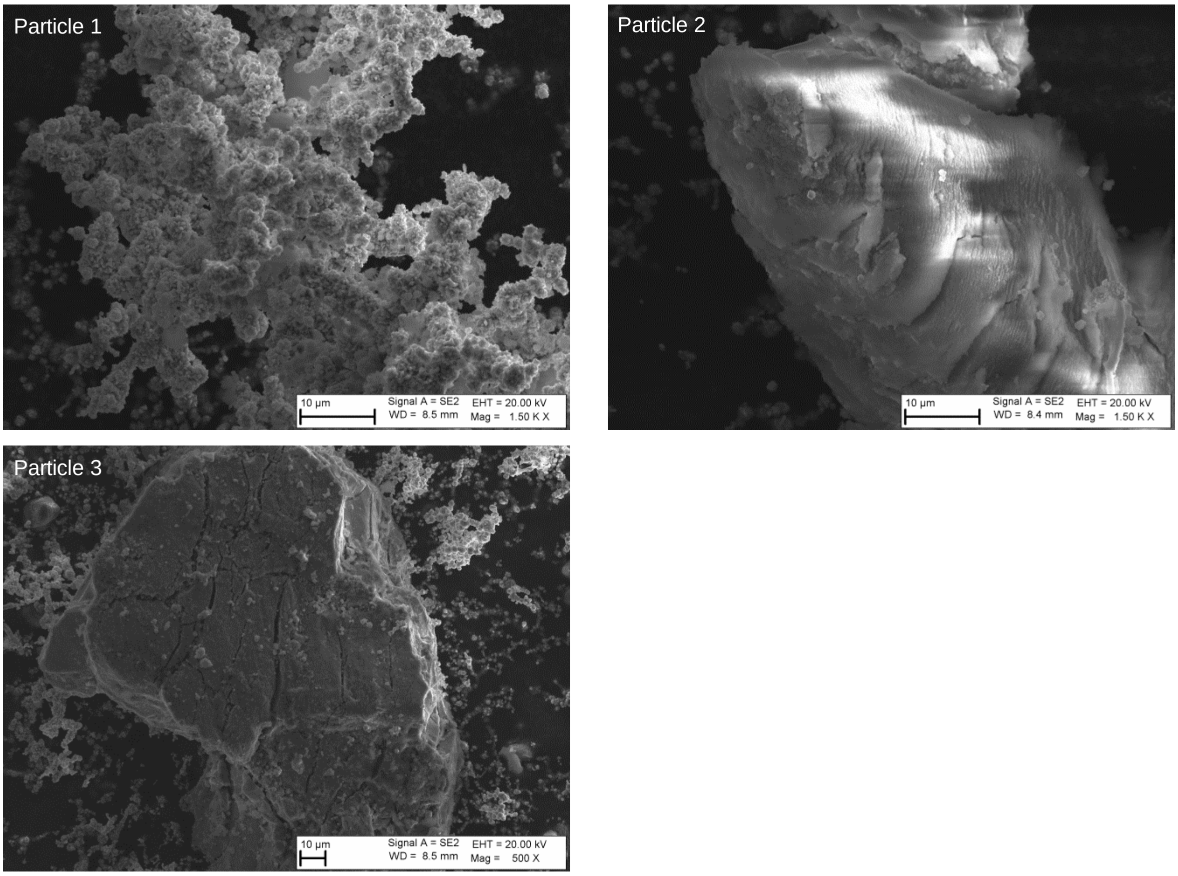


Figure 1. Three different types of particles from the fuel material.

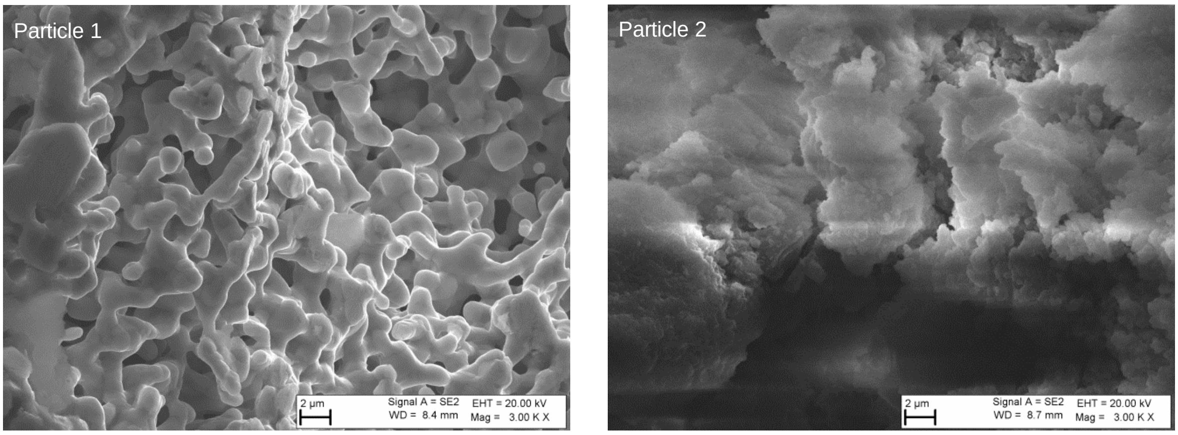


Figure 2. SEI of two different types of particles from the ash material.

Appendix 3

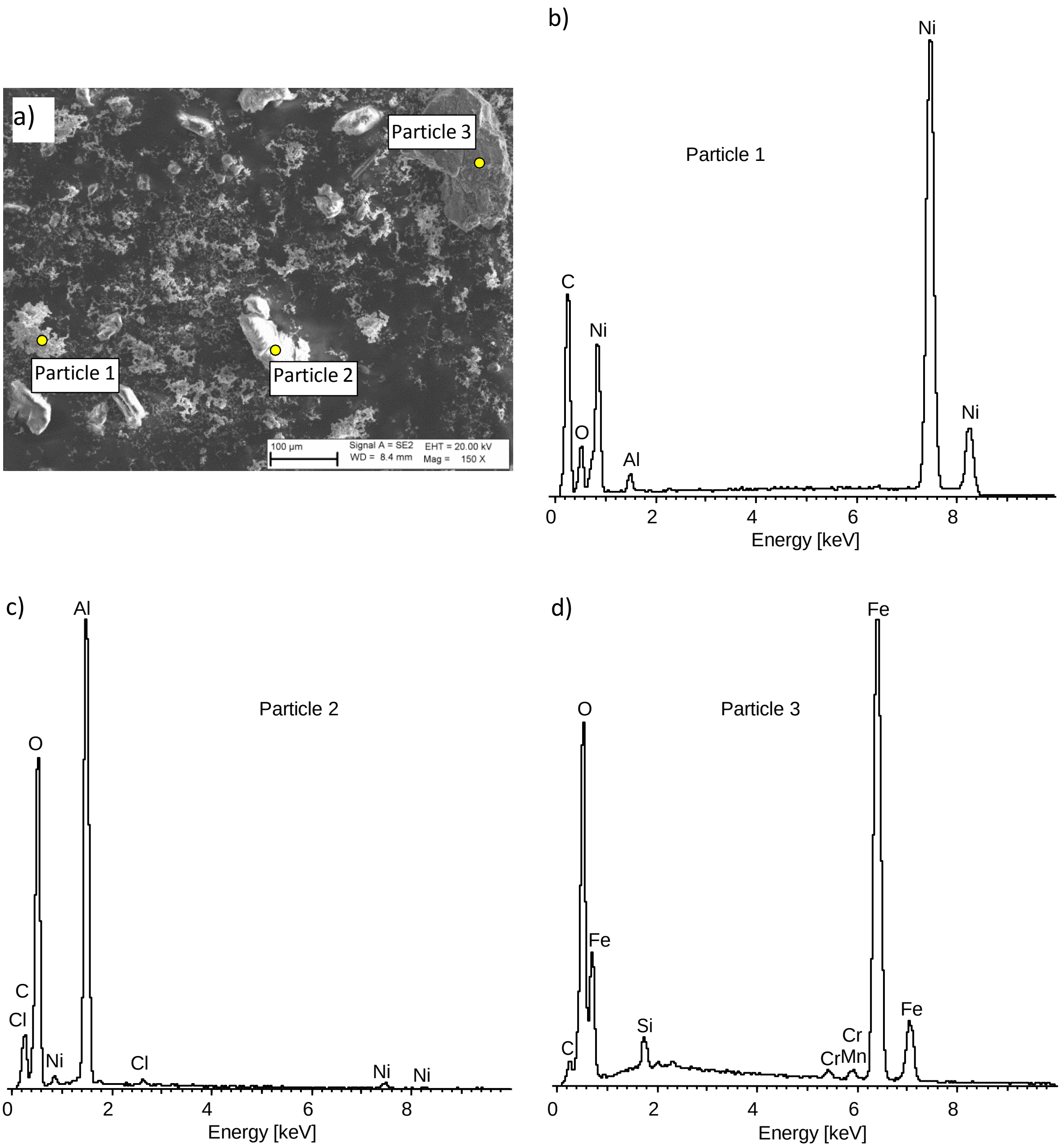


Figure 3. SEI showing the areas where EDS analysis where performed on the different fuel particles (a), EDS spectrum from the three different type of particles found in the fuel material; particle 1 (b), particle 2 (c) and particle 3 (d).

Appendix 3

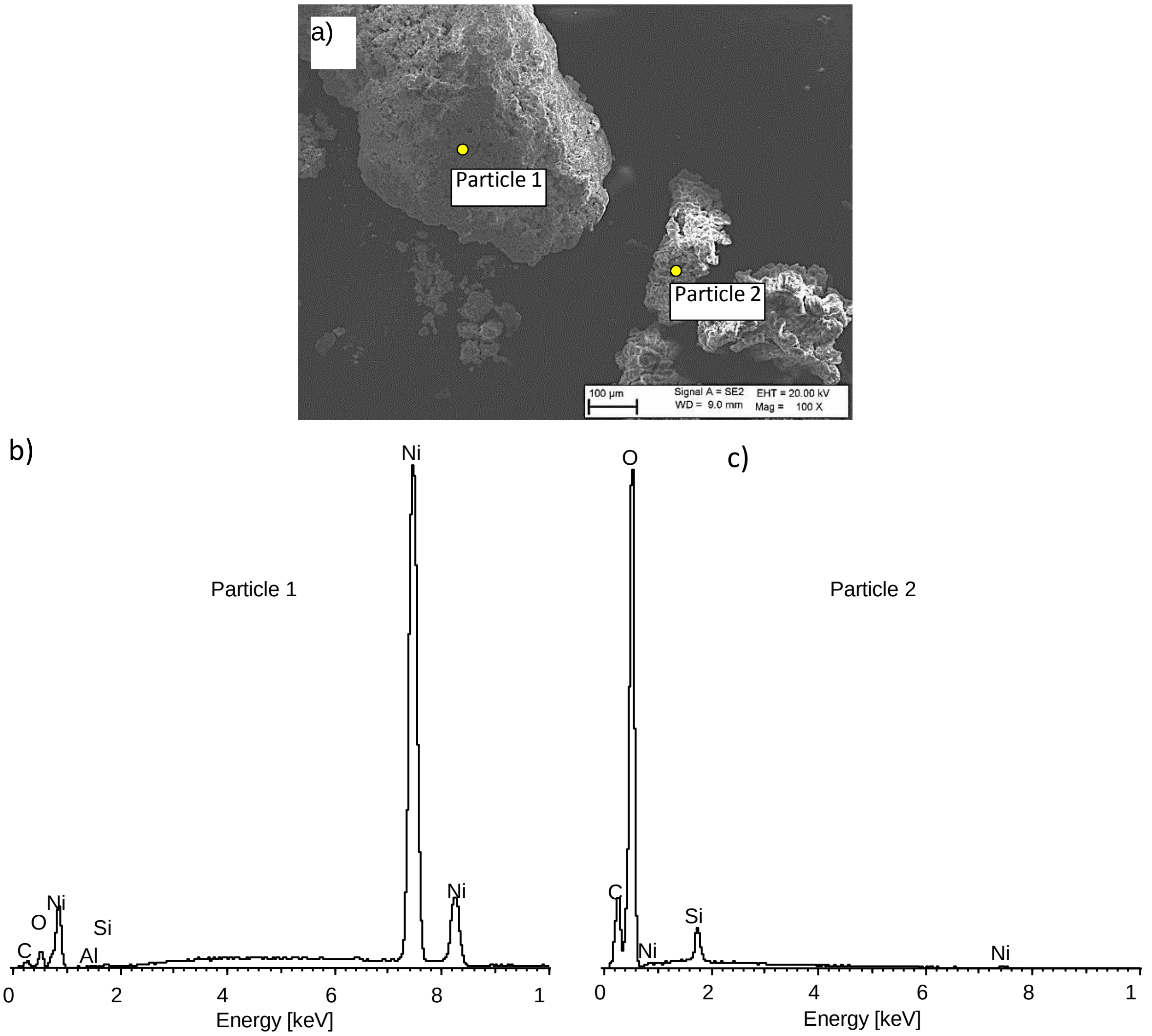
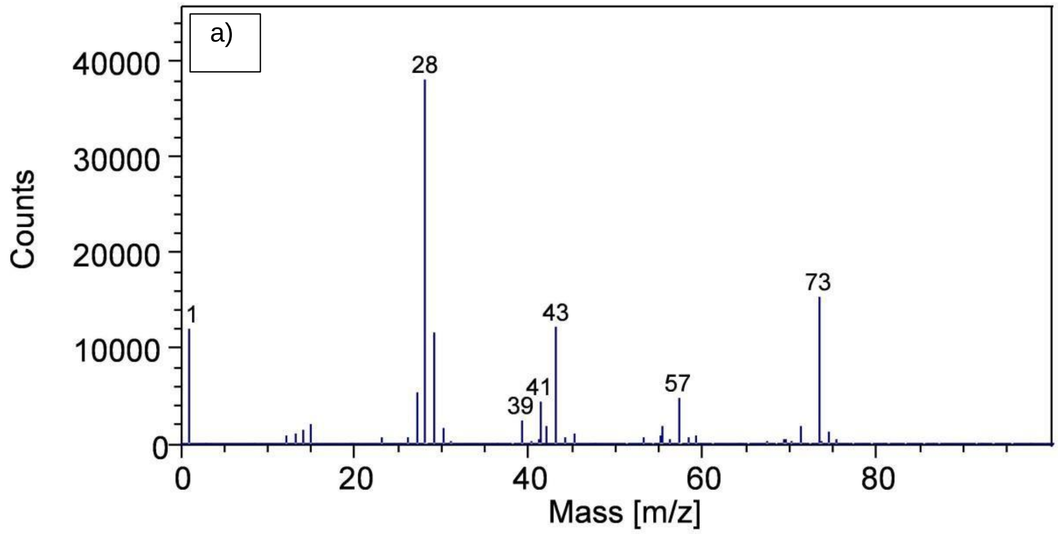


Figure 4. SEI showing the areas where EDS analysis where performed on the different ash particles (a), EDS spectrum from the two different type of particles found in the ash material; particle 1 (b) and particle 2 (c).

Appendix 3



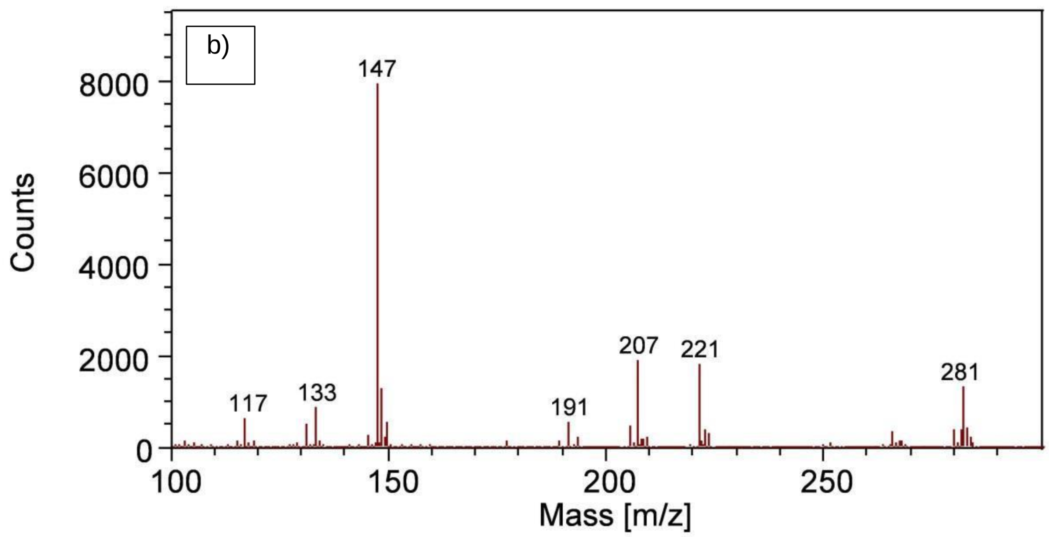


Figure 5. Positive ToF-SIMS spectrum of a carbon adhesive sticker surface: a) 0-100 amu b) 100-300 amu.

Appendix 3

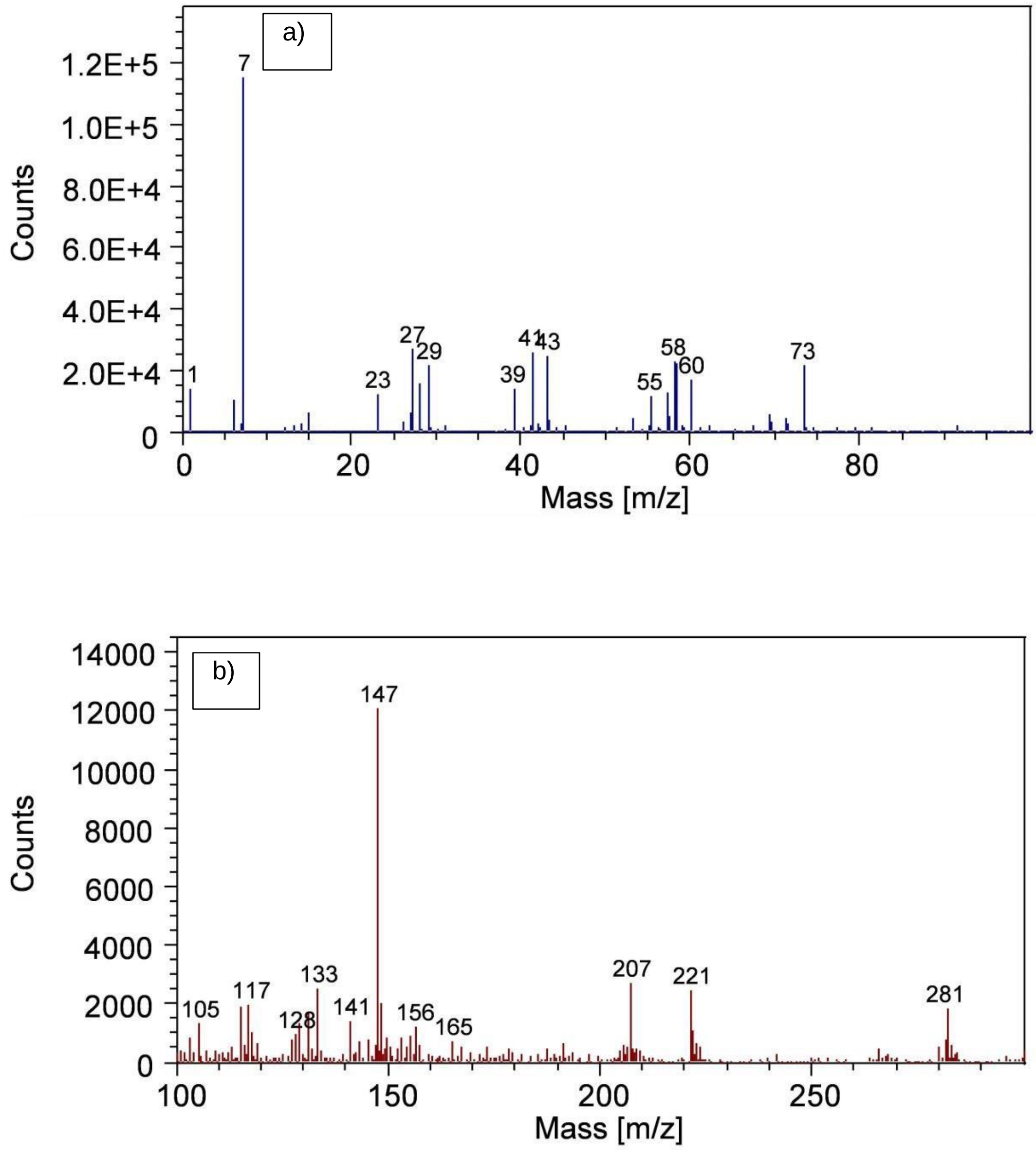
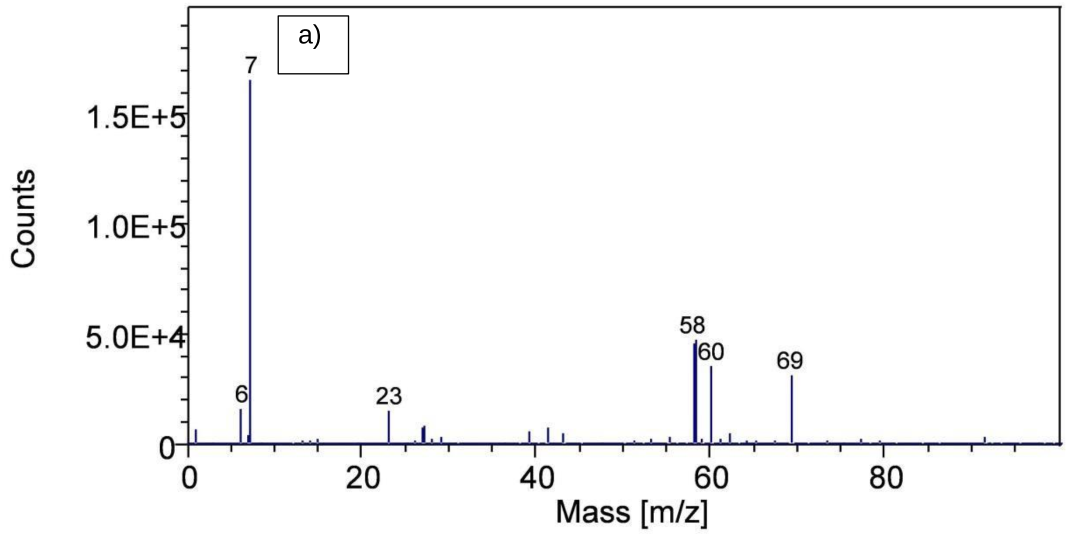


Figure 6. Positive ToF-SIMS spectrum of the surface of a fuel powder grain before sputter cleaning: a) 0-100 amu and b) 100-300 amu.

Appendix 3



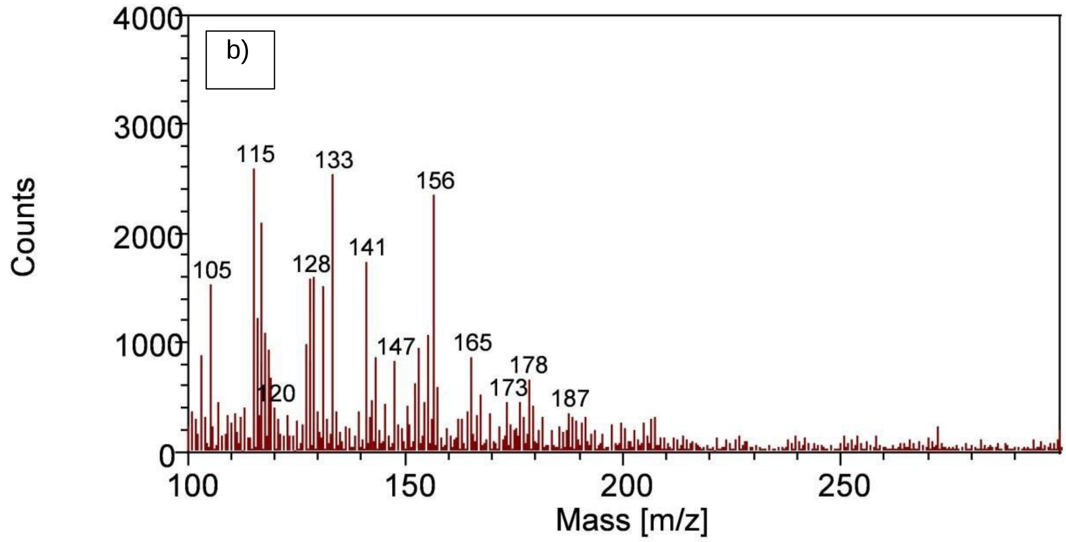


Figure 7. Positive ToF-SIMS spectrum of the surface of a fuel powder grain after sputter cleaning for 180 s: a) 0-100 amu and b) 100-300 amu.

Appendix 3

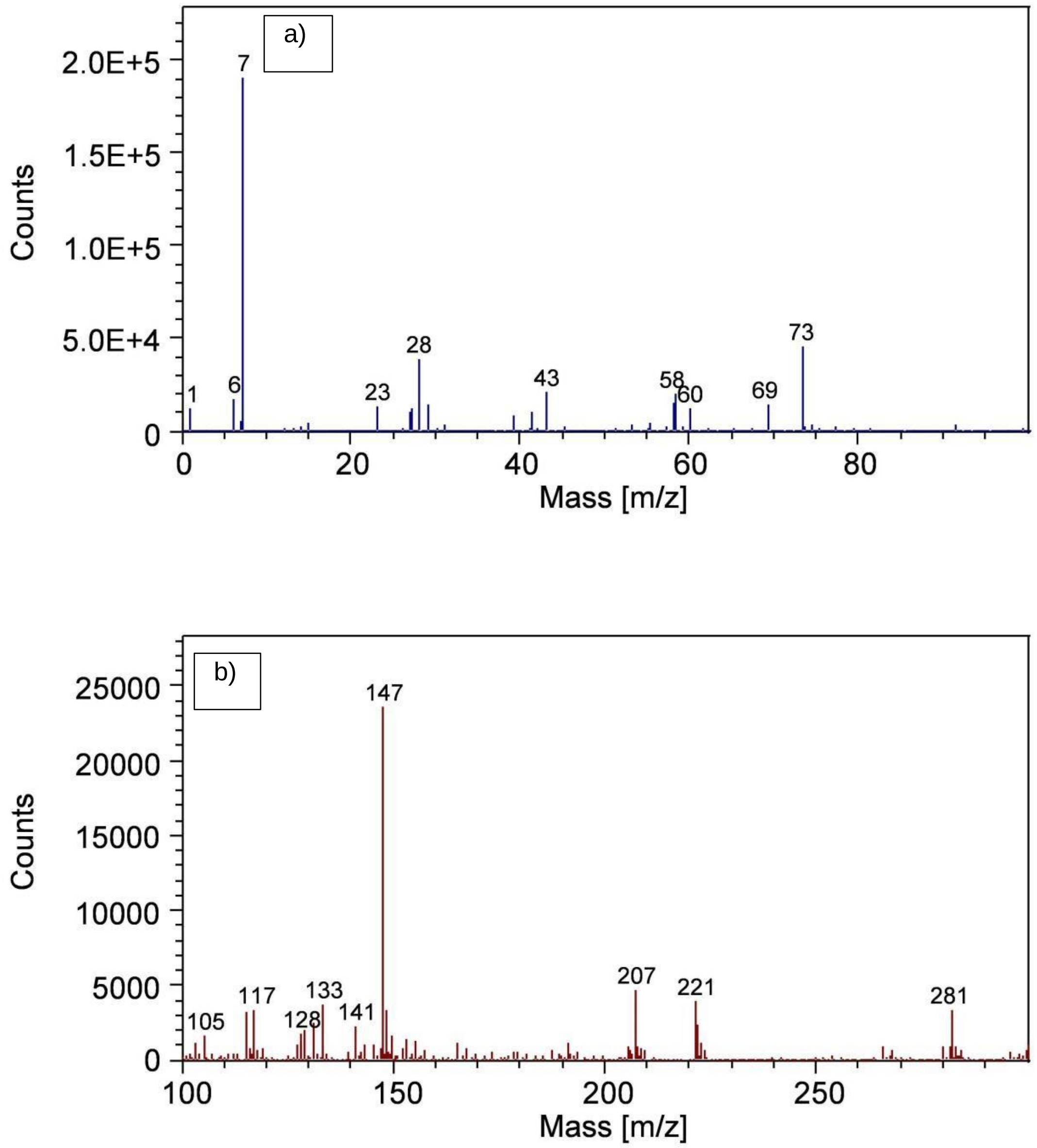
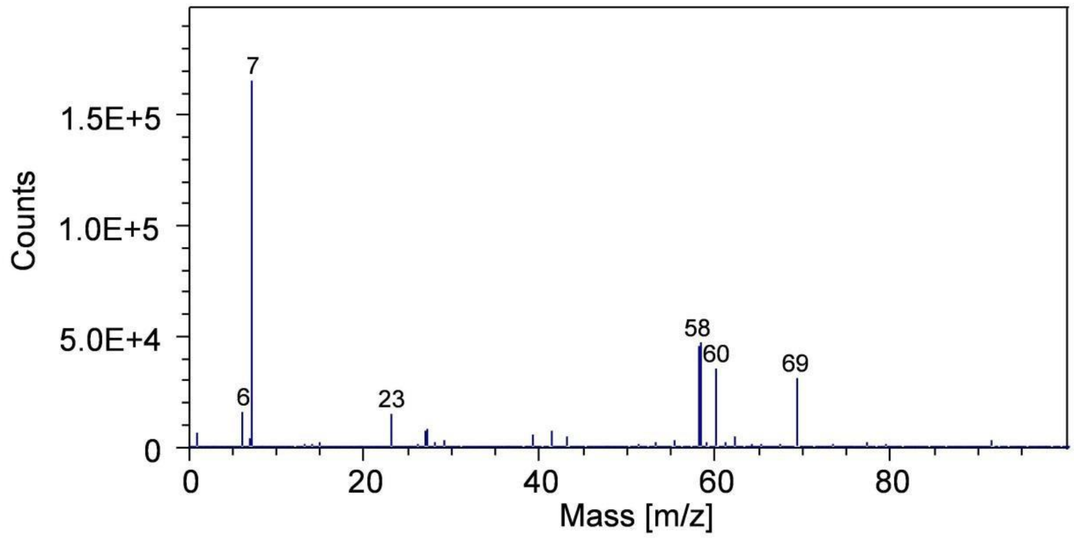


Figure 8. Positive ToF-SIMS spectrum of the surface of a fuel powder grain after sputter cleaning for 180 s followed by storing 16 h in the vacuum chamber: a) 0-100 amu and b) 100-300 amu.

Appendix 3



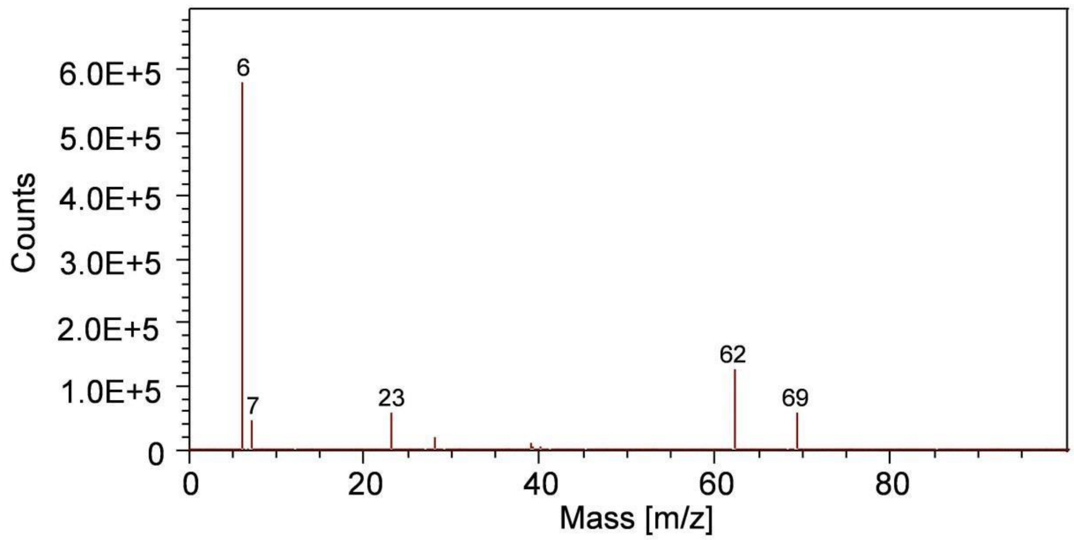
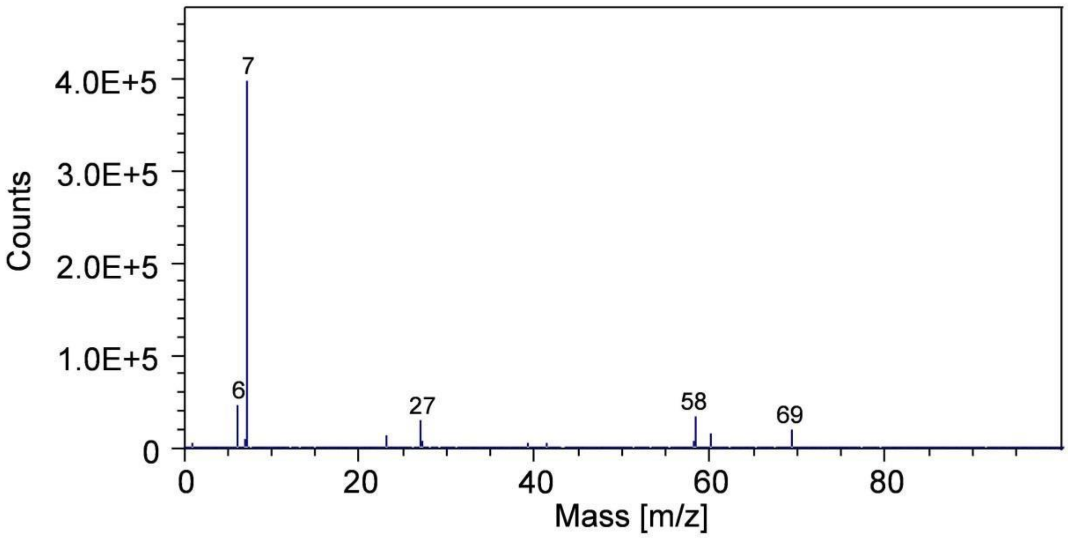


Figure 9. Positive ToF-SIMS spectrum of the surface of a fuel (above) and ash (below) powder grain after sputter cleaning for 180 s.

Appendix 3



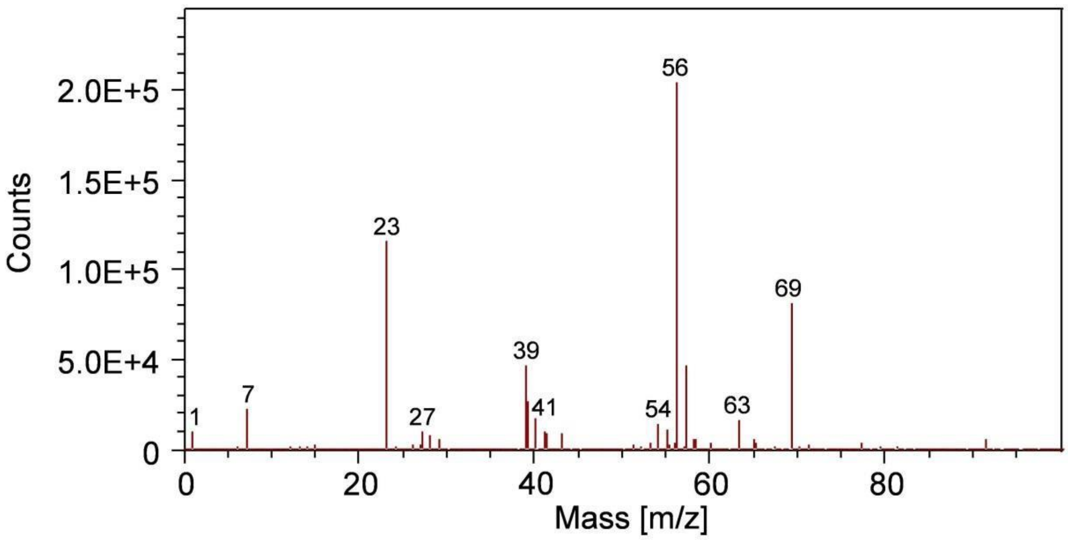


Figure 10. Positive ToF-SIMS spectrum of the surface of different types of fuel powder grains; one with low Ni content (above) and one rich in Fe (below) after sputter cleaning for 180 s.

Appendix 3

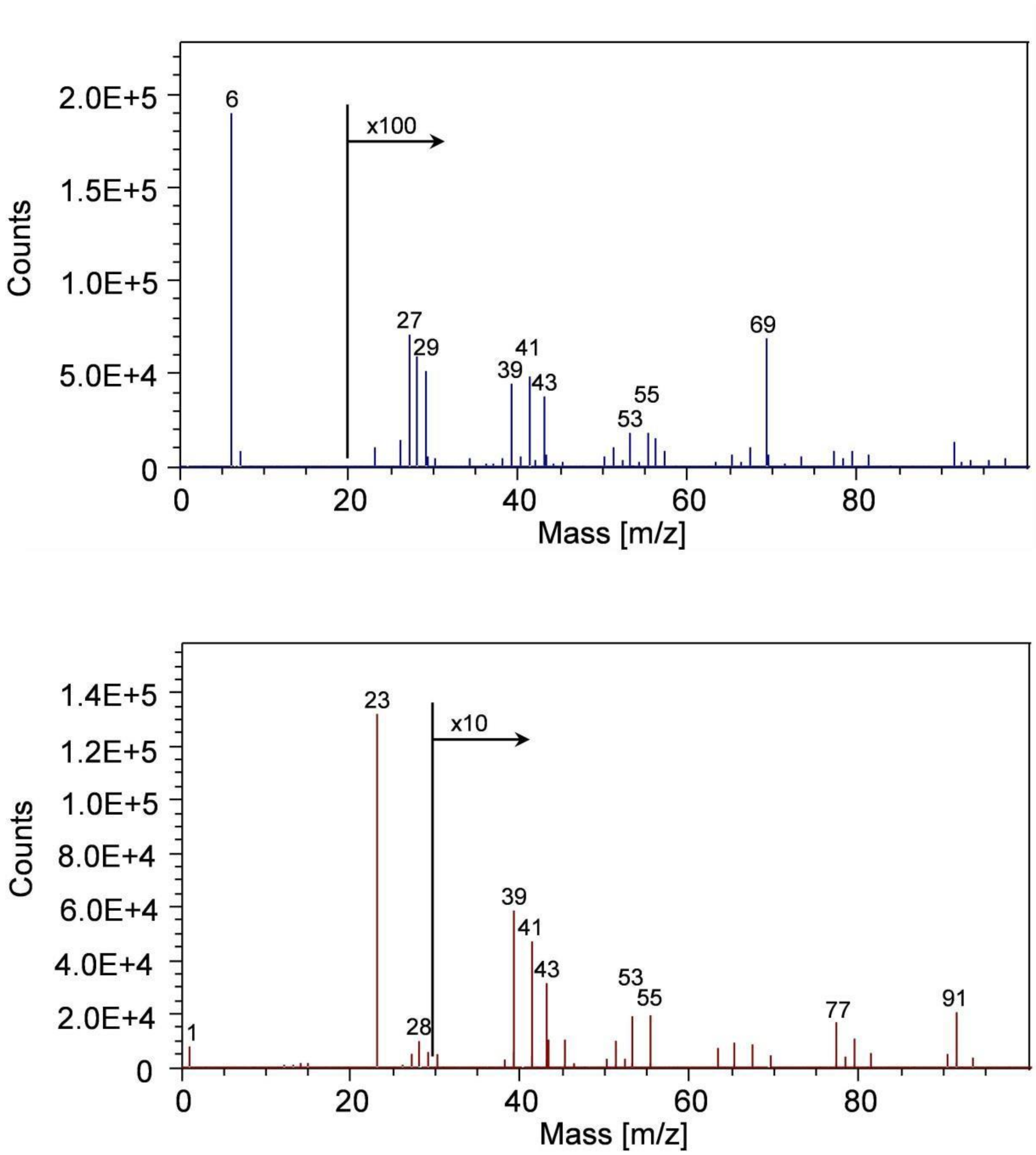


Figure 11. Positive ToF-SIMS spectrum of the surface of different types of ash powder grains; one with Li (above) and one without Li (below) after sputter cleaning for 180 s.

Appendix 4

Results ECAT ICP-MS and ICP-AES

Jean Pettersson
Inst. of Chemistry-BMC, Analytical Chemistry
Uppsala University

The samples are placed in quartz micro-Kjedahl vessels for dissolution with extra pure sub-boiled nitric acid (3.0 ml). They were heated to 136 degree and after that diluted to 50.0 ml.
Further dilution 1000 times was done before the measurement with ICP-MS.
The resulting values are corrected with blanks (the pure acid). The isotopic abundances are calculated and presented in the table below. Standards are known reference solutions in order to cheek the instrument. The natural isotopic abundance is shown in the last line of the table. The difference between the standards and the natural abundance is due to the fact that the signals are not mass biased corrected with isotopic reference standards.

mg sample	Sample id	Li 6	Li 7	Ni 58	Ni 60	Ni 61	Ni 62
	Standard 2	6,0	94,0	66,0	27,6	1,3	4,0
	Standard 3	6,0	94,0	66,1	27,5	1,3	4,1
	Standard 4	6,0	94,0	66,0	27,5	1,2	4,1
2,13	sample 1 ash	57,5	42,5	0,3	0,3	0,0	99,3
2,13	Sample 2 fuel	5,9	94,1	65,9	27,6	1,3	4,2
	Nat. abundance	7,6	92,4	68,1	26,2	1,1	3,6

Three different samples were analyzed by inductively coupled plasma atomic emission spectroscopy operated at standard conditions, ICP-AES.
The samples are placed in quartz micro-Kjedahl vessels for dissolution with extra pure sub-boiled nitric acid (3.0 ml). Heated to 136 degree and after that diluted to 50.0 ml.
The concentrations are calculated against acid matched calibration solutions.

The measured analytes were Ni, Li, and Al. The elements Ni and Al are measured with two independent emission lines to minimize risk for systematic errors. The elements C, H, O, N, He, Ar and F cannot be measured quantitatively by this technique.
Sample 1 was ash coming from the reactor in Lugano. Only a few granules of grey sample were possible to obtain from the ash and they didn't look exactly the same. One large and two very small granules were observed.
Sample 2 was the fuel used to charge the E-Cat. It's in the form of a very fine powder. Besides the analyzed elements it has been found that the fuel also contains rather high concentrations of C, Ca, Cl, Fe, Mg, Mn and these are not found in the ash.

Results as weight present of the samples.

	Ni 231nm %	Ni 232nm %	Li 670nm %	Al 396nm %	Al 394nm %
1 ash 2,13mg 50ml	95.9	95.6	0.03	0.00	0.05
2 fuel 2.13 mg 50ml	55.4	55.0	1.17	4.36	4.39

EXHIBIT 15

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ARTICLES OF INCORPORATION OF J.M. CHEMICAL PRODUCTS, INC.

ARTICLE I. NAME

The name of this corporation is J.M. Chemical Products, Inc.

ARTICLE II. DURATION

This corporation shall have perpetual existence commencing upon the filing of these Articles.

ARTICLE III. PURPOSE

This corporation is organized for the purpose of transacting any or all lawful business.

ARTICLE IV. CAPITAL STOCK

This corporation is authorized to issue 1,000 shares ($1.00) par value common stock which shall be designated "Common Shares."

ARTICLE V. PRE-EMPTIVE RIGHTS

The shareholders of the corporation shall have no pre-emptive right to acquire unissued or treasury shares of the corporation.

ARTICLE VI. PRINCIPAL OFFICE

The principal place of business/mailing address is: 7900 Glades Road, Suite 530, Boca Raton, Florida 33434.

ARTICLE VII. REGISTERED AGENT

The name and street address of the initial registered office of this corporation is Henry W. Johnson, 7900 Glades Road, Suite 530, Boca Raton, Florida 33434.

ARTICLE VIII. INITIAL DIRECTORS/OFFICERS

The names and addresses of the members of the initial Board of Directors and officers of this corporation are:

NAME **ADDRESS**

D/P/S/T Henry W. Johnson 7900 Glades Road, Suite 530, Boca Raton, Florida 33434

ARTICLE IX. INCORPORATOR

The name and address of the incorporator is:

NAME	ADDRESS
Henry W. Johnson	7900 Glades Road, Suite 530, Boca Raton, Florida 33434

ARTICLE X. INDEMNIFICATION

The corporation shall indemnify any officer or director, or any former officer or director, to the full extent permitted by law.

ARTICLE XI. AMENDMENT

This corporation reserves the right to amend or repeal any provision contained in these Articles of Incorporation, or any amendment hereto; and any right conferred upon the shareholders is subject to this reservation.

ACCEPTANCE OF REGISTERED AGENT

Having been named as registered agent to accept service of process for the above stated corporation at the place designated in this certificate, I am familiar with and accept the appointment as registered agent and agree to act in this capacity. I submit this document and affirm that the facts stated herein are true. I am aware that the false information submitted in a document to the Department of state constitutes a third degree felony as provided for in s817.155, F.S.

7/24/2014

Henry W. Johnson, Registered Agent
Incorporator

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14 JUN 27 AM 11: 2?
SECRETARY OF STATE
TALLAHASSEE, FLORIDA

EXHIBIT 16

Sent: Saturday, July 05, 2014 at 10:36 PM
From: "Andrea Rossi" <ar.123@mail.com>
To: "Tom Darden" <tdarden@industrialheat.co>, "Joe Pike" <jpike@evofem.com>, "John Mazzarino" <jmazzarino@industrialheat.co>, "JT Vaughn" <jvaughn@industrialheat.co>, "Elizabeth Darden Wooten" <edarden@gmail.com>, "T. Barker Dameron" <tbdameron@gmail.com
>
Subject: Andrea Rossi- next important step

Dear All:
In the incoming meeting we will have next week, please allow me to encourage you to take a decision regarding where to put at work our 1 MW plant. I really and strongly hope you will consider the solution I found, to rent it to JM, in its factory in Florida where they will use it to process their chemical products. Please think carefully before losing them. They are positive to us, but in September must start and they must know asap if they have to use our plant or provide otherwise. This solution will:
1- allow to Industrial Heat to say to the Investors that they are getting 360,000 dollars per year of rental, with a payback of a plant like this, whose construction cost is 200,000 $, in less than 6 month
2- allow to your Customer-Investors-Visitors to hear from a real Customer that he is making money with our plant
3- allow us to start in September the operation of the plant, with no further loss of time
4- allow us not to expose the know how, since the maintainance of the plant is made by us and the plant remains our property: a rental is not a sale
5- allow us to make all the Authorities make all the measurements necessary to get the Authorizations for the next plants
6- allow you to get orders to supply for rent thousands of plants
7- allow the plant work for 24 hours per day for 360 days per year, while if used as a room heater it could work only 4 months, not per 24 hours per day, with obvious loss of profit.
Your proposal to put the plant in a factory owned by yourself at least until recently is dramatically less convincing.
Let me do this and I will make a masterpiece (half masterpiece has already been done finding the Customer as a Chemival Industry and getting the authorization from the Florida State Radiation Control Office).
Fulvio is completing the control system, made by 110 computers interconnected. Also that is a masterpiece.
Warmest Regards to all,
Andrea

EXHIBIT 17

Term Sheet

The parties to this Term Sheet are Industrial Heat, LLC ("IH"); JM Chemical Products, Inc. ("JMC"), the operator of a Miami production facility; and Leonardo Corporation ("Leonardo").

1. Industrial Heat, LLC, directly or through its affiliates, owns a 1 MW E-Cat steam plant (the "1 MW Plant") built by affiliates of Leonardo in Italy in 2013.
2. JMC operates a production facility in Miami, FL, which requires low temperature steam.
3. Leonardo has technical knowledge about the operation and maintenance of the 1 MW Plant.
4. IH intends to make available to JMC the 1 MW plant for a period of 2 years.
5. Leonardo will assist in the installation of the 1 MW Plant at the Miami JMC facility, at no cost to JMC or IH.
6. JMC will pay rent of $1000 per day to IH or its designee, monthly in arrears, once the 1 MW plant is installed in their facility and operating at a capacity of 1 MW. However, if the plant provides less than 1 MW of thermal energy, the rental rate will be reduced proportionally. If the plant produces more than 1 MW, there will be no increase in the rental rate.
7. IH will provide all maintenance on the 1 MW Plant during the 2 year rental period.
8. Dr. Andrea Rossi of Leonardo Corp will be responsible for the operation of the 1 MW Plant, assisted by Eng. Fulvio Fabiani and any others designated by IH. There will be no additional cost to JMC or IH for these services.
9. The personnel of JMC will not have access to the inside of the 1 MW Plant or to information about how the 1 MW Plant operates, which are trade secrets of Leonardo and IH.
10. If the 1 MW Plant fails to operate, rent will be reduced proportional to the time that the 1 MW Plant fails to operate, unless the failure is caused by some other party or reason besides IH or Leonardo. If the 1 MW Plant fails to operate for reasons which are not controlled by IH or Leonardo, rent will not be reduced. By way of example, if electrical power is not furnished to the plant, and as a result it fails to operate, rent will be owed nonetheless.
11. If the 1 MW Plant fails to operate for any reason, JMC will not be paid any consequential damages or costs and IH will have the option to terminate the rental agreement and pick up the 1mW Plant.
12. JMC will provide reasonable insurance covering the cost of any damage caused by the 1 MW Plant, naming IH and Leonardo as additional insureds.
13. IH will be allowed to visit the 1 MW Plant at any time, with customers or with IH personnel.
14. IH may provide whatever security, monitoring and control measures it deems appropriate to protect and monitor the 1 MW Plant and related equipment.
15. IH will continue to own the 1 MW Plant and JMC will not have any right to buy or retain the plant. Upon expiration of the rental period, or earlier termination if there is a

default under the rental agreement provided for above, IH may pick up the 1 MW Plant and/or exercise any other rights under this Term Sheet or available by law.

16. JMC will not encumber the 1 MW Plant with any lien or obligation to any third party.
17. IH or Leonardo will furnish to JMC a letter from the Healthcare Office of Miami allowing the operation of the 1 MW Plant.
18. IH and Leonardo will be responsible for their personnel inside the factory of JMC, and JMC will be responsible for their personnel inside their factory.
19. JMC will keep records of the operation of the 1mW Plant as reasonably requested by Leonardo or IH and will provide copies of such records to Leonardo and IH upon request.
20. The Confidentiality Agreement entered into as of July 28th, 2014, by and between IH and JMC shall continue in full force and effect. JMC agrees that it will not make any public announcements regarding the 1 MW Plant unless first approved by IH.

This term sheet is executed effective as of August 13th, 2014 and is binding upon the parties hereto unless and until modified by a subsequent written agreement executed by the parties.

INDUSTRIAL HEAT, LLC

By: [signature]

Name: J.T. Vaughn

Title: Vice President

LEONARDO CORPORATION

By: [signature]

Name: ANDREA ROSSI

Title: C.E.O.

JM CHEMICAL PRODUCTS, INC.

By: [signature]

Name: Henry W. Johnson

Title: President

EXHIBIT 18

J.M. Products, Inc.
"Advanced Derivatives of Johnson Matthew Platinum Sponges"
7861 46TH STREET
DORAL, FLORIDA 33166

HENRY W. JOHNSON
mailto:hjohnson@hwjlaw.net

TELEPHONE (786)631-4676
TELECOPIER (786)631-4741

July 1, 2015

Industrial Heat
8025 Triangle Drive
Raleigh, NC 27617

Attention: J.T. Vaughn
Vice President

Dear Mr. Vaughn:

During the month of June in our Doral factory we received from your plant the amount of energy of 1 MWh/h, for a total of 624 MWh for 26 days, while for 4 days we received 750 kWh/h, for a total of 72 MWh Please forward your invoice for the agreed daily amount of $1,000.00 per day for 26 days = $26,000.00 plus $750/day for 4 days=$3,000.00, for a total of $29,000.00.

Sincerely,

J.M. Products, Inc.

Henry W. Johnson
President

HWJ:ck

J.M. Products, Inc.
7861 46TH STREET
DORAL, FLORIDA 33166

HENRY W. JOHNSON
mailto:hjohnson@hwjlaw.net

TELEPHONE (786)631-4676
TELECOPIER (786)631-4741

August 1, 2015

Industrial Heat
8025 Triangle Drive
Raleigh, NC 27617

Attention: J.T. Vaughn
Vice President

Dear Mr. Vaughn:

During the month of July in our Doral factory we received from your plant the amount of energy of 1 MWh/h, for a total of 624 MWh for 26 days, while for 4 days we received 750 kWh/h, for a total of 72 MWh. Please forward your invoice for the agreed daily amount of $1,000.00 per day for 26 days = $26,000.00 $ plus $750/day for 4 days=$3,000.00, for a total of $29,000.00.

Sincerely,

J.M. Products, Inc.

Henry W. Johnson
President

HWJ:ck

J.M. Products, Inc.
7861 46TH STREET
DORAL, FLORIDA 33166

HENRY W. JOHNSON
mailto:hjohnson@hwjlaw.net

TELEPHONE (786)631-4676
TELECOPIER (786)631-4741

October 12, 2015

Industrial Heat
8025 Triangle Drive
Raleigh, NC 27617

Attention: J.T. Vaughn
Vice President

Dear Mr. Vaughn:

During the month of September in our Doral factory we received from your plant the amount of energy of:

15 days @ 1 MWh/h
15 days@ .75 MWh/h

Sincerely,

J.M. Products, Inc.

Henry W. Johnson
President

HWJ:ck

J.M. Products, Inc.
7861 46TH STREET
DORAL, FLORIDA 33166

HENRY W. JOHNSON
mailto:hjohnson@hwjlaw.net

TELEPHONE (786)631-4676
TELECOPIER (786)631-4741

September 8, 2015

Industrial Heat
8025 Triangle Drive
Raleigh, NC 27617

Attention: J.T. Vaughn
Vice President

Dear Mr. Vaughn:

During the month of August in our Doral factory we received from your plant the amount of energy of:

15 days @ 1 MWh/h
16 days@ .75 MWh/h

Please invoice to us as follows:

$ 1,000.00 x 15, total	$ 15,000.00
$ 750.00 x 16, total	$ 12,000.00
Total amount:	$ 27,000.00

Sincerely,

J.M. Products, Inc.

Henry W. Johnson
President

HWJ:ck

J.M. Products, Inc.
7861 46TH STREET
DORAL, FLORIDA 33166

HENRY W. JOHNSON
mailto:hjohnson@hwjlaw.net

TELEPHONE (786)631-4676
TELECOPIER (786)631-4741

January 4, 2016

Industrial Heat
8025 Triangle Drive
Raleigh, NC 27617

Attention: J.T. Vaughn
Vice President

Dear Mr. Vaughn:

During the month of December in our Doral factory we received from your plant the amount of energy of:

20 days @ 1 Mwh/h, 24 hours /day
11 days @ 750 kWh/h, 24 hours/day (upon our request the power has been reduced due to our technical problems)

Sincerely,

J.M. Products, Inc.

Henry W. Johnson
President

HWJ:ck

EXHIBIT 19

---------- Forwarded message ----------
From: **eon333@libero.it** <eon333@libero.it>
Date: Mon, Jul 13, 2015 at 12:26 PM
Subject: R: Re: Andrea Rossi
To: jvaughn@industrialheat.co

Hi, JT!
OK for the address to send from now on the patent papers.
About the meeting of Tuesday, you obviously can come when you want, while Joe Murray cannot enter in the factory of JM because, as I have explained to Tom during the visit with Brian Mc Laughlin, I do not allow anybody, except for the personnel already reciprocally authorized, to approach the plant before the tests on course will have been completed.

Warm Regards,
Andrea Rossi

> ----Messaggio originale----
> Da: jvaughn@industrialheat.co
> Data: 13/07/2015 15.10
> A: "eon333@libero.it"<eon333@libero.it>
> Cc: "Trista Balmer"<tbalmer@industrialheat.co>
> Ogg: Re: Andrea Rossi
>
> Thanks, Andrea. We'll try to get this processed.
>
> Also, I would like to introduce you to one of our new team members, Joe Murray. He and I have booked a flight down on Tuesday afternoon and will depart Wednesday afternoon. I hope we can come see you at the plant on Tuesday afternoon, then we'll go get cleaned up at the hotel and plan to do dinner with you on Tuesday evening, and then spend some time at the plant on Wednesday morning through lunch or so--does that work? I am looking forward to seeing you, Barry and Fulvio and also introduce you guys to Joe.
>
> Separately, concerning the provisional applications--rather than mailing to the shop, could you please mail the receipts and a copy of the applications to me at 111 E. Hargett St., Suite 300, Raleigh, NC 27601? Alternatively, you can scan and email if you like--feel free to encrypt the email and/or attachments (we use Virtru for this purpose, but not sure if it works with your email).
>
> Best,
> JT
>
> On Mon, Jul 13, 2015 at 8:48 AM, eon333@libero.it <eon333@libero.it> wrote:
> Dear Tista, JT:

Please find attached the invoice # 29-2015.
Warmest Regards,
Andrea

--
JT Vaughn
Industrial Heat
jvaughn@industrialheat.co

EXHIBIT 20

J. M. Products, Inc

James A. Bass

Director of Engineering

7861 N. W. 46th St
Doral, Florida 33166
786-631-4676

EXHIBIT 21

Ecat final documentation
M.Eng. Fulvio Fabiani
to:
JT Vaughn
02/23/2016 10:28 AM
Cc:
tdarden
Hide Details
From: "M.Eng. Fulvio Fabiani" <fulvio.fabiani@mail.com>
To: "JT Vaughn" <jvaughn@industrialheat.co>
Cc: tdarden <tdarden@industrialheat.co>
History: This message has been forwarded.

Dear JT (and Dear Tom who reads us in copy),
finally after a year of stress I have slept a full weekend (YEAAAAAHHHH)

I wanted to let you know the schedule of how to proceed for the next days.

First step: Condensation of digital data for not distracting precise analysis.
At the end I will send you a excel file with all electrical and thermal data of the system throughout the period test.
This step will keep me busy until approximately the first week of March 2016.

Then I will work on my official report to bring to light all the flaws and functional deficiencies of the system in order to have sufficient information to replicate a system with lower costs and with greater reliability.

In that report, the plant stop periods (total or partial) will be also mentioned and the reasons therefor.

This phase will use my time to the end of March 2016.

At the same time I believe it is appropriate to clarify if you are interested in the continuation of our counseling relationship maybe exchanging a draft of a contract renewal.

I am convinced that we will be able to find a point of mutual interest and useful to meet together the future development of the project.

Best regards.
M.Eng. Fulvio Fabiani
+1(919)812-7863

Fw: Re: February 2016 invoice
M.Eng. Fulvio Fabiani
to:
JT Vaughn, tdarden
04/06/2016 01:30 PM
Cc:
"Wendy Carter Industrial Heat NC"
Hide Details
From: "M.Eng. Fulvio Fabiani" <fulvio.fabiani@mail.com>
To: "JT Vaughn" <jvaughn@industrialheat.co>, tdarden <tdarden@industrialheat.co>
Cc: "Wendy Carter Industrial Heat NC" <wcarter@industrialheat.co>

2 Attachments

Industrial Heat - TCA with USQL 2016 april 2016.odt USQL 03 2016 - March Invoice to IH.pdf

Hello JT (and TOM),

thanks for your permission via sms.

I prepare the raw data for the official delivery as soon as possible.

After the certified delivery of RAW DATA, I will format all the digital media eliminating any sensitive technical information concerning our business relationship as stipulated in the contract expired April 1, 2016.

Attached to this email, copy of the March 2016 invoice relating to the contract mentioned above, I ask the favor of authorizing the payment as soon as possible.

I also attach my proposal to renew the contract that I would be happy to discuss with you and/or Tom.

Have a nice day.

Fulvio Fabiani
C.E.O. of USQL LLC
+1(919)8127863

Fulvio Fabiani to: jvaughn 04/14/2016 08:34 PM

Cc: tdarden

Dear JT (and Tom in CC),

I am collecting the raw data you requested me and I will provide asap to send them to you.

In the meantime, please be informed that my invoice in March has not been processed and I did not receive any payment.

As per your proposal to talk sometime about the prolongement of the Agreement between the two of us and to continue on a monthly basis, I am not fully convinced that I would be able to perform my job in the best way I can do - which is the only way I can work.

Therefore, I would kindly ask you to consider the possibility to agree a time limited agreement that would make me comfortable in performing my activities in the interest of your company.

Thank you. Best regards,

Fulvio Fabiani
C.E.O. of USQL LLC

Check in hand
Joseph Murray
to:
Fulvio Fabiani, Fulvio Fabiani
04/26/2016 11:53 AM
Hide Details
From: Joseph Murray <jmurray@industrialheat.co>
To: Fulvio Fabiani <fulviofabiani@mail.com>, Fulvio Fabiani <fulvio.fabiani@mail.com>

Fulvio,

I understand from Barry that you are in Canada. I have your check in hand for delivery. I am more than happy to meet you somewhere and give you the check and you can give me the final report and the IH raw data. Just to make sure we are sync'ed up: You committed to delivering a final report from your efforts at the plan at the end of March-2016. You made that commitment when we met we met in March. In addition you said you would provide us with the raw data that belongs to IH. Furthermore, you indicated that you had measurements from the flow meter that you had taken from time to time.

Several weeks ago you agreed to give me the final report and the raw data once JT or Tom approved. We both received approval from JT.

I would like to give you this check as soon as possible. I am happy to fly to Miami to give you the check and to catch up on outstanding issues.

Note that it is unnecessary to use Barry as a go between. I have sent you text messages and emails. Feel free to reply.

Please advise.

Joe.

--
Joe Murray
Industrial Heat
p: 919.670.2771
e: jmurray@industrialheat.co

Status update
Joseph Murray
to:
Fulvio Fabiani, Fulvio Fabiani
05/16/2016 04:29 PM
Hide Details
From: Joseph Murray <jmurray@industrialheat.co>
To: Fulvio Fabiani <fulviofabiani@mail.com>, Fulvio Fabiani <fulvio.fabiani@mail.com>

Fulvio:

I still have the check made out to US Quantum Leap. If you have the raw data and your final report, I am happy to meet with you somewhere to exchange the check for the data and final report. Or if you would prefer, you can send me the data and final report, and I will that same day FedEx to you the check at whatever address you provide. But I need the data and final report in order to release the check.

Thanks,

Joe .

--
Joe Murray
Industrial Heat
p: 919.670.2771
e: jmurray@industrialheat.co

EXHIBIT 22

On the Nuclear Mechanisms Underlying the Heat Production by the E-Cat

Norman D. Cook[1] and Andrea Rossi[2]

1. Department of Informatics, Kansai University, Osaka, 1095-569, Japan
2. Leonardo Corporation, Miami Beach, Florida, 33139, USA

We discuss the isotopic abundances found in the E-Cat reactor with regard to the nuclear mechanisms responsible for excess heat. We argue that a major source of energy is a reaction between the first excited-state of Li-7 and a proton, followed by the breakdown of Be-8 into two alphas with high kinetic energy, but without gamma radiation. The unusual property of the Li-7 isotope that allows this reaction is similar to the property that underlies the Mossbauer effect: the presence of unusually low-lying excited states in stable, odd-Z and/or odd-N nuclei. We use the lattice version of the independent-particle model (IPM) of nuclear theory to show how the geometrical structure of isotopes indicate nuclear reactions that are not predicted in the conventional version of the IPM. Finally, we speculate on similar mechanisms that may be involved in other low-energy nuclear reactions (LENR).

PACS numbers: 21. Nuclear structure 27.40.+z Properties of specific nuclei 1<A<64

1 Introduction

The checkered history of low-energy nuclear reaction (LENR) research remains highly controversial. It includes disputed claims of both experimental successes and failures in both Nickel and Palladium systems. Reported results and theoretical models are far too diverse to allow definitive conclusions to be drawn, but Storms [1, 2] has summarized the overwhelming consensus that nuclear effects have been obtained in experimental set-ups where conventional theory predicts the total absence of nuclear involvement. While further empirical work remains a high priority, a remaining theoretical task is to demonstrate how the published data on heat production and isotopic transmutations are consistent with the major themes of nuclear physics, as established over the past century.

In the latest empirical test of Andrea Rossi's invention, known as the E-Cat, significant excess heat (a ratio of output/input energy in excess of 3.0) over the course of one month was found [3]. For technological exploitation, it may be sufficient to mimic the materials and protocols that have made that possible (e.g., Parkhomov [4]), but the huge diversity of conditions that have been reported in the "cold fusion" literature for 26 years suggest that there may exist general LENR mechanisms that have not yet been identified. Although progress has been made in defining the solid-state, chemical and electromagnetic field properties of the nuclear active environment (NAE), the specifically ***nuclear*** aspects of the NAE have not generally been addressed. Here, we argue that femtometer-level LENR can occur in isotopes with low-lying excited-states, provided that an appropriate, Angstrom-level molecular environment has been created.

In the present study, we focus on recent findings of nuclear transmutations concerning Lithium isotopes [3] in light of the lattice version [5] of the independent-particle model (IPM) of the nucleus. Specifically, after brief review of the well-established IPM, we consider details of the substructure of the ${}^{7}_{3}Li_4$

and $^{8}{}_{4}Be_4$ isotopes that allow for the generation of alpha particles at kinetic energies well beyond what could be produced solely through chemical reactions.

2 Methods

2.1 Theory: The Independent-Particle Structure of Nuclei

For more than six decades, it has been known that many nuclear properties can be described in terms of the simple summation of the properties of the constituent protons and neutrons. In the 1930s, this theoretical perspective was rejected by Niels Bohr, who favored a "collective" view of nuclei, but the shell model assumption of spin-orbit coupling in the early 1950s proved to be a major theoretical success that established the "independent-particle" approach as the central paradigm of nuclear structure theory.

Most importantly, the IPM description of nuclear states allowed for a coherent explanation of experimentally observed spins and parities (***J***π) (and, more approximately, magnetic moments, μ) as the summation of the ***j***π and μ of any unpaired protons and neutrons. Subsequently, the ground-state spin and parity of more than 2800 relatively-stable nuclear isotopes and, most impressively, the nearly half-million excited-states of those isotopes, as tabulated in the *Firestone Table of Isotopes* (1996) [6], have been classified in the IPM. Arguably, it is this undisputed success of the IPM that has led many nuclear physicists to conclude that LENR phenomena are unlikely to be real, insofar as they are not consistent with the established principles of nuclear theory. As discussed below, we have found that the theoretical framework provided by the IPM is, on the contrary, essential for explaining the transmutations reported to occur in the E-Cat.

The early mathematical development of the IPM was undertaken by Eugene Wigner [7] in the 1930s, but the IPM did not become the dominant model of nuclear structure until the early 1950s, with the emergence of the shell model [8]. In fact, Wigner and the inventors of the shell model shared the Nobel Prize in Physics in 1963, and their combined insights gave nuclear structure theory a coherent quantum mechanical basis. The bold assumption of the shell model was that there occurs a coupling between quantum numbers, ***l*** and ***s***, to produce an ***observable*** total angular momentum, ***j*** (=$l \pm s$). Inherent to that assumption, however, was the highly ***unrealistic*** notion that "point" nucleons "orbit" freely in the nuclear interior and do not interact with other nucleons (in first approximation) that as orbiting within the nuclear potential well. Similar assumptions had also been made in the still earlier Fermi gas model of the nucleus, but were eventually rejected because of the theoretical successes of the liquid-drop model (LDM) concerning nuclear binding energies, radii, fission phenomena, etc. The LDM, in turn, was based upon ***realistic*** assumptions about the nuclear interior: electrostatic and magnetic RMS radii of protons and neutrons of about 0.85 fm [9], a nuclear core density of 0.17 nucleons/fm^3 (implying a nearest-neighbor internucleon distance of only 2.0 fm) and the ***non-orbiting*** of nucleons – all of which argued strongly ***against*** a diffuse nuclear "gas" and ***for*** a dense nuclear "liquid".

The inherent contradictions between the gaseous-phase IPM and the liquid-phase LDM are of course summarized in most nuclear textbooks, but an interesting blend of those two competing models was first developed in the 1970s in the form of a lattice model of nuclear structure (the history of which is discussed in ref. [5]). The lattice model (a "frozen liquid-drop") has most of the properties of the traditional LDM, but, when nuclei are built around a central tetrahedron of four nucleons, the lattice shows the remarkable property of reproducing the correct sequence and occupancy of all of the ***n***-shells of the shell model as triaxially-symmetrical (spherical) lattice structures. Moreover, the ***j***-subshells within the ***n***-shells of the shell model emerge as cylindrical structures and the ***m***-subshells arise as conical substructures – all in the same sequence and with the same occupancy of protons and

neutrons as known from the conventional IPM.

Although various aspects of the mathematical identity between the shell and lattice models have frequently been published in the physics literature, the lattice model itself has been dismissed as a "lucky" reproduction of the symmetries of the shell model and has had little impact on nuclear theorizing, in general. The fact remains, however, that the lattice and gaseous-phase versions of the IPM reproduce the same patterns of ***observable*** spin and parity (***J***π) values based upon very different assumptions concerning the "point" or "space-occupying" structure of the nucleons themselves. Here, we consider the lattice IPM to be a realistic alternative to the gaseous-phase IPM, and elaborate on its implications in relation to LENR phenomena.

The quantal properties in the lattice model are defined in Eqs. (1-6), and are illustrated in Figure 1. Related theoretical arguments have been published since the 1970s, and full details are available online [5].

n = (|x| + |y| + |z| - 3) / 2 (Eq. 1)
l = (|x| + |y|) / 2 (Eq. 2)
j = (|x| + |y| -1) / 2 (Eq. 3)
m =|y| *(-1)^((x-1)/2)/ 2 (Eq. 4)
s = (-1)^((x-1)/2)/ 2 (Eq. 5)
i = (-1)^((z-1)/2) (Eq. 6)

The significance of the "quantal geometry" (Eqs. 1-6) (Figure 1) can be simply stated: every unique grid site in the lattice corresponds to a unique set of nucleon quantum numbers, the sum of which is identical to that produced in the conventional IPM. Conversely, knowing the quantum characteristics of individual nucleons, their positions (Cartesian coordinates) in the lattice can be calculated, as shown in Eqs. (7-9).

x = |2m|(-1)^(m-1/2) (Eq. 7)
y = (2j+1-|x|)(-1)^(i/2+j+m+1/2) (Eq. 8)
z = (2n-3+|x|-|y|)(-1)^(i/2+n+j+1) (Eq. 9)

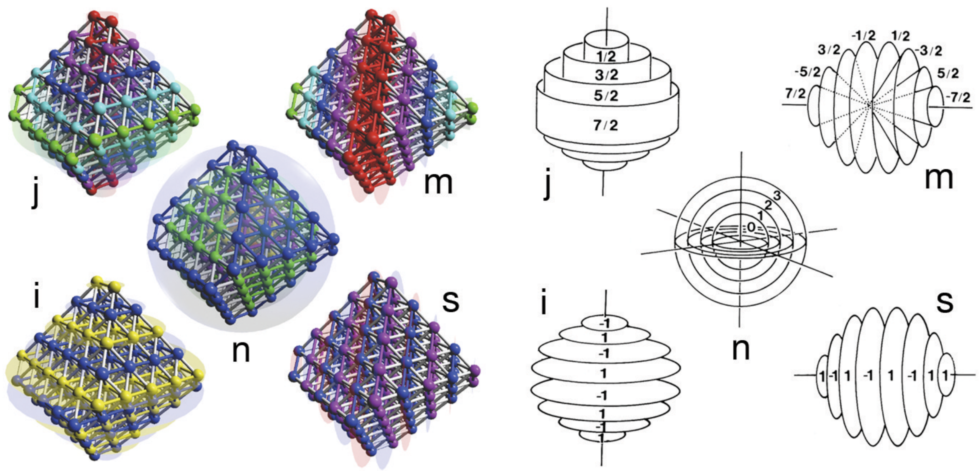

Figure 1: The geometry of nuclear quantum numbers in the lattice representation of the IPM.

A simple example of the identity between IPM quantal features and lattice symmetries is illustrated in Figure 2 for the ground-state of ${}^{15}_{7}N_8$. On the left is shown the build-up of protons and neutrons in a conventional tabulation of IPM states in relation to the quantum numbers. On the right is shown the corresponding lattice structure for those 15 nucleons. Note that the geometrical configuration of neutrons (blue)

and protons (yellow) is given explicitly by the lattice definitions of the quantum numbers. In other words, the configuration of nucleons in the lattice IPM is determined by the quantum characteristics of the given isotope's nucleons.

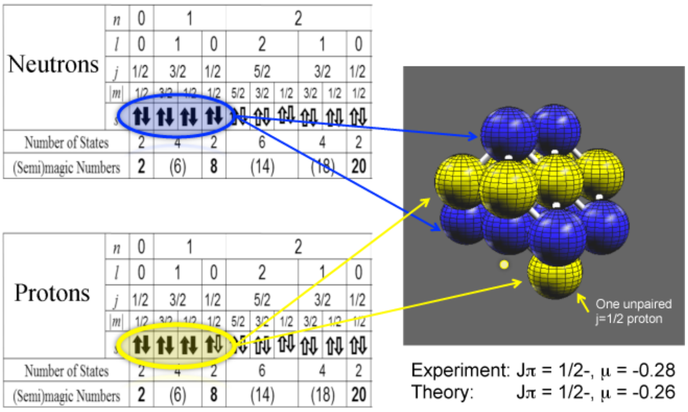

Figure 2: The IPM quantal states of the 8 neutrons and 7 protons of $^{15}_{7}N_{8}$ (the filled arrows on the left) and their lattice positions (right), as determined from Eqs. (1-6). The unpaired proton is responsible for the spin/parity and magnetic moment predictions of the IPM; the lone unfilled proton site (-1, -1, -3) in the second ***n***-shell is shown as a dot.

In the same way that there is a precise identity between IPM states and lattice configurations for all ground-state nuclei, excited-states have corresponding lattice structures whose spins/parities are identical to those measured experimentally. For example, the nine lowest-lying states of $^{15}_{7}N_{8}$ are shown in Figure 3.

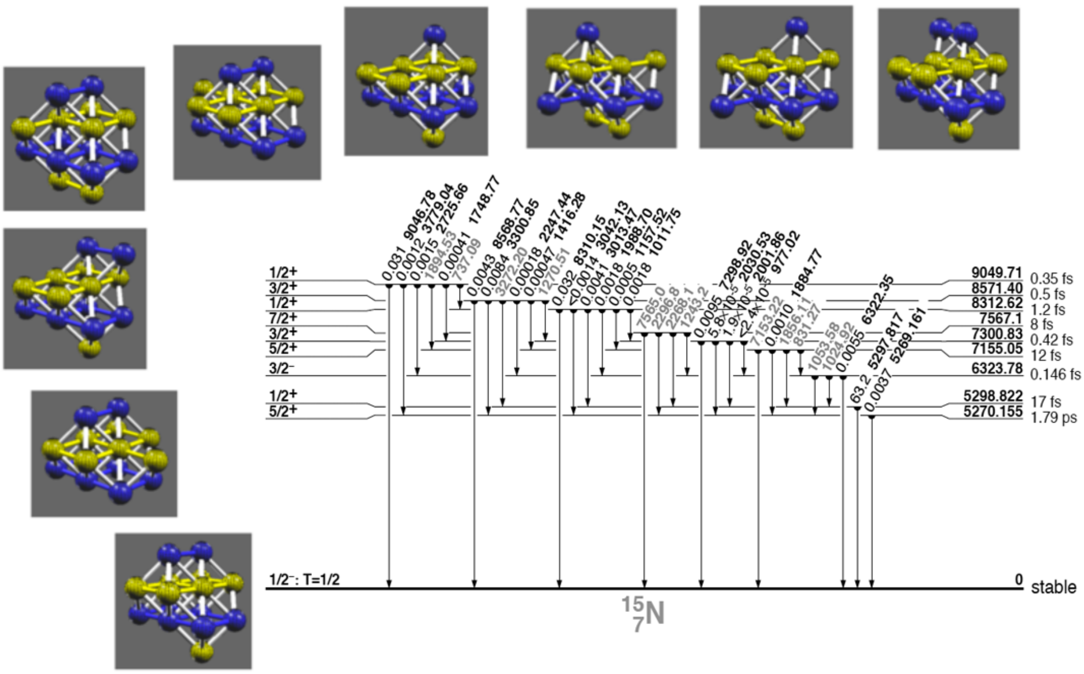

Figure 3: The low-lying excited states of $^{15}_{7}N_{8}$, and their corresponding lattice structures. Every lattice structure is a unique set of proton and neutron sites, whose ***j***π values sum to the measured ***J***π values that are known from experiment and shown in the level diagram.

2.2 Experiment: The New Transmutation Data

In the recent Lugano report on the E-Cat [3], two types of nuclear transmutation were noted (Table 1). Similar isotopic changes have also been reported by Parkhomov [4], lending credence to the earlier report, but neither experimental study discussed possible theoretical nuclear mechanisms. The first type of transmutation was a strong decrease in $^{7}{}_{3}Li_4$ relative to the only other stable isotope of Lithium, $^{6}{}_{3}Li_3$. The second was a strong relative increase in one Nickel isotope, $^{62}{}_{28}Ni_{34}$, and large relative decreases in $^{58}{}_{28}Ni_{30}$ and $^{60}Ni^{32}$, accompanied by small, but significant decreases in $^{61}{}_{28}Ni_{33}$ and $^{64}{}_{28}Ni_{36}$ (Table 1). These effects need to be explained within the framework of conventional nuclear theory.

The dilemma that theorists face is that both excess heat production and altered isotopic ratios are strongly suggestive of nuclear involvement, but conventional theory alone provides no clue on how these nuclear reactions could arise. While this theoretical stalemate remains unresolved, however, we demonstrate below how specific isotopic structures in the lattice IPM could in principle lead to the strong depletion of $^{7}{}_{3}Li_4$, while implying the generation of alpha particles – provided only that energetic justification for such effects can be found from basic theory.

Table 1: Transmutations at the Onset and Conclusion of the E-Cat Test [1]

Isotope	Natural Abundance	Abundance at Onset	Abundance at Conclusion
$^{6}{}_{3}Li_3$	7.5%	8.6%	92.1%
$^{7}{}_{3}Li_4$	92.5%	91.4%	7.9%
$^{58}{}_{28}Ni_{30}$	68.077%	67.0%	0.8%
$^{60}{}_{28}Ni_{32}$	26.223%	26.3%	0.5%
$^{61}{}_{28}Ni_{33}$	1.140%	1.9%	0.0%
$^{62}{}_{28}Ni_{34}$	3.634%	3.9%	98.7%
$^{64}{}_{28}Ni_{36}$	0.926%	1.0%	0.0%

In theory, the changes in Lithium isotopes could be a consequence of three distinct mechanisms: (i) *de novo* creation of $^{6}{}_{3}Li_3$ (leading to relative increases in this isotope) (ii) the transmutation of $^{6}{}_{3}Li_3$ and/or $^{7}{}_{3}Li_4$ by the addition/removal of one neutron (leading to relative increases and decreases, respectively), or (iii) *de novo* destruction of $^{7}{}_{3}Li_4$ (leading to relative decreases in this isotope).

De novo creation of $^{6}{}_{3}Li_3$ (i) is the most problematical, because it implies the sequential accretion of protons and neutrons; low energy mechanisms of that type are unknown. Similarly, the transmutation of $^{6}{}_{3}Li_3$ into $^{7}{}_{3}Li_4$ or vice versa (ii) requires the accretion or depletion of neutrons in an experimental set-up where free neutrons have not been detected; nuclear mechanisms of that type are also unknown.

De novo destruction of $^{7}{}_{3}Li_4$ (iii), in contrast, is theoretically plausible, insofar as the accretion of one proton would transmute $^{7}{}_{3}Li_4$ into $^{8}{}_{4}Be_4$, which could then decay to two alphas with the release of significant kinetic energy, leading to a relative decrease in $^{7}{}_{3}Li_4$:

$$^{7}{}_{3}Li_4 + p \rightarrow {}^{8}{}_{4}Be_4 \rightarrow 2\alpha \ (17.26\ MeV) \qquad (Eq.\ 10)$$

The question of energetic mechanisms aside, the depletion of $^{7}{}_{3}Li_4$ through the accretion of one proton is a theoretical possibility insofar as it does not imply gamma radiation. That is to say, the decay of $^{8}{}_{4}Be_4$ to two alpha particles is known to be gamma-free. Provided that the initial approach of a proton to the Lithium isotope can be energetically justified, the formation of $^{8}{}_{4}Be_4$ and the subsequent generation of energetic alphas would therefore not be problematical. Clearly, an abundance of such reactions would lead to four observable effects: (i) absolute decreases in $^{7}{}_{3}Li_4$ with (ii) relative increases in $^{6}{}_{3}Li_3$, together with (iii) the generation of alpha particles, and (iv) the production of significant kinetic

energies, as the alphas are repelled from one another.

2.3 Using the Lattice IPM to Explain LENR

While the IPM accurately specifies the properties of excited-states (as was illustrated for the level diagram of $^{15}{}_{7}N_{8}$, Figure 3), the conventional Fermi-gas-like perspective on nuclear structure explicitly denies the possibility of nuclear substructure (beyond that implied by deformations of the nuclear potential well).

In contrast, the lattice representation of the IPM makes precisely the same predictions concerning the quantal properties of nuclei (Eqs. 1-6), but the lattice structures can also be used to specify the "stereochemical" structure of nuclei. In other words, because there are specific, often unique, lattice structures corresponding to each and every ground- and excited-state, the lattice version of the IPM provides candidate structures that are involved in various nuclear reactions. If the high-temperature, high-pressure conditions within the E-Cat provide sufficient energy to allow Hydrogen nuclei to overcome the Coulomb barrier and to approach Lithium nuclei, then the Lithium nucleus itself may be promoted to a low-lying excited state. An interaction between Hydrogen and Lithium nuclei within appropriate solid-state environments could then be accompanied by certain types of LENR that depend principally on the detailed substructure of the Lithium isotope.

3 Results

3.1 Lithium Transmutations

The two stable Lithium isotopes, $^{6}{}_{3}Li_{3}$ and $^{7}{}_{3}Li_{4}$, are well characterized in the IPM in terms of their constituent particles (Table 2). Given the IPM properties of the nucleons around the $^{4}{}_{2}He_{2}$ core, their fine-structure in the lattice IPM is unambiguous.

Table 2: The substructure of the Lithium isotopes. Generally, the IPM description of isotopes gives properties close to those measured experimentally (spin/parities matching empirical values and magnetic moments within 20% of empirical values).

Isotope	Binding Energy	Spin/Parity	Magnetic Moment	RMS Radius
Li-6	**31.994 MeV**	**1+**	**+0.822**	**2.589 fm**
[He-4	28.296 MeV	0+	0.000	1.676 fm]
[p		1/2+	+2.793	0.865 fm]
[n		1/2+	-1.914	0.873 fm]
	Theory:	**1+**	**+0.889**	**2.545 fm**
Li-7	**39.244 MeV**	**3/2-**	**+3.256**	**2.444 fm**
[He-4	28.296 MeV	0+	0.000	1.676 fm]
[p		3/2-	+3.793 (Schmidt)	0.865 fm]
[n		1/2+	-1.914	0.873 fm]
[n		1/2+	+1.914	0.873 fm]
	Theory:	**3/2-**	**+3.793**	**2.550 fm**

That is, both the spin/parity and the magnetic moments of these nuclei can be understood simply as the summation of the properties of a $^{4}{}_{2}He_{2}$ core plus a few additional nucleons. For $^{6}{}_{3}Li_{3}$, the spins of the last unpaired proton (*j*=1/2-) and the last unpaired neutron (*j*=3/2-) combine to give a ***J***=1+ nucleus. In contrast, the spin properties of the two neutrons from the second shell in $^{7}{}_{3}Li_{4}$ cancel each other out, and the properties of $^{7}{}_{3}Li_{4}$ are essentially due to the one unpaired *j*=3/2- proton.

We have previously suggested [11] that the bulk of the energy produced by the E-Cat may be a consequence of Lithium reactions. Here, we hypothesize that the energy is a consequence of an interaction between $^{7}{}_{3}Li_{4}$ and a proton, resulting in the formation of $^{8}{}_{4}Be_{4}$, which immediately breaks down into 2 alpha particles. The alpha particles are

released with significant kinetic energy, but without gamma radiation. We must reiterate that the energetics of this reaction are still uncertain. On the one hand, we know that there is a strong relative depletion in ${}^7_3Li_4$, and many of the classical LENR systems utilize Lithium in the electrolyte and produce ${}^4_2He_2$ particles. On the other hand, alphas were not measured in the Lugano test, while gamma radiation was entirely absent. What therefore can be said about the structure of ${}^7_3Li_4$, in particular, in relation to the hypothesized: ${}^7_3Li_4 + p \rightarrow {}^8_4Be_4 \rightarrow 2$ alpha reaction?

The lattice structure for the ${}^7_3Li_4$ ground-state is shown in Figure 4 (left), but this turns out not to be the basis for an explanation of the ${}^7_3Li_4 + p \rightarrow 2$ alphas reaction. As illustrated in Figure 4 (right), there are four strongly-bonded proton sites on the surface of the ground-state ${}^7_3Li_4$ (all of which are candidate structures for excited-states of ${}^8_4Be_4$), but binding of a proton at any of those four sites does ***not*** lead to a ${}^8_4Be_4$ geometrical structure containing two alpha tetrahedrons. As a consequence, if a proton were added to the ground-state ${}^7_3Li_4$ shown in Figure 4, the newly-formed ${}^8_4Be_4$ isotope would require reconfiguration of nucleon positions and the inevitable release of gamma radiation prior to alpha release. Significant (in excess of 1.0 MeV) gamma radiation has not been observed in the E-Cat, indicating that the ground-state of ${}^7_3Li_4$ (Figure 4) is an ***unlikely*** starting point for the relevant reaction. Does the lattice IPM provide no insight?

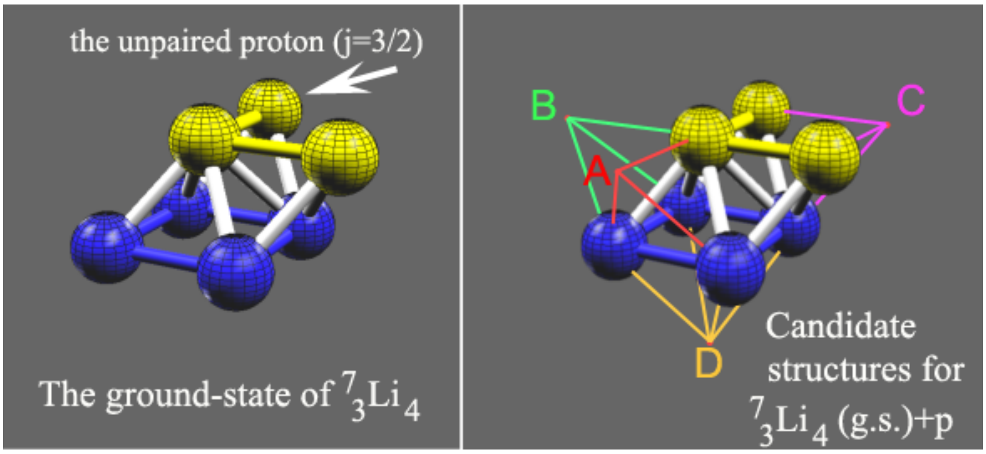

Figure 4: (Left) The ground-state of ${}^7_3Li_4$. Among several dozen theoretical possibilities, the lattice locations of the last two paired-neutrons and the last unpaired-proton, as shown here, provide a $J\pi$ value (3/2-) that is in agreement with experiment. A mirror-image isomeric state has the same properties. (Right) The ground-state of ${}^7_3Li_4$ and the four lattice locations to which a proton can be added [(A) 1, -3, 1; (B) -3, -3, 1; (C) -1, 3, 1; and (D) -1, -1, -3]. All four produce compact structures (with 3 or 4 nearest neighbor bonds to the ${}^7_3Li_4$ core), but none produces a ${}^8_4Be_4$ isotope with two distinct, pre-formed alpha tetrahedrons.

On the contrary, the lattice IPM provides clues when excited-state configurations are considered. There is an unusually low-lying excited state of ${}^7_3Li_4$ at 0.477 MeV ($J\pi$ =1/2-). A ${}^7_3Li_4$ isotope with those properties can be constructed in the lattice IPM, if the third proton of ${}^7_3Li_4$ is located at the lower level of protons (lattice coordinates: -1, -1, -3) (Figure 5A). When a fourth proton is added at a neighboring lower proton level (lattice coordinates: -3, -3, -3) (Figure 5B), the newly-formed ${}^8_4Be_4$ isotope will have a $J\pi$ value of 2+, and will contain two distinct alpha tetrahedrons (Figure 5C). As is experimentally known, the first excited-state of ${}^8_4Be_4$ has $J\pi$=2+ and decays to 2 alpha particles without gamma irradiation (Figure 5D).

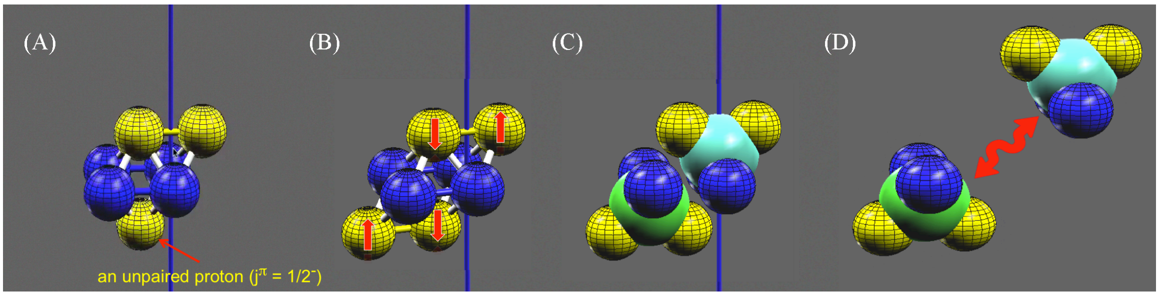

Figure 5: The lowest-lying excited-state of $^{7}{}_{3}Li_4$ (A) has a lattice structure to which an additional proton will produce a two-tetrahedron structure, giving $^{8}{}_{4}Be_4$ (B). The double alpha lattice structure (C) can then break into independent two alpha particles (D), which are released with 17 MeV of angular momentum, but without gamma radiation.

What is of particular interest with regard to the structure shown in Figure 5B is that the $^{8}Be^{4}$ configuration is formed from $^{7}{}_{3}Li_4$, where there is one unpaired, spin-up ***j***=1/2- proton. By adding one spin-down ***j***=5/2- proton to form $^{8}{}_{4}Be_4$, the properties of the two unpaired protons sum to a ***J***π=2+ state. The ***J***π=2+ $^{8}{}_{4}Be_4$ isotope is relevant because there are three distinct $^{8}{}_{4}Be_4$ states (a ground-state, ***J***π=0+, and two ***J***π=2+ excited states) – all three of which decay to 2 alpha particles without gamma radiation. In other words, unlike the gaseous-phase version of the IPM (where nuclear substructure is essentially absent), the lattice IPM predicts the generation of two alpha particles, unaccompanied by gamma radiation, directly from the ***J***=1/2- first excited-state (0.478 MeV) of $^{7}{}_{3}Li_4$.

The two stable Lithium isotopes illustrate the fact that the excited-states of most isotopes arise at energies greater than 2 MeV. The lowest-lying excited state of $^{6}{}_{3}Li_3$ (***J***π=1+) is at 2.186 MeV, whereas that for $^{7}{}_{3}Li_4$ (***J***π=3/2-) is moderately low at 0.478 MeV. We suggest that it is the presence of odd-A isotopes that makes them more susceptible to configurational changes, in general, and proton accretion, in particular. It must be stated that an energetic justification of the $^{7}{}_{3}Li_4$ + p → $^{8}{}_{4}Be_4$ reaction is still lacking, but if such a reaction is possible, then the geometry of these nuclear states becomes relevant.

3.2 Nickel Transmutations

With regard to the transmutations of Nickel, the most obvious reaction mechanisms in NiH systems are listed in Eqs. (11-15). They all entail the addition of one proton to stable Nickel isotopes. If all five reactions actually occur, the net effect would be several β^{+} decays, and small deposits of stable isotopes: $^{59}{}_{27}Co_{32}$, $^{63}{}_{29}Cu_{34}$, and $^{65}{}_{29}Cu_{36}$ in the E-Cat "ash". In the recent experimental reports [3, 4], significant accumulations of Cobalt and Copper isotopes were ***not*** found, indicating that reactions (11), (14) and (15) did not occur and therefore that all Nickel isotopes were ***not*** equally susceptible to transmutation.

$^{58}{}_{28}Ni_{30}$ (0^{+})+p → $^{59}{}_{29}Cu_{30}$ (3/2^{-})(EC + β^{+}) → $^{59}{}_{28}Ni_{31}$ (3/2^{-})(EC+β^{+}) → $^{59}{}_{27}Co_{32}$ (7/2^{-})(stable) (Eq. 11)
$^{60}{}_{28}Ni_{32}$ (0^{+}) + p → $^{61}{}_{29}Cu_{32}$ (3/2^{-}) (EC + β^{+}) → $^{61}{}_{28}Ni_{33}$ (3/2^{-})(stable) (Eq. 12)
$^{61}{}_{28}Ni_{33}$ (3/2^{-}) + p → $^{62}{}_{29}Cu_{33}$ (1^{+}) (EC + β^{+}) → $^{62}{}_{28}Ni_{34}$ (0^{+})(stable) (Eq. 13)
$^{62}{}_{28}Ni_{34}$ (0^{+}) + p → $^{63}{}_{29}Cu_{34}$ (3/2^{-})(stable) (Eq. 14)
$^{64}{}_{28}Ni_{36}$ (0^{+}) + p → $^{65}{}_{29}Cu_{36}$ (3/2^{-})(stable) (Eq. 15)

Moreover, in spite of the fact that the absorption of an alpha particle by $^{58}{}_{28}Ni_{30}$ would lead directly to an increase in $^{62}{}_{28}Ni_{34}$ ($^{58}{}_{28}Ni_{30}$ + α → $^{62}{}_{30}Zn_{32}$ → $^{62}{}_{29}Cu_{33}$ → $^{62}{}_{28}Ni_{34}$), the absence of stable isotopes $^{62}{}_{30}Zn_{34}$, $^{64}{}_{30}Zn_{36}$, and $^{66}{}_{30}Zn_{38}$ in the post-reaction ash indicates that alpha particles (released from the LiH reaction) were ***not*** absorbed by $^{60}{}_{28}Ni_{32}$ and

$^{62}{}_{28}Ni_{34}$. The dramatic increase in $^{62}{}_{28}Ni_{34}$ must, therefore, be explained through a different mechanism, without implying transmutations for which there is no empirical evidence.

Again, neglecting details of the energetic mechanisms, the main possibility for augmenting $^{62}{}_{28}Ni_{34}$ abundance is reaction (13). Reaction (13) entails the direct uptake of a proton by $^{61}{}_{28}Ni_{33}$ (mechanism unknown), leading to $^{62}{}_{29}Cu_{33}$ (9.7 min), the decay of which would result in the desired isotope, $^{62}{}_{28}Ni_{34}$. Problematical here is the small abundance of the precursor $^{61}{}_{28}Ni_{33}$, which accounts for only 1.14% of the Nickel isotopes. The overwhelming abundance of $^{62}{}_{28}Ni_{34}$ in the ash and the virtual absence of other isotopes might nonetheless be explained as a consequence of the sampling method. Because ToF-SIMS analysis was made on milligram samples obtained specifically at regions observed under the scanning electron microscope to have undergone morphological changes, it is possible that the $^{62}{}_{28}Ni_{34}$ isotopes recoiled toward the surface of the Nickel grains. If the sample itself was not representative of the Nickel remaining in the E-Cat, the large abundance of $^{62}{}_{28}Ni_{34}$ would indicate only the participation of $^{61}{}_{28}Ni_{33}$ in the reaction and its migration to sites that were sampled for isotopic analysis. Further experimental study is needed to clarify the situation.

At the temperature of operation of the E-Cat used in the Lugano test, the Lithium contained in the $LiAlH_4$ is vaporized, and consequently was distributed evenly within the volume of the E-Cat. In contrast, the Nickel fuel remained in a solid or liquid state. At the time of sampling after one month of operation, Nickel was found to be encrusted on the internal surface of the reactor, from which a 2 mg sample of "ash" was obtained near to the center of the charge. Starting with an initial charge of approximately 1 gram, it cannot be said that the 2 mg sample was necessarily representative of the entire Nickel charge, but it remains to be explained how the isotopic ratios in the 2 mg sample show predominantly $^{62}{}_{28}Ni_{34}$.

Isotopes with extremely low-lying excited states are of particular interest in LENR research because they exhibit quantal transitions from one nucleon state to another with minimal external input. In this regard, the lowest-lying excited-state of one of the most stable isotopes in the Periodic Table of Elements, $^{61}{}_{28}Ni_{33}$ (a $\boldsymbol{J}$=5/2+ state at 0.0674 MeV), is a likely candidate for energy release in response to low-level thermal agitation. That excitation energy stands in contrast to all of the stable even-even isotopes of Nickel whose lowest-lying excited-states are typically 20~40 fold higher (>1.3 MeV).

There is, in fact, a small number of comparable excited states in stable isotopes across the Periodic Table, notably, $^{103}{}_{45}Rh_{58}$ ($\boldsymbol{J}$=7/2, 0.0397 MeV) and $^{105}{}_{46}Pd_{59}$ ($\boldsymbol{J}$=3/2, 0.280 MeV), both of which have been implicated in prior LENR research. Noteworthy, however, is the fact that their natural abundances are extremely low. Specifically, $^{103}{}_{45}Rh_{58}$ is present in the Earth's crust at a level of 0.0010 mg/kg, and $^{105}{}_{46}Pd_{59}$ at 0.0033 mg/kg, whereas $^{61}{}_{28}Ni_{33}$ is present at a level of 0.9576 mg/kg. These relative abundances mean that technological application of their LENR capacities would be, respectively, 1000 times and 300 times more expensive for Rhodium and Palladium relative to Nickel.

As noted above, nuclear reactions involving low-lying excited-states are speculative insofar as the initiating "cold fusion" reaction demands the accretion of a proton by a stable nucleus at temperatures not normally reached except in "hot fusion" conditions. The question arises whether or not an energetically favorable mechanism might initiate MeV nuclear events. In this context, the relatively low-energy $^{7}{}_{3}Li_{4}$ + p reaction, leading to 17 MeV alpha release, is of considerable interest.

4 Discussion

The Nickel-$LiAlH_4$ system known as the E-Cat is one of several dozen LENR configurations for which excess heat has been experimentally demonstrated [1, 2]. The E-Cat is, however, apparently unique in allowing for the reliable production of significant energy using relatively inexpensive materials. Although its main source of energy

appears to be the $^{7}{}_{3}Li_4$(p, α)α reaction, the recently reported transmutations [3] are strongly suggestive of two distinct types of LENR – neither of which is easily explained in traditional nuclear physics. Specifically, both of the most likely reactions induced in the E-Cat entail nucleon uptake by stable, odd-A isotopes. The coincidence that both $^{7}{}_{3}Li_4$ and $^{61}{}_{28}Ni_{33}$ are stable ***J***=3/2- isotopes with low-lying excited states (<0.5 MeV) is suggestive that the unanticipated phenomena of LENR may be a consequence of the detailed substructure of easily-excited stable isotopes. Particularly in light of the fact that the quantal states of nucleons in the IPM have a straightforward lattice geometry [5], from which nuclear ***J***π-values and magnetic moments can be predicted, we conclude that it is worthwhile to examine the largely-overlooked nuclear structure aspects of LENR. Stated conversely, as important as the solid-state environment and the surrounding electromagnetic field is for inducing nuclear effects, the nuclear reactions themselves appear to occur only in a few specific isotopes and involve only a few specific quantal transitions. If the excitation of stable nuclei to low-lying excited-states is indeed an essential prerequisite of LENR phenomena, it would not be surprising that LENR effects can occur in very different solid-state/chemical environments, provided only that the necessary proton/deuteron constituents can be brought into contact with the unusually-reactive low-lying excited-states of substrate nuclei.

4.1 A Plethora of Cold Fusion Theories

Many quantum-theory-based hypotheses have been advocated to explain cold fusion phenomena. Gullstroem [12] has proposed a neutron exchange mechanism to explain specifically the E-Cat transmutation effects. Muelenberg [13] and Muelenberg and Sinha [14] have proposed a "lochon" (local charged boson) model as a means for overcoming the Coulomb repulsion between protons, deuterons and other nuclei. Previously, Ikegami and others [15-21] have proposed that alpha particles can be generated by Lithium (following proton accretion or deuteron stripping). Quantitative results and a consensus concerning their significance in specific experimental contexts are yet to be obtained, but such theoretical work will eventually be of fundamental importance in order to provide an energetic justification for LENR phenomena.

4.2 A Common Theme

What all LENRs have in common are unanticipated nuclear events that traditional nuclear physicists would categorically maintain to be impossible. There is indeed little doubt that the "central dogma" of atomic physics:

Neutrons ←→ Protons → Electrons

generally holds true. Nuclei have strong influence on extra-nuclear events, but not vice versa – primarily because electron transitions occur at the level of several electron-Volts (eV), while nuclear transitions typically occur at the level of millions of electron Volts (MeV). However, LENR phenomena, in general, and the recently reported transmutation results [3], in particular, clearly indicate that there are circumstances where nuclear reactions can be initiated in chemical systems at relatively low-energies.

It is noteworthy, moreover, that the well-known Mössbauer effect also entails "violation" of the central dogma, but is today an established part of nuclear physics. As Wertheim noted in 1960 [22]:

> "Nuclear physicists have a strong and understandable tendency to ignore the chemical binding of the atoms whose nuclei they investigate. This is based on the fundamentally sound precept that the energies involved in nuclear reactions are so much larger than the energies of chemical binding that the atom may well be thought of as a free atom when analyzing nuclear events." (p. 1)

This "precept" was, however, found to be violated in the Mössbauer effect and

immediately led to a suitable expansion of the central dogma of atomic physics to include a small set of low-energy solid-state phenomena in which electron effects can influence nuclear effects:

Neutrons ←→ Protons ←→ Electrons

The phenomena of late 20th / early 21st century "cold fusion" physics (LENR) appear to take place in a similar energetic context.

Be that as it may, the changes in natural isotopic abundances in the E-Cat and other "cold fusion" systems are unambiguous indication that nuclear reactions have occurred – reactions that require explanation that is consistent with nuclear structure theory. Clarification of precise mechanisms will undoubtedly require measurements of low-level gamma radiation within LENR systems to establish unambiguously which quantum states of which nucleons in which isotopes are involved.

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EXHIBIT 23

JONES DAY

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February 17, 2016

Via E-Mail and US Mail
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Silver Law Group
87889 Overseas Highway
P.O. Box 710
Islamorada, Florida 33036

John:

IPH International B.V. ("IPH"), pursuant to Section 10 of the License Agreement dated October 26, 2012 (the "Agreement"), is hereby requiring Leonardo Corporation and Andrea Rossi to assign to IPH the Licensed Patents (as defined in the Agreement) with respect to the Territory (as also defined in the Agreement). Section 10 of the Agreement states, in part, that "[u]pon the request of the Company, Leonardo and Rossi shall assign to the Company the Licensed Patents with respect to the Territory ...."

An assignment is enclosed with this letter. Please promptly either return the executed assignment to me or advise me that Leonardo Corporation and Andrea Rossi will not execute the assignment.

Respectfully,

Christopher R.J. Pace

cc: IPH International BV

Encl. Assignment

ASSIGNMENT

THIS ASSIGNMENT, made by us, **Andrea Rossi**, a citizen of Italy, currently residing at 1331 Lincoln Road, Apt. 601, Miami Beach, Florida 33139, and **Leonardo Corporation**, a domestic corporation, currently having a principal place of business at 1331 Lincoln Road, Apt. 601, Miami Beach, Florida, 33139;

WITNESSETH: That,

WHEREAS, Andrea Rossi is the inventor listed in all the patent applications/patents contained in Exhibit A to this Assignment and all patents issued from such patent applications and all continuations, continuations-in-part, divisions, extensions, substitutions, reissues, re-examinations and renewals of any of the foregoing; and

WHEREAS, **IPH International B.V.**, a Netherlands company, having a registered address at Burgemeester des Tombeplein 97, 7311 AK, Apeldoorn, Netherlands, hereinafter referred to as Assignee, is entitled pursuant to an existing agreement between the parties to have assigned to it all (100%) of Andrea Rossi and Leonardo Corporation's rights, titles and interests in and to said inventions as described in said applications/patents, and in and to any and all Letters Patent which shall be granted therefor in the United States, the remainder of North America, Central America, Caribbean, South America, China, Russia, Saudi Arabia, or Arabian Emirates;

NOW, THEREFORE, To Whom It May Concern, be it known that for good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, Andrea Rossi and Leonardo Corporation by these presents do hereby assign, transfer and convey unto said Assignee, its successors and assigns, the entire (100%) right, title, and interest in and to the said inventions and applications/patents, and in and to any and all continuations, continuations-in-part, divisions, or extensions thereof, and in and to any and all Letters Patent of the United States of America, the remainder of North America, Central America, Caribbean, South America, China, Russia, Saudi Arabia, or Arabian Emirates, reissues, reexaminations or other forms of protection thereof which may be granted therefor or thereon, for the full end of the term for which said Letters Patent may be granted along with any term extensions thereon or therefor, together with the right to claim the priority of said applications/patents in the United States, the remainder of North America, Central America, Caribbean, South America, China, Russia, Saudi Arabia, or Arabian Emirates in accordance with the International Convention, the same to be held and enjoyed by said Assignee, its successors and assigns, as fully and entirely as the same would have been held and enjoyed by Andrea Rossi and Leonardo Corporation if this assignment had not been made.

Andrea Rossi and Leonardo Corporation hereby request that said Letters Patent be issued in accordance with this assignment.

Andrea Rossi and Leonardo Corporation further covenant and agree that, at the time of the execution and delivery of these presents, Andrea Rossi and/or Leonardo Corporation possess full title to the inventions and applications/patents above-mentioned (except to the extent such title is already held by Assignee or Industrial Heat, LLC), and that Andrea Rossi and/or Leonardo Corporation have the unencumbered right and authority to make this assignment.

Andrea Rossi and Leonardo Corporation further covenant and agree to execute any additional papers which may be requested to confirm the right of the Assignee, its representatives, successors, or assigns to secure patent or similar protection for the said inventions in the United States, the remainder of North America, Central America, Caribbean, South America, China, Russia, Saudi Arabia, or Arabian Emirates and to vest in the Assignee complete title to the said inventions and Letters Patent, without further compensation, but at the expense of said Assignee, its successors, assigns, and other legal representatives; and we hereby instruct, and further covenant and agree to bind our heirs, legal representatives, and assigns, to do same, without further compensation, but at the expense of said Assignee or its representatives.

IN WITNESS WHEREOF, I have hereunto set my hand and seal on this ______ day of February, 2016.

____

Andrea Rossi

IN WITNESS WHEREOF, I have hereunto set my hand and seal on this ______ day of February, 2016.

____

Leonardo Corporation
Name: ______________________
Title: ______________________

WITNESSED BY:

______________________________ ______________

Signature Date

______________________________ ______________

Signature Date

Exhibit A

1. All patent applications or patents that claim priority to Italian Patent No. IT1387256, entitled "Processo ed apparecchiatura per ottenere reaxioni esotermiche, in particolare da nickel ed idrogeno", that are filed and/or issued in North America, Central America, Caribbean, South America, China, Russia, Saudi Arabia, or Arabian Emirates

2. U.S. Patent Application No. 12/736,193, entitled "Method and Apparatus for Carrying Out Nickel and Hydrogen Exothermal Reaction"

3. All patent applications or patents that claim priority to European Publication No. EP2259998 published December 15, 2010, entitled "Method and Apparatus for Carrying Out Nickel and Hydrogen Exothermal Reaction", that are filed and/or issued in North America, Central America, Caribbean, South America, China, Russia, Saudi Arabia, or Arabian Emirates

4. U.S. Patent Application for particulars and theory

5. U.S. Patent Application for control systems

6. U.S. Patent Application for additives and catalyzers in process and apparatus

7. U.S. Patent Application for Hot Cat

8. U.S. Patent Application for direct conversion of photons into electric energy

9. U.S. Patent Application for particulars of the reactor

10. U.S. Patent No. 9,115,913, entitled "Fluid Heater"

EXHIBIT 24

Now, at 08.16 a.m. of Wednesday Sept 16 the 1 MW E-Cat is stable; the E-Cat X is resisting at very promising levels, but we have to wait to know if we reached the necessary reliability.

September 13, 2015 (Day 202)

Right now it is 11.59 p.m. inside the computers container: we have just finished an important reparation to a reactor. The 1 MW is working at 3/4 of its power in this moment, but we are confident it will recover soon.

The E-Cat X continues to be very promising and extremely interesting. Now it seems much more robust and we'll see what will happen next…

September 10, 2015 (Day 202)

All right, let's put down at work: now, at 09.13 p.m. of Sept 10 I am inside the computers container, looking at the cover of ribbon of the USPTO, while the plant is well and stable.

September 7, 2015 (Day 199)

Now at 10.30 a.m. of Monday September 07 (Labor Day in the USA: greetings to all the workers of the USA!) the situation is: 1 MW E-Cat: stable and well, all data normal E-Cat X: is in operation.

September 5, 2015 (Day 197)

Now, at 08.20 a.m. of Saturday September 5th, the 1 MW plant is working well and stable but at 3/4 of its power, because we are making maintainance to a

reactor. The "voice" is good, we are relatively calm.

September 3, 2015 (Day 195)

Today Sept 03 at10 a.m.: E-Cat X in preparation, should start Sunday. 1 MW E-Cat stable.

September 2, 2015 (Day 194)

Now, at 07.53 p.m. inside the 1 MW plant the situation is normal; the E-Cat X is still in construction. I am working on new patents.

September 1, 2015 (Day 193)

Right now in the plant it's 10.05 p.m. of September 1. The 1 MW E-Cat is working at 3/4 of the power because we have problems in one reactor, The other 3 reactors are stable and well.

August 28, 2015 (Day 189)

Today, at 09.10 a.m. of Friday Aug 28th, the 1MW E-Cat is stable, the E-Cat X is in construction. No troubles, so far.

August 22, 2015 (Day 183)

Now it's 08.05 p.m. inside the plant, it is working stable: I am working here with my great Team. The E-Cat X is in re-construction and I am convinced we have resolved the problem. If God wants, we should be close …it is very promising.

August 18, 2015 (Day 179)

EXHIBIT 25

Ronald:
That's in my dreams, yes. F8.
Warm Regards,
A.R.

5. Caterine
April 14, 2016 at 12:25 PM

Dear Dr Andrea Rossi:
I read from your enemies that they do not accept the results of the ERV because they have made different measures: but this is ridiculous, it is as if a team refuses the results recorded by the official referee because they have a personal referee that has measured differently !!!
Go ahead, Andrea, get rid of them and go on with the production of the E-Cat !
Caterine

6. Andrea Rossi
April 14, 2016 at 1:47 PM

Caterine:
You gave me a brilliant idea: the next time I will make a tennis match with my wife I will bring my personal referee.
Thank you, that's genial. We use to bet pizza and beer, but next time if we will end up with the usual 6-0, 6-0, 6-0 for her, I will pull out the results got from my P.R.V.R. (Personal Referee for Validation of Result) and if the results of him will be that I won, I will not pay the pizza, let alone the beer !
Warm Regards,
A.R.

7. Bernie Koppenhofer
April 14, 2016 at 12:38 PM

Dr. Rossi: We have agreed on one issue for five years. Happy customers will ultimately decide the fate of your new fire. That is why I do not understand why you cannot persuade the customer of the year long test to come forward and give his opinion of his savings using the E-Cats.

8. Andrea Rossi
April 14, 2016 at 1:44 PM

Bernie Koppenhofer:
You are too intelligent not to understand that a company cannot be happy of all the blogosphere hurricane around this issue. Our Customer spoke his satisfaction with facts, not words: he bought 3 units like the one he tested during this year with a company set up specifically for this purpose.
Warm Regards,
A.R.

AO 441 (Rev. 07/10) Summons on Third-Party Complaint

UNITED STATES DISTRICT COURT

for the

Southern District of Florida

Andrea Rossi, et al. *Plaintiff* v. Industrial Heat, LLC et al. *Defendant, Third-party plaintiff* v. J.M. Products, Inc., et al. *Third-party defendant*	)))))))	Civil Action No. CASE NO. 1:16-cv-21199-CMA

SUMMONS ON A THIRD-PARTY COMPLAINT

To: *(Third-party defendant's name and address)* Fabio Penon
POIESIS srl
via M.A. Calza 10
35128 Padova
Italy

A lawsuit has been filed against defendant Industrial Heat, LLC et al. , who as third-party plaintiff is making this claim against you to pay part or all of what the defendant may owe to the plaintiff Andrea Rossi, et al. .

Within 21 days after service of this summons on you (not counting the day you received it) — or 60 days if you are the United States or a United States agency, or an officer or employee of the United States described in Fed. R. Civ. P. 12 (a)(2) or (3) — you must serve on the plaintiff and on the defendant an answer to the attached complaint or a motion under Rule 12 of the Federal Rules of Civil Procedure. The answer or motion must be served on the defendant or defendant's attorney, whose name and address are:

Christopher R.J. Pace, Jones Day, 600 Brickell Avenue, Suite 3300, Miami, FL 33131

It must also be served on the plaintiff or plaintiff's attorney, whose name and address are:
John W. Annesser, Esq., Silver Law Group, 87889 Overseas Highway, P.O. Box 710, Islamorada, FL 33036

If you fail to respond, judgment by default will be entered against you for the relief demanded in the third-party complaint. You also must file the answer or motion with the court and serve it on any other parties.

A copy of the plaintiff's complaint is also attached. You may – but are not required to – respond to it.

Date: 08/05/2016

CLERK OF COURT

Signature of Clerk or Deputy Clerk

Civil Action No. CASE NO. 1:16-cv-21199-CMA

PROOF OF SERVICE

(This section should not be filed with the court unless required by Fed. R. Civ. P. 4 (l))

This summons for *(name of individual and title, if any)* ______________________________

was received by me on *(date)* ______________ .

❒ I personally served the summons on the individual at *(place)* ______________________________

______________________________ on *(date)* ______________ ; or

❒ I left the summons at the individual's residence or usual place of abode with *(name)* ______________

______________________________ , a person of suitable age and discretion who resides there,

on *(date)* ______________ , and mailed a copy to the individual's last known address; or

❒ I served the summons on *(name of individual)* ______________________________ , who is

designated by law to accept service of process on behalf of *(name of organization)* ______________

______________________________ on *(date)* ______________ ; or

❒ I returned the summons unexecuted because ______________________________ ; or

❒ Other *(specify)*: ______________________________

______________________________ .

My fees are $ ________ for travel and $ ________ for services, for a total of $ 0.00 .

I declare under penalty of perjury that this information is true.

Date: ______________

____
Server's signature

____
Printed name and title

____
Server's address

Additional information regarding attempted service, etc:

Print | Save As... | Add Attachment | Reset

AO 441 (Rev. 07/10) Summons on Third-Party Complaint

UNITED STATES DISTRICT COURT

for the

Southern District of Florida

Andrea Rossi, et al. *Plaintiff* v. Industrial Heat, LLC et al. *Defendant, Third-party plaintiff* v. J.M. Products, Inc., et al. *Third-party defendant*	)))))))	Civil Action No. CASE NO. 1:16-cv-21199-CMA

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Date: 08/05/2016

CLERK OF COURT

Signature of Clerk or Deputy Clerk

AO 441 (Rev. 07/10) Summons on Third-Party Complaint (Page 2)

Civil Action No. CASE NO. 1:16-cv-21199-CMA

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AO 441 (Rev. 07/10) Summons on Third-Party Complaint

UNITED STATES DISTRICT COURT

for the

Southern District of Florida

Andrea Rossi, et al. *Plaintiff* v. Industrial Heat, LLC et al. *Defendant, Third-party plaintiff* v. J.M. Products, Inc., et al. *Third-party defendant*	)))))))	Civil Action No. CASE NO. 1:16-cv-21199-CMA

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Date: 08/05/2016

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AO 441 (Rev. 07/10) Summons on Third-Party Complaint

UNITED STATES DISTRICT COURT

for the

Southern District of Florida

Andrea Rossi, et al.
Plaintiff
v.
Industrial Heat, LLC et al.
Defendant, Third-party plaintiff
v.
J.M. Products, Inc., et al.
Third-party defendant

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