Send Orders for Reprints to reprints@benthamscience.net

The Open Physical Chemistry Journal, 2013, *5*, 17-27 17

Open Access

Confirmations of Santilli's Intermediate Controlled Nuclear Fusion of Deuterium and Carbon Into Nitrogen Without Harmful Radiations

J. V. Kadeisvili, C. Lynch and Y. Yang*

Thunder Fusion Corporation, 150 Rainville Rd., Tarpon Springs, FL, 34689, USA

Abstract: We present five independent confirmations of the intermediate controlled nuclear fusion of Nitrogen from Deuterium and Carbon without the emission of harmful radiations or the release of radioactive waste, first achieved by R. M. Santilli [12] following extended mathematical, theoretical and experimental research, and preliminarily confirmed by R.Brenna, T. Kuliczkowski, and L.Ying [13].

Keywords: Nuclear fusions, nuclear syntheses, radioactive waste.

1. INTRODUCTION

In this paper, we present five experimental confirmations of the Intermediate Controlled Nuclear Fusions (ICNF), also called "warm fusion", of Deuterium and Carbon into Nitrogen according to the reaction:

$$D(2,1,1^+,2.0141) + C(12,6,0^+,12.0000) + TR \rightarrow$$

$$\rightarrow N(14,7,1+,14.0030) + \Delta E, \qquad (1.1a)$$

$$\Delta E = (E_D + E_C) - E_N = 0.0111 \sim u = 10.339 MeV$$

$$\approx 1.5 \times 10^{-15} BTU \qquad (1.1b)$$

where TR stands for a suitably engineered "trigger" forcing polarized Deuterium and Carbon nuclei to 1~fm mutual distance, and ΔE is the energy output.

Additionally, Santilli predicted in Ref. [11] and verified experimentally in paper [14] the ICNF of Oxygen and Carbon into Silica according to the reaction and related energy output:

$$O(16,8,0^+,17.9991) + C(12,6,0^+,12.0000) + TR \rightarrow$$

$$Si(28,14,0^+,29.9737) + \Delta E \qquad (1.2a)$$

$$\Delta E = 0.0254 \sim u \qquad (1.2b)$$

Additional ICNF have been predicted in Ref. [11] and will be studied in subsequent works.

ICNF of type (1.1) or (1.2) are significant because they cannot produce harmful radiations and cannot release radioactive waste. Either the fusions occur. in which case no neutron or other harmful radiation are possible since the synthesized element is light, natural and stable, or the fusions do not occur, in which case, the energy used for the fusions is about 10^{-6} smaller then the energy needed for the separation of the original nuclei as a condition to produce neutron radiations. Needless to say, ICNF do produce electron, gammas and other radiations that are however trapped by the walls of the equipment.

*Address correspondence to this author at the Thunder Fusion Corporation, 150 Rainville Rd., Tarpon Springs, FL, 34689, USA;
E-mail: research@thunder-fusion.com

The first novelty of Santilli's ICNF over cold and hot fusions (see monograph [1] for details) is a truly controlled exposure of nuclei out of their electron clouds, which is an evident pre-requisite for any nuclear fusion. Such an exposure is achieved via the polarization of the orbits of atomic electrons into toroids caused by intense magnetic fields at atomic vicinity of electric arcs, as illustrated in (Fig. **1**).

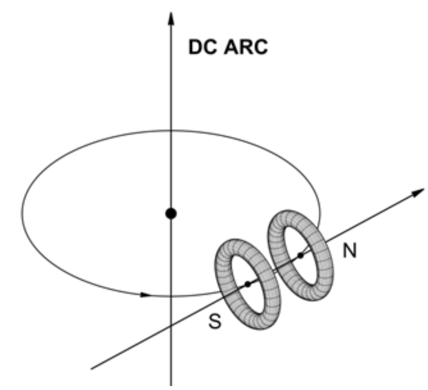

Fig. (1). Conceptual rendering of Santilli's polarization of the orbitals of peripheral atomic electrons via the strong magnetic field at atomic vicinity of an electric arc, which magnetic fields can reach values of the order of 1012 G or more, thus having strength amply sufficient for the indicated polarization.

Such a polarization has permitted the creation of a new chemical species, today known as *Santilli magnecules* in order to distinguish them from the ordinary "molecules", which is illustrated in (Fig. **2**) (for detailed mathematical, theoretical and experimental studies, see Ref. [1] and papers quoted therein). Recent independent experimental verifications on the existence, systematic production and industrial applications of Santilli magnecules can be found in Refs. [2-4].

The second novelty of ICNF over the cold and hot fusions is that of using the minimal amount of energy needed for the systematic and controlled exposure of nuclei in preparation for the nuclear fusion. Santilli argues that cold fusions are generally at random due to the lack of energy necessary for the controlled exposure of nuclei, while hot fusions use excessive energy with ensuing uncontrollable instabilities. Fusions of type (1.1) and (1.2) were called ``intermediate" in Ref. [11] because occurring at energies intermediate between those of the cold and of the hot fusions.

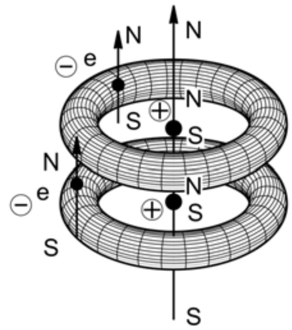

Fig. (2). Conceptual rendering of Santilli magnecules, here referred to two generic atoms assumed at absolute zero degree temperature. The toroidal polarization of the electron orbitals of Figure 1 creates a new magnetic field not existing for spherical distributions that allows the bonding of polarized atoms via opposing magnetic polarities. Note that the magnetic attractions overcome possible Coulomb repulsions due to atomic charges since the atoms are neutral, thus having a null total mutual Coulomb force.

The third novelty of ICNF over the cold and hot fusions is the use of a non-unitary covering of quantum mechanics, developed by Santilli and various other scientists under the name of *hadronic mechanics* (see monographs [5] and vast references quoted therein).

A main conceptual argument is that nuclear fusions can only occur under "contact" between extended nuclei, thus implying non-linear, non-local and non-potential interactions that are beyond any hope of representation via quantum mechanics. The resulting non-Hamiltonian character of nuclear fusions then suggests the use of a non-unitary theory.

An additional argument is that quantum mechanics is a theory structurally reversible over time, in the sense that the underlying mathematics based on *Lie algebras* and related axioms have no direction of time, while nuclear fusion are structurally irreversible over time. It then follows that quantum mechanics predicts with equal probabilities both the fusion of two nuclei into a third, as well as the spontaneous decay of the synthesized nucleus into the two original nuclei with evident violation of causality and other physical laws. The main branch of hadronic mechanics, with the covering *Lie-admissible structure*, has been conceived and constructed for the consistent representation of irreversible processes at large, and of nuclear fusions in particular.

Santilli proved the necessity of hadronic mechanics for the most elementary and most fundamental fusion, the synthesis of neutrons inside stars according to Rutherford's historical conception as "compressed Hydrogen atoms" (i.e., via electrons totally compressed inside protons), according to the known reaction

$$p^{+} + e^{-} \rightarrow n + \nu. \tag{1.3}$$

The rest energy of the neutron is $0.874 ~MeV *bigger* than the sum of the rest energies of the proton and of the electron. Consequently, rather than having the usual "negative binding energies" with related "mass defects" that are typical for all quantum bound states, the synthesis of the neutron requires a "positive binding energy", resulting in a "mass excess" for which the Schrodinger equation no longer admits physically consistent solutions [1,5, 6, 7, 10].

Santilli has shown that the use of the non-unitary hadronic covering of quantum mechanics permits the achievement of an *exact* representation of "all" characteristics of the neutron in synthesis (1.3) at both the non-relativistic [6] and relativistic [7] levels.

Besides these mathematical and theoretical studies, Santilli has conducted extensive experiments [9] confirming the synthesis of the neutron from a Hydrogen gas as originally tested by Don Borghi *et al.* [8] (see review [10]). Hence, Santilli studied theoretically and experimentally the fundamental synthesis of the neutron from the Hydrogen atom prior to any study on nuclear fusion.

ICNF are achieved in specially designed reactors, called *Hadron Reactors* (because conceived and designed via the use of the covering hadronic mechanics) admitting in their interior a DC arc submerged within a gas acting as one of the two components of the fusion, called *Hadronic Fuels*. Fusions occur in the atomic vicinity of the arc and, as such, cannot reach explosive character of the type of nuclear bombs. In particular, ICNF are truly controlled via a variety of engineering means, including the control of the power, the pressure, the flow, the "trigger" and other means. Therefore, ICNF have multiple means for their halting without any release of radiations or radioactive wastes.

Hadronic mechanics has permitted the identification of the physical laws that have to be verified for ICNF to occur, first presented in Ref. [10] and today known as *hadronic laws for nuclear fusions*. Among these laws, besides the verification of all needed conservation laws for spin, energy, parity, etc., we mention the need for nuclear spin couplings of planar singlet or axial triplet type (Fig. **3**).

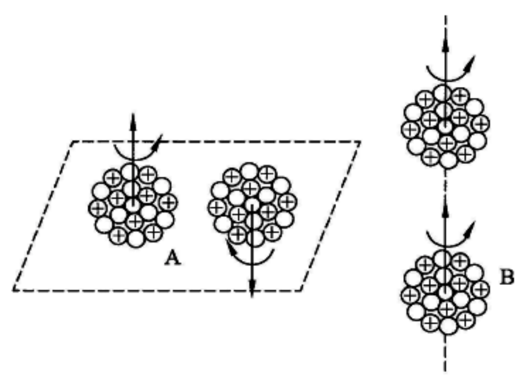

Fig. (3). A view of Santillis nuclear couplings necessary for systematic fusions of spinning nuclei [11]: the planar single coupling in the left (antiparallel spin) and the axial triplet coupling in the right (parallel spins). Different nuclear couplings cause large repulsive forces that prohibit the fusion, as it is the case for the planar triplet coupling or the axial singlet coupling. It is evident that random nuclear couplings allow only random fusions at best.

It should be noted that the configuration of polarized and coupled atoms of (Fig. **2**) verifies hadronic laws for nuclear fusion by only misses the "trigger" for pushing the nuclei at 1~fm mutual distance at which point the strongly attractive nuclear forces are activated and the fusion is inevitable.

The manually operated Hadronic Reactor I depicted in (Fig. **4**) was used by Santilli for the first experimental verification of nuclear fusions (1.1). Fig. (**5**) depicts the same reactor when used for the verification of ref. [13]. Hadronic reactor II depicted in (Fig. **6**) is the first reactor with the automatic control of the arc and cooling system capable of predicting steam. Hadronic Reactor III depicted in (Fig. **7**) is the first high pressure reactor with automatic control, and dual (internal and external) cooling system operating at 1,000 psi.

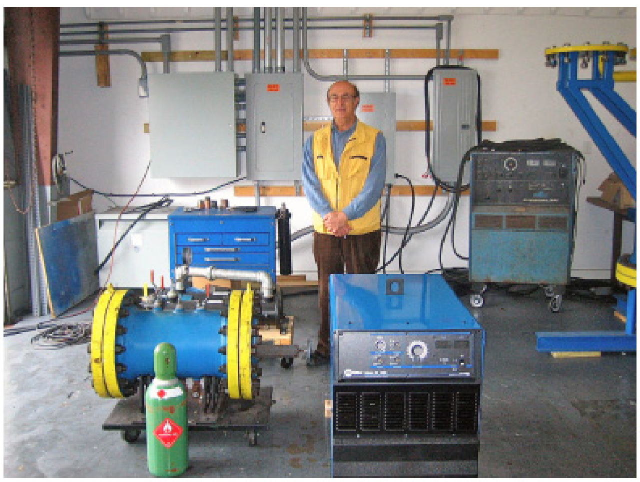

Fig. (4). A view in the left of Santilli and the equipment used for the first synthesis of Nitrogen from Deuterium and Carbon in 2010 [11] showing from the Miller Dimension 1000 AC-DC converter with maximal power output of 50 kW, the pressure bottle of 99.99% pure Deuterium, and the carbon steel reactor, called Hadronic Reactor I. Note the manual control of the internal electric arc.

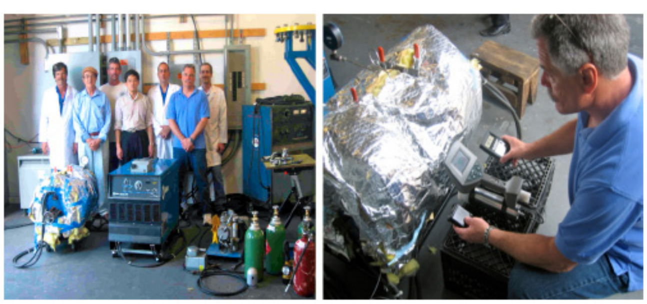

Fig. (5). A view in the left of the participants in the verification in 2011 [13] of Nitrogen synthesis from Deuterium and Carbon [12]. The picture also shows that the used equipment is the same as that originally used (Fig. **4**). In the r.h.s we show one of various measurements confirming lack of radiations.

Hadronic Reactors IV and V depicted in (Figs. **8** and **9**) have been specifically built for the systematic measurements presented in this paper. In particular, they have the automatic initiation and optimization of the electric arc with automatic recording of all data and, as such, they have allowed numerous essentially identical tests.

Fig. (6). A picture in the left of Hadronic Reactor II used in 2011 for the ICNF of Silica from Oxygen and Carbon with automatic control of the arc and cooling means, showing in the right the first production of steam from ICNF. A DVD on the operation of the reaction is provided by Lecture VB of the World lecture Series from the link http://www.world-lecture-series.org/level-v.

Fig. (7). A few views of Hadronic Reactor III built by Santilli in 2012, including from top left: a general view of the container housing the reactor; the interior 1, 000 psi reactor; the touch screen for the automatic control and recording of all data; and the steam produced by using air and carbon as hadronic fuel. A DVD on the operation of the reaction is provided by Lecture VC of the World lecture Series from the link http://www.world-lecture-series.org/level-v. The thunder simulation at high voltage can be heard from the link http://www.santilli-foundation.org/docs/Thunder-Fusions.amr.

In closing this introduction, we should recall that, as stressed in Ref. [11], conventional Hydrogen *is not* recommended as hadronic fuel because its use in hadronic reactors would produce a neutron flux as confirmed in measurements [10].

Necessary prerequisites for the full understanding of this paper are a knowledge of hadronic mechanics [5], the fusion of the neutron from the proton and the electron [10], the hadronic laws necessary for ICNF [11], and the preceding experiments [12-14].

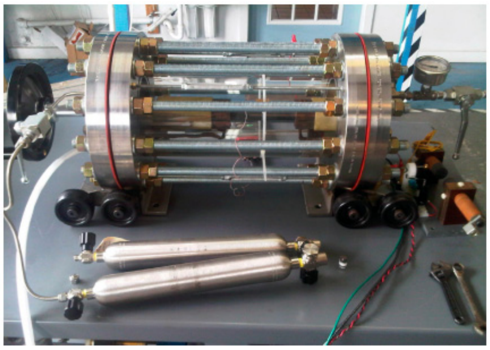

Fig. (8). A view of Hadronic Reactors IV used for the measurements presented in this paper/its dimensions are the same as those of Hadronic Reactor I (Figure 4). The main differences are given by the availability of automatic controls of the arc, automatic monitoring, recording and printing of all data, and a transparent Pyrex tube used for the tests reported this paper to verify visually the internal operations and sensors. Particularly important is a visual verification of the existence of a stable arc because, in its absence, the reactor can show power absorption while the electrodes are in a short, in which case no ICNF can evidently occur.

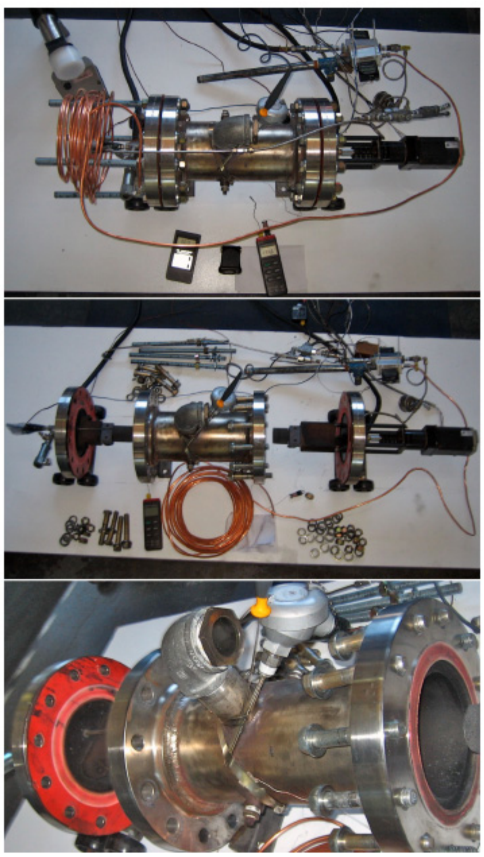

Fig. (9). Views of the Hadronic Reactor V used in the tests reported in this paper. The top view shows the reactor in fully assembled conditions, with radiation detector Sam 035 in the top left, and the 907 Pamrad and PM1703GN neutron detectors in the lower left. The central view shows the reactor in open conditions as used for the replacement of the electrodes. The lower view shows the periscope with a transparent Pyrex window used to confirm the existence of the arc during tests.

2. EXPERIMENTAL CONFIRMATIONS OF THE NITROGEN SYNTHESIS

2.1. Description of the Tests

In this section, we report five tests conducted on April 18, 2013, at the laboratory of Magnegas Corporation located at 150 Rainville Rd. Tarpon Springs, Florida, on the intermediate, controlled nuclear fusion of Nitrogen from Deuterium and Carbon without radiations as first reported by Santilli in Ref. [12].

All five tests were done via the use of Hadronic Reactors IV and V depicted in (Figs. **8** and **9**). In particular, reactor IV with the transparent Pyrex wall was used for visual verifications of interior operations and sensors while all measurements reported below were done via Hadronic Reactor V having the following specifications:

1) A central cylinder consisting of a 12 OD x 24” L stainless steel tube with welded on hollow flanges at each end;
2) Two plan flanges bolted to both end flanges to seal the chamber for up to 300 psi;
3) A stationary anode, made of commercially available, 2 OD carbon graphite rod housed in one of the end flanges;
4) A moveable cathode, also made by the same commercially available 2 OD carbon graphite rod, housed in the other plain flange through sliding means whose position is set t by a stepper motor operated by the automatic controls of the arc;
5) The electrodes are replaced following their consumption by unbolting the plain flanges and removing all interior parts of the reactor.

All tests were done by using the same power supply as that of Ref. [12], consisting of a Miller Dimension 1000 AC-DC converter operated at 40 V DC and 900 A for a total of 36 KVA.

The arc is operated by the same automatic means used for Hadronic Reactor III (Fig. **7** and descriptive DVD from the link http://www.world-lecture-series.org/level-v), that includes touch screen operations, the recording of all data installed in the reactor via a USB port for print out following the tests.

Hadronic Reactor V is equipped with a number of sensors recorded by the indicated automatic controls link, including various temperatures, pressure and other sensors to record data from the interior and the exterior of the cylindrical part of the reactor, its end flanges, and other components.

All tests were conducted according to the same procedure as that of ref. [12], namely:

1) A vacuum down to -30 psi was pulled down of the reactor via a commercially available vacuum pump;
2) The reactor was flushed with a Deuterium gas supplied by AirGas Specialty Gases of Cinnaminson, NJ, that was guaranteed to be 99.999% pure;

3) Following said flushing, the reactor was filled up to 100 psi with said Deuterium gas;
4) Five laboratory bottles we filled up prior to any activation of the arc (one per test), to secure samples of the gas in the interior of the reactor (comprising said pure deuterium gas plus residual impurities in the interior of the reactor), said bottles are sealed and marked N1B, N1B#2m N2B, N3B and N4B, where N stands for Nitrogen, B stands for "Before the test" and #2 stand for repetition of the first test for verifications.

Following the recording of ambient temperature and other data, the test was initiated by activating the arc for two minutes while all data were being monitored and recorded, and five laboratory bottles were filled up with the gas in the interior of the reactor at the end of the test and labeled N1A, N1A#2, N2A, N3A, and N4A where A stands for "After the tests".

During all tests, Hadronic Reactor V was exposed to radiation counts = via the following detectors:

1) A Lithium activated photon-neutron detector model P M 1703GN manufactured by Polimaster, Inc., with sonic and vibration alarms;
2) A photon-neutron detector model SAM 935 manufactured by Berkeley Nucleonics, Inc., with the photon channel activated by NaI and the neutron channel activated by He-3l;
3) An alpha, beta, gamma and X-ray detector model 907 PalmRAD manufactured by Berkeley Nucleonics.

It should be indicated that hadronic reactors with interior and exterior cooling means are now available (Figs. **6** and **7**). Nevertheless, the authors selected the use of Hadronic Reactor V (Fig. **9**) without any cooling systems in order to reproduce the conditions of tests [11] as close as possible.

2.2. Confirmations of No Harmful Radiations

The first important aspect to report is the absence of any detection of radiations by the three detectors places near Hadronic Reactor V during all tests on the Nitrogen synthesis from Deuterium and Carbon, thus confirming the lack of emission of harmful radiations reported in Refs. [12-14].

Evidently, various electromagnetic radiations are produced by the electric arc in the interior of the reactor, but they are trapped by the metal walls and do produce detectable radiations in the outside.

Additionally, no radioactive waste was detected at the completion of the tests and after the disassembly of the reactor, by therefore confirming the absence of radioactive waste also reported in Refs. [12-14].

Hence, our measurements confirm Santillis view that ICNF are constituted by the transition from light, natural and stable isotopes (Deuterium and Carbon) to a light, natural and stable isotope (Nitrogen), under which conditions no radiation or radioactive waste ins conceivably possible.

2.3. Confirmations Via Gas Chromatography

Next, we report the gas chromatographic measurements conducted on samples N1B, N1B#2, N2B, N2B and N4B (obtained "Before" the activation of the arc) and samples N1A, N1A#2, N2A, N3A and N4A (obtained After the activation of the reactor), in whose samples where repeated for verifications.

The first analyses here reported were conducted by Oneida Research Services in Whitesboro, NY, via IVA 110s equipped with a vacuum chamber (with an air-cooled turbomolecular pump), sample inlet with temperature control system and monitor, high performance quadrupole mass spectrometer system.

The analyzer also has interchangeable electro-pneumatic and manual sample piercing system, electro-pneumatic vacuum isolation valves, inlet pressure monitor for pump down, automatic calibration port, computer-controlled sampling valve and valve switching panel (VSP).

The original laboratory report from Oneida is available in its entirely from the link of Ref. [15]. In the left of (Fig. **10**), we reproduce Oneida's Nitrogen counts in ppm before (B) and after (A) the test that, as one can see, show systematic increases of Nitrogen counts following the activation the reactor.

In the right of (Fig. **10**), we reproduce Oneida's Deuterium counts also in ppm, before (B) and after (A) the tests. As one can see, the data confirm the decrease of Deuterium counts as expected from the increase of Nitrogen counts. As it is well known, Nitrogen and Carbon Monoxide (CO) have the same 28 a.m.u. Therefore, there is a possibility that Oneida's Nitrogen counts may be due at least in part to CO. This possibility is first excluded by the Oxygen counts of Ref. [15], as one can verify, since the Oxygen counts generally increase, although minimally, following the tests due to the release under high temperature of the Oxygen occluded in the carbon electrodes.

The possibility of misinterpreting CO for Nitrogen is also excluded by measurements on the same samples conducted in the analytic laboratory of Magnegas Corporation in Tarpon Springs, Florida.

In Fig. (**11**), we reproduce the confirmation of the increase of Nitrogen following the activation of the reactor obtained via a Gas Chromatographer Mass Spectrometer equipped with Infra-Red detector (GC-MS/IRD) available at the analytic laboratory of Magnegas Corporation. Note that the excess Nitrogen was first established via the GC-MS, and then confirmed via the IR signature of Nitrogen obtained via the IRD.

These confirmatory analyses are also illustrated in part in (Figs. **11** and **12**), where we reproduce the confirmation of the decrease of Deuterium gas following the activation of the reactor obtained via a Gas Chromatographer with Thermal Conductivity Detection (GC-TCD) also available at Magnegas Corporation.

This dual confirmation of any chromatographic measurement is solely possible in a GC- MS equipped with IRD as strongly recommended by Santilli [1] because, in this

Nitrogen Counts

N1B	N1A	N1B#2	N1A#2
3,610	14994	3741	15008

N2B	4170	N3B	N3A
4170	6554	2683	4471

N4B	N4A		
5567	6554		

Deuteriium Counts

N1B	N1A	N1B#2	N1A#2
991,893	949798	991356	947056

N2B	N2A	N3B	N3A
990845	966806	992839	979263

N4B	N4A		
987880	982062		

Fig. (10). Summaries of the chromatographic analyses conducted by Oneida research Lab- oratories that can be obtained in their entirety from the link of Ref. [15]. The left table summarizes the Nitrogen counts in ppm before (B) and after (A) the conducted of the tests showing a systematic increase of said counts. The right table summarizes the Deuterium counts before (B) and after (A) the tests showing a systematic decrease of the counts. Note that the decrease of said counts, thus providing first systematic evidence on the Nitrogen synthesis that, under the conditions considered, can only occur from Deuterium and carbon.

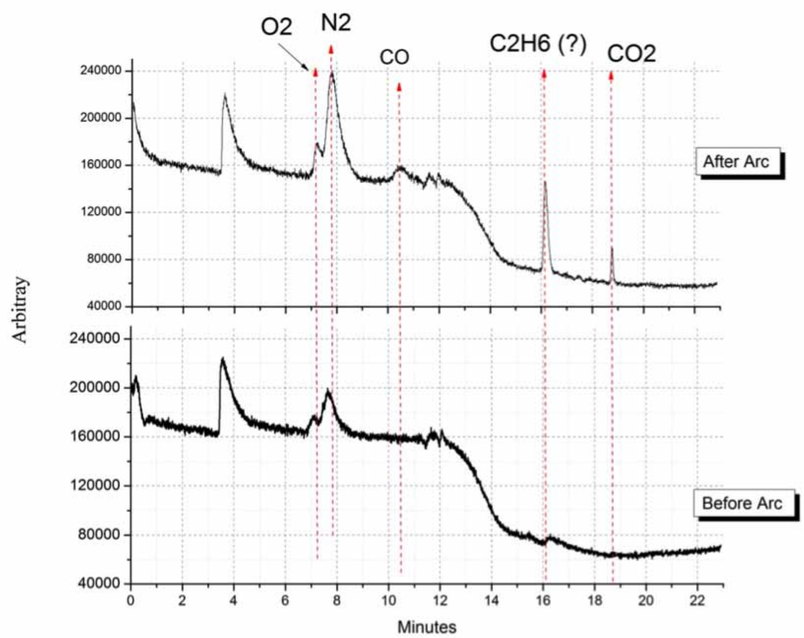

Fig. (11). Confirmation of the increase of Nitrogen following the activation of the arc obtained via a GC-MS/IRD also available at the laboratory of Magnegas Corporation in Tarpon Springs, Florida.

case, the same gas can be analyzed via both the GC-MS and the IRD. In the event the same gas is analyzed with two separate instruments, the GC-MS and, separately, the IRD, there is the emergence of excessive ambiguities in matching the scans of the two instruments.

In conclusion, the Oneida gas chromatographic analyses, when combined with the independent verifications obtained via the GC-MS and the GC-MS/IRD at magnegas Corporation, confirm Santilli's ICNF of Nitrogen from Deuterium and Carbon without harmful radiations (see Section 2E for the excess heat).

2.4. Confirmations of Santilli Magnecules

As illustrated by the data of (Fig. **10**), the counts for the decrease of Deuterium are, in general, a multiple of the counts for the increase of Nitrogen. This occurrence requires the identification of where the excess Deuterium occurs in the chromatographic analyses by Oneida [15].

For this purpose, we note, from the Oneida data summarized in (Fig. **13**), that the original Deuterium gas obtained from the reactor prior to the activation of the arc, shown a few chemical species due to known molecules. However, following the activation of the arc, the data on the same samples show the creation of a series of new species that are detectable all the way to 500 a.m.u., although cut at 92 a.m.u. in (Fig. **11**) for simplicity.

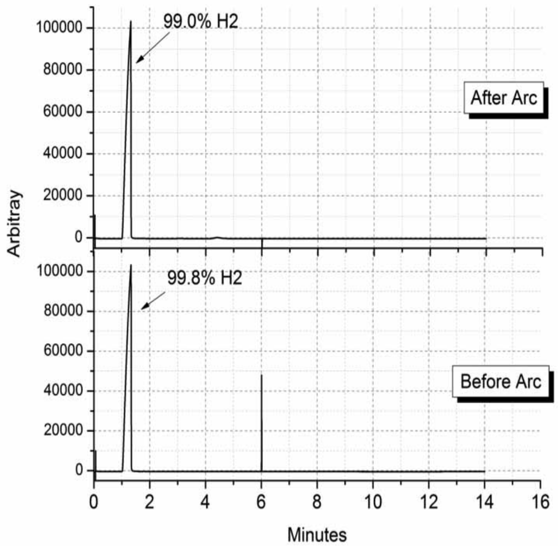

Fig. (12). Conformation of the decrease of Deuterium following the activation of the arc obtained via a GC-TCD available at the laboratory of magnegas Corporation in Tarpon Springs, Florida.

It is evident that a number of the new species following the activation of the arc can indeed be due to new conventional molecules. This is the case for the large increase of 44 a.m.u. that can evidently be due to the increase of Carbon Dioxide CO_2, the increase of 26 a.m.u. is expected to be due to acetylene C_2D_2, and the same occurs for other a.m.u..

However, it is unquestionable that a considerable number of the new species can solely be interpreted quantitatively via Santillis magnecules [1]. This is typically the case for small values of a.m.u., such as 5, or 6, a.m.u., as well as for large values of a.m.u. that, when analyzed via an Infra-Red Detector (IRD), show no Infra-Red (IR) signature at their a.m.u. value, thus establishing that said species cannot possible have a valence bond [1].

The creation of Santilli magnecules by a DC electric arc was originally established via systematic measurements by Santilli [1], has been independently confirmed in Refs. [3-4, 13] and it is confirmed by the GC-MS/IRD measurements reported herein (see, e.g., Fig. **11**) due to the absence of IR signatures for chemical species created by the arc with large values of a.m.u..

As recalled in the introduction, we believe that the creation of Santilli magnecules by the electric arc is a necessary pre-requisite for truly controlled and systematic nuclear fusions in view of the need for the proper alignment of nuclear spins (Fig. **3**) that is inherent by magnecular bonds (Fig. **2**).

2.5. Confirmations Via Excess Heat

It is evident that the sole measurements of excess Nitrogen following the activation of the arc is not sufficient to establish that said excess originated from the ICNF of Deuterium and Carbon into Nitrogen due to various possible alternative interpretations.

ORS REPORT NO. 199968-001
DATE TESTED: 3/19/2013
PACKAGE TYPE: MAGNEGAS CYLINDER

Sample	a.m.u.	N1B	N1A
Mass	2	90,209	175,752
Mass	3	51,898	790,291
Mass	4	8,443,180	6,625,830
Mass	5	169	1,461
Mass	6	10,687	6,709
Mass	7	0	0
Mass	8	0	0
Mass	9	0	0
Mass	10	0	0
Mass	11	0	0
Mass	12	0	21,180
Mass	13	0	3,242
Mass	14	6,075	23,851
Mass	15	60	24,896
Mass	16	2,582	71,708
Mass	17	1,768	50,718
Mass	18	8,386	238,735
Mass	19	1,720	32,348
Mass	20	8,507	155,124
Mass	21	0	1,568
Mass	22	0	1,532
Mass	23	0	0
Mass	24	0	293
Mass	25	0	679
Mass	26	0	3,809
Mass	27	0	6,202
Mass	28	58,724	199,947
Mass	29	415	7,877
Mass	30	487	8,891
Mass	31	0	4,712
Mass	32	13,321	12,235
Mass	33	0	1,079
Mass	34	0	1,763
Mass	35	0	665
Mass	36	0	1,912
Mass	37	0	846
Mass	38	0	1,814
Mass	39	0	3,455
Mass	40	682	3,118

Sample	a.m.u.	N1B	N1A
Mass	41	0	4,387
Mass	42	0	5,525
Mass	43	0	10,054
Mass	44	187	122,917
Mass	45	0	2,332
Mass	46	0	1,289
Mass	47	0	136
Mass	48	0	181
Mass	49	0	131
Mass	50	0	852
Mass	61	0	0
Mass	62	0	207
Mass	63	0	171
Mass	64	0	235
Mass	65	0	278
Mass	66	0	665
Mass	67	0	123
Mass	68	0	0
Mass	69	0	0
Mass	70	0	0
Mass	71	0	0
Mass	72	0	91
Mass	73	0	0
Mass	74	0	169
Mass	75	0	0
Mass	76	0	405
Mass	77	0	217
Mass	78	0	493
Mass	79	0	601
Mass	80	0	1,060
Mass	81	0	1,260
Mass	82	0	2,857
Mass	83	0	3,780
Mass	84	0	10,524
Mass	85	0	661
Mass	86	0	0
Mass	87	0	0
Mass	88	0	0
Mass	89	0	0
Mass	90	0	0
Mass	91	0	429
Mass	92	0	283

Fig. (13). Summaries of the data in a.m.u. of the chromatographic analyses conducted by Oneida Research Laboratories [15] on the gas content of the reactor before (B) and then after (A) the activation of the reactor. The former data show only a few conventional molecular species, while the latter data show the creation by the arc of a considerable number of new species that are generally detectable all the way to 500 a.m.u., some of which are evidently ordinary molecules but others are Santilli magnecules [1].

Final ambiguities were resolved via accurate and systematic measurements of excess heath, that is, heath produced by Hadronic Reactor V in excess of that caused by the used electricity.

Due to the crucial character of heath measurements, Hadronic Reactor V was equipped with a variety of internal and external sensors connected to the touch screen control of the arc that had an accurate recording of absorbed electric power, internal and external temperatures and other data all expressed as a function of time.

Copy of the complete record of these data can be downloaded from the link of Ref. [16]. In Fig. (**14**), we report one of the various temperature profiles on hand measurements via thermocouples for the main cylindrical part of the hadronic reactor and of the end flanges during the conduction of one of the tests.

In Fig. (**15**), we report samples of temperature profile via measurements obtained by the automatic recording of data for the cylindrical part of the reactor, as well as for the interior gas temperature following the activation of the arc.

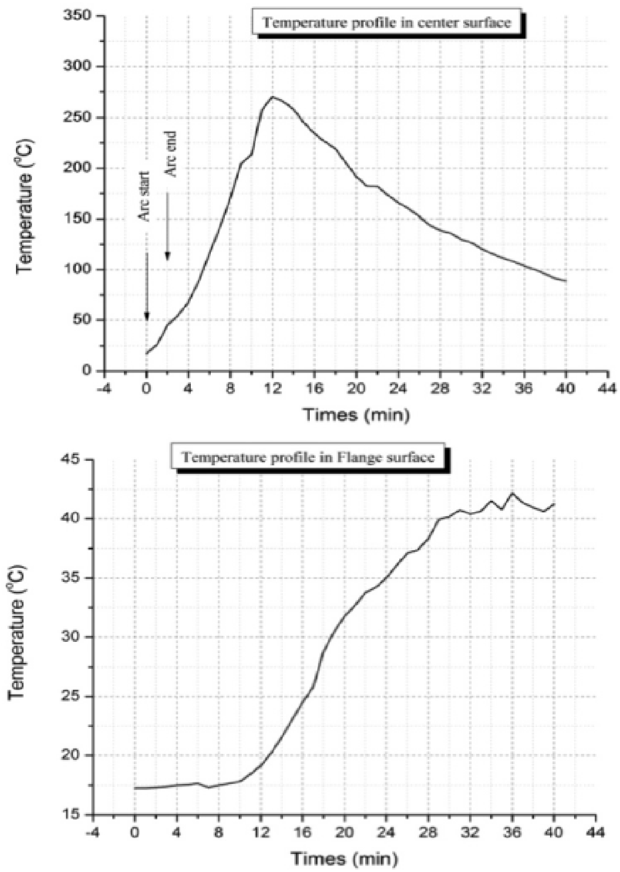

Fig. (14). In the left, we show the temperature profiles of the central cylindrical surface of Hadronic Reactor V measured recorded via thermocouples, and in the right we show the corresponding thermal profile of the end flanges

In addition, the absorbed electric energy was measured both manually as well as via calibrated instruments with recording in the automatic controls, both from the grid as well as at the arc. The comparison of the heat energy produced by the reactor with the absorbed electric energy, has indicated a clear excess of produced heat energy over the absorbed energy, thus confirming that the excess Nitrogen counts are indeed due to ICNF.

Due to the importance of energy profiles, we also conducted systematic simulations of the heat energy produced by the arc and compared them to the produced energy as derived by the various measurements.

As shown below, these simulations confirm the excess heat derived from direct measurements of absorbed and produced energy. However, it should be clarified that the simulations below are a mere complement to the direct measurements of excess heat and not the fundamental data for scientific conclusions. As it is well known, an electric arc can generate temperatures of the order of 4, 0000 C and more. The resulting heat is transferred to the gas surrounding the arc via radiation, convection, and conduction. As the gas heats up, its density and pressure change while inducing a flow inside the reactor (see Fig. **16** for a schematic view).

The equations governing the non-isothermal flow in gas are given by (see, e.g., Ref. [17]):

$$\rho,\partial u\text{-}\partial t.+\rho,\mathbf{u}\cdot\nabla\mathbf{u}.=-\nabla p+\nabla\cdot\eta,\nabla\mathbf{u}+,,\nabla\mathbf{u}.\text{-}T..-,2\eta\text{-}3.,\nabla\cdot\mathbf{u}.\mathbf{I}+\rho\mathbf{g} \qquad (2.1a)$$

$$,\partial\rho\text{-}\partial t.+\nabla\cdot(\rho\mathbf{u})=0 \qquad (2.1b)$$

where ρ denotes the density in (kg/m^3), u the velocity in (m/s), η the viscosity in (Pa·s), p the pressure in (Pa), and g the gravity vector in (m/s^2). The density of the gas inside the reactor can be characterized in first approximation by the ideal gas law:

$$\rho=,Mp\text{-}RT. \qquad (2.2)$$

where M denotes the molar weight in kg/mol, R the universal gas constant in J/molK and T the temperature in K.

The convective and conductive heat transfer inside the reactor can be sufficiently described by the equation:

$$\rho,C\text{-}p.,\partial T\text{-}\partial t.+\nabla\cdot,-k\nabla T.=-\rho,C\text{-}p.\mathbf{u}\cdot\nabla T+Q \qquad (2.3)$$

where C_p denotes the heat capacity in (J/kg K), k is thermal conductivity in (W/mK), and Q denotes the power density in (W/m^3) of the arc as a heat source.

Equations (2.1)-(2.3) are generally solved via a Computational Fluid Dynamics (CFD) method, which is a branch of fluid dynamics solving equations via numerical methods and algorithms. Computers are used to perform the calculations required to simulate the interaction of gases and solids while surfaces are defined by boundary conditions.

At the internal surfaces of the reactor, radiation is described by surface-to-surface methods. This implies the mutual irradiation from the two surfaces. At the outer surfaces of the reactor, radiation is described by surface-to-ambient methods, which implies that there is no reflected radiation from the surroundings.

We analyzed the heat inside the reactor via a long and a short time scale initiating at t = 0, when the power is turned on. The shorter scale captures the heating of the arc and the gas close to it. The pictures of (Fig. **17**) shows the temperature distribution inside the reactor at t = 20, 60, and 120 s.

Platinum resistive temperature sensors were fastened to the surfaces of the steel chambers central cylinder both inside and outside the reactor. Temperature readings were logged automatically by the controls every second after the electric Arc was powered up.

The arc inside the reactor was powered for duration of 2 m and its cooling down was monitored while heat radiated to the surroundings in ambient conditions. Each experimental run was started close to ambient temperature of nominally 21o C. As indicated earlier, the power input was of about 40 kW and the wattmeter measured an average power consumption of 4.8 MJ.

A thermal CFD analysis of the reactor was done to model the expected temperature rise both inside and outside the central cylinder by using as the only source of heat that from the electric arc. Comparison curves of the measured thermal profiles against the CFD computed values at 4.8 MJ energy input establish whether there has been an excess heat over that produced by the electric power absorbed.

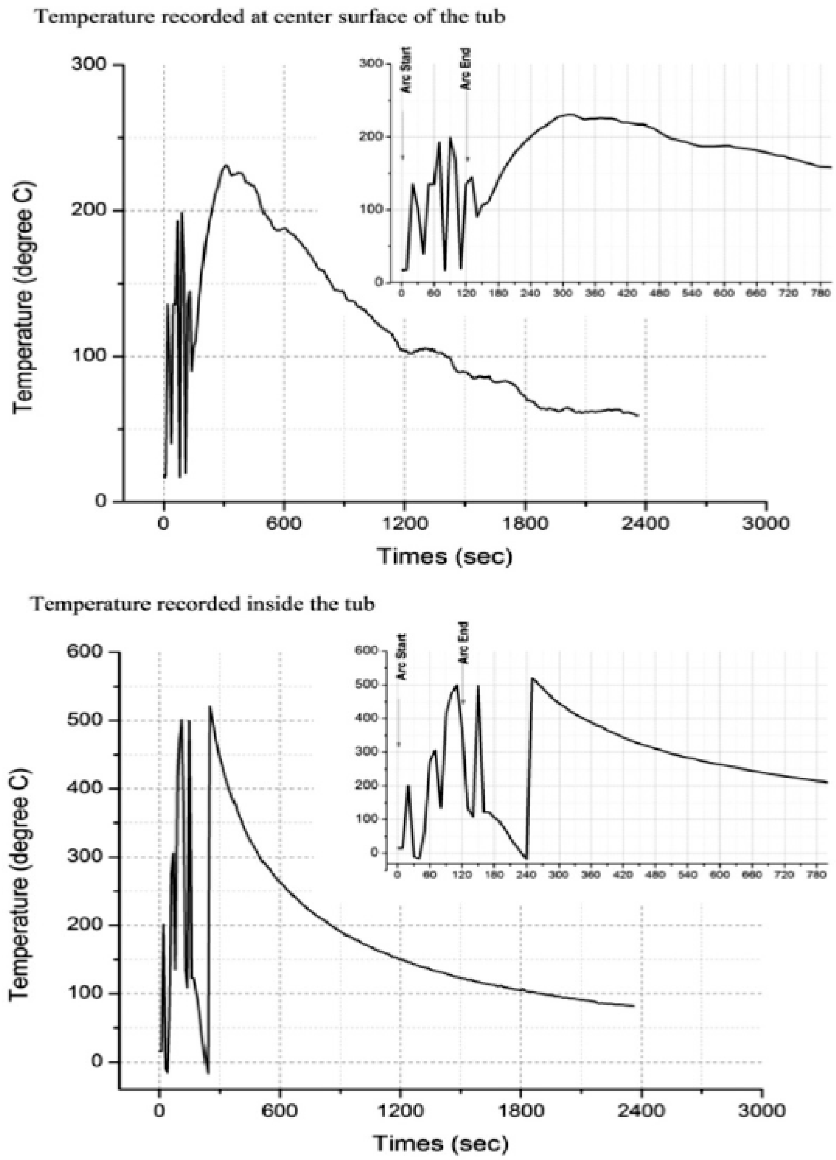

Fig. (15). In the left we show the temperature profiles of the the central cylindrical surface of Hadronic Reactor V measured by thermocouples, and in the right we show the temperature profiles of the interior of the hadronic reactor, both measured by thermocouples and recorded by the automatic controls of the arc.

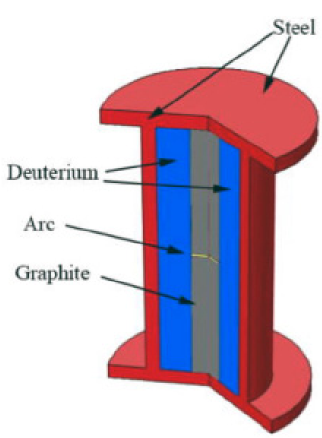

Fig. (16). A schematic view of the interior of the Hadronic Reactor V used for the heat simulation presented in this section.

The measurements inside the cylinder were interrupted by the EMA due to arc interference. The CFD Simulations shown that the total radiation heat flux along the outside surface was losing to 40 kW, thus implying that the heat of the modeling was balanced in the reactor.

Figs. (**18** and **19)** provides a comparison between the thermal profile in the interior the reactor center cylinder between the measured heat (continuous curve) and CFD simulations (dashed curves) for the power input of 40 kW , thus establishing the existence of excess heat over that produced by the arc.

Vides and a comparison between the heat produced by 40 kW in the central cylinder (continuous curve) and the heat actually measured (dashed curves), thus confirming the existence of excess heat over that produced by the absorbed electric power.

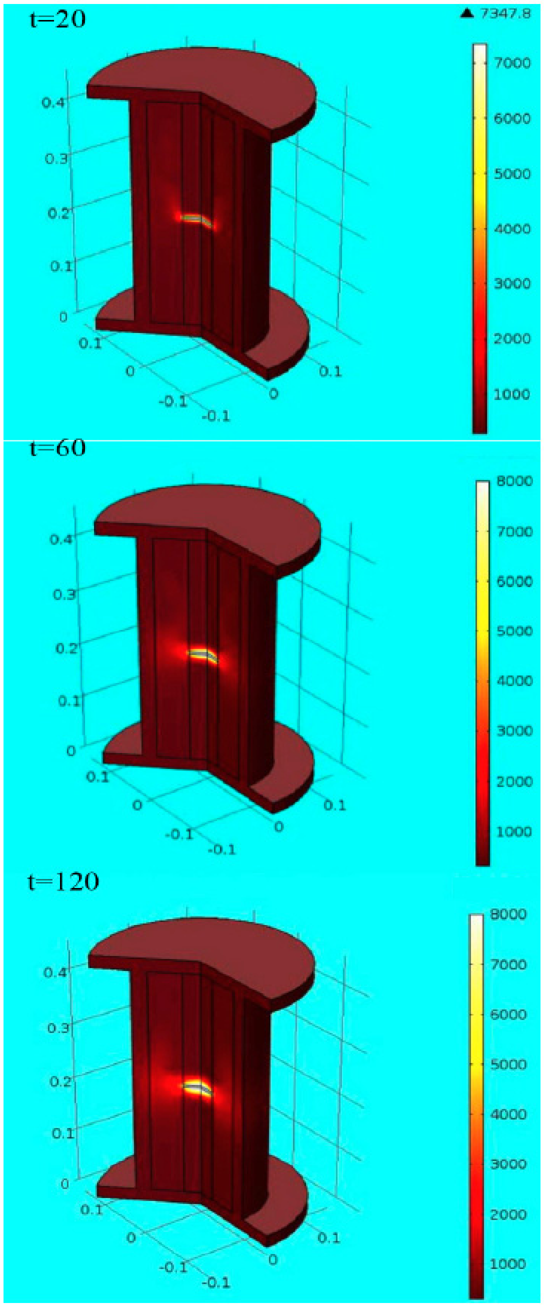

Fig. (17). Temperature (K) distribution inside the reactor as per the schematic of (Fig. **17**) at t = 20, 60, and 120 s.

Following the consideration of various possible interpretations, in the authors view, the excess heat generated by the Hadronic Reactor V can only originate from the ICNF of Deuterium and Carbon into Nitrogen.

3. CONCLUDING REMARKS

When suitably selected to verify all nuclear conservation laws, two light, natural and stable isotopes (called hadronic fuels because the theory is elaborated via the use of hadronic mechanics) do admit a laboratory fusion into a third isotope which is also light, natural and stable, with the consequential release of energy in the form of heat due to the well-known mass defect.

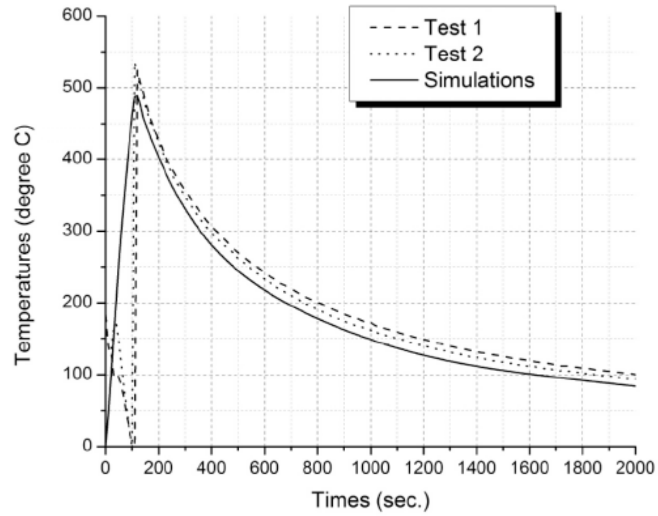

Fig. (18). Comparison of thermal profiles in the interior the reactor cylindrical part between the measured heat (dashed curves) and CFD simulations (continuous curve) for the power input of 40 kW, establishing the existence of excess heat over that produced by the arc.

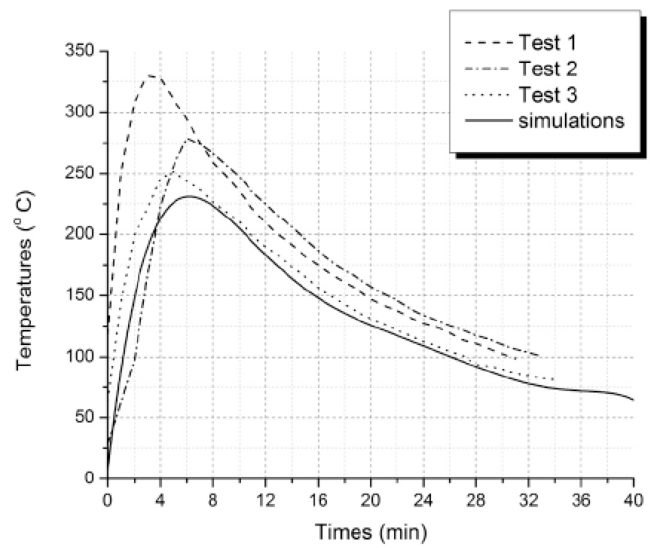

Fig. (19). Comparison of heat produced by 40 kW in the exterior of the central cylinder (continuous curve) between the heat actually measured (dashed curves) and the CFD simulation (continuous curve), confirming the existence of excess heat over that produced by the absorbed electric power.

The fusion is achieved in a pressure vessel (called hadronic reactor) via an internal DC electric arc submerged within one the hadronic fuels (Fig. **1**) and via the use of other engineering means.

The fusions preferably occur at the minimal energy requested for the fusion by conservation laws (called threshold energy) in order to avoid instabilities caused by excess energies (as in the hot fusion), or lack of systematic fusions for insufficient energy (as it is often the case for the cold fusion), thus illustrating the name of intermediate (or warm) fusion.

The fusions are made possible by the controlled exposure of nuclei out of their electron clouds. They were achieved via the polarization of the orbitals into toroids and the proper alignment of nuclear spins necessary for the fusion (Fig. **3**), as well as other features that are assured by Santilli magnecular bonds of hadronic fuels (Fig. **2**).

The fusions are indeed controlled via the control of the power, the pressure, the fuel flow and other mechanical means, and their energy output can be increased significantly via a trigger [11,12,14], namely, an external action forcing the properly exposed and aligned pairs of nuclei at mutual distances of the order of 1 f m, at which distances there is the activation of the strongly attractive nuclear forces under which force (as well nuclear exposure and proper spin alignment) fusions are inevitable.

The fusions do occur without the emission of harmful radiations outside hadronic reactors and without the release of radioactive waste because, either the fusions occur, in which case no neutron or other harmful radiation or waste can be released (since we have by conception the fusion of light, natural and stable isotopes into light, natural and stable isotopes), or the fusions do not occur, in which case the energy used by hadronic reactors is basically insufficient for any nuclear disintegration as needed to generate harmful radiations.

An important feature that should be taken into consideration is that, in this paper, we have repeated the measurements of Refs [12, 13] under conditions as close to the original measurements as possible, thus without the use of any trigger by assumptions.

The implications of the lack of a "trigger" are audible since the operation of Hadronic Reactor V was essentially silent during all tests while, by comparison, the operation of hadronic Reactor III (Fig. **7**) with a "trigger" caused a "thunder-type" noise one can hear from recording: www.santilli-foundation.org/docs/Thunder-Fusions.amr

Therefore, by keeping in mind the clear production of excess heat under the limited power and conditions of our tests, it is reasonable to expect, and in any case worth investigating the production of considerable more excess heat under a suitable selection and engineering realization of the trigger [18].

CONFLICT OF INTEREST

The author(s) confirm that this article content has no conflicts of interest.

ACKNOWLEDGEMENT

Particular thanks are due to R. M. Santilli because, without his authorization for freely using the content of his publications, without his deep criticisms of our presentation, and without his continuous consultations and support, this paper would not have been possible. Additional thanks are due to numerous other colleagues for the reading of preliminary versions, although the authors are solely responsible for the content of this paper.

REFERENCES

[1] Santilli, R.M. Foundations of Hadronic Chemistry, with Applications to New Clean Energies and Fuels, Kluwer Academic Publishers: The Netherlands, 2001.

[2] Day, D. Report on GC-TCD analysis and density measurements of Santilli Magne-hydrogen; Laboratory Report; 2011. http://www.santilli-foundation.org/docs/Eprida-MH-Certification-10-11.pdf

[3] Yang, Y.; Kadeisvili, J.V.; Marton, S. Experimental Confirmations of Santilli's MagneHydrogen: *Int. J. Hydrogen Energ.*, **2013**, *38*, 5002.

[4] Yang, Y.; Kadeisvili, J.V.; Marton, S. Additional Experimental Confirmations of the New Chemical Species of Santilli Magnecules. *Open Phys. Chem.*, **2013**, *5*, 1-16.

[5] Santilli, R.M. Elements of Hadronic Mechanics, Volumes I and II. 1st ed.; Ukraine Academy of Sciences; Ukraine, 1994-1995.

[6] Santilli, R.M. Apparent consistency of Rutherford's hypothesis on the neutron as a compressed hydrogen atom: Hadronic J., 1990, 13, 513, http://www.santilli-foundation.org/docs/Santilli-21.pdf

[7] Santilli, R.M. Recent Theatrical Experimental Evidence on the Apparent Synthesis of the Neutron from Protons and Electrons. *Chinese J. Sys, Eng. Electron*., **1995**, *6*(4), 177.

[8] Borghi, C.; Giori C.C.; Dallolio, A. CENUFPE Communication, 1969, Number 8 and (Russian) Phys. Atomic Nuclei 1993, 56, 205.

[9] Santilli, R.M. Apparent confirmation of Don Borghi's experiment toward the synthesis of neutron from protons and electrons. *Hadronic J*., **1997**, *30*, 709.

[10] Kadeisvili, J.V. The Rutherford-Santilli Neutron. *Hadronic J*., **2008**, *31*, 1.

[11] Santilli, R.M. The novel Intermediate Controlled Nuclear fusions, a repor for its industrial realization. *Hadronic J.*, **2008**, *31*, 15.

[12] Santilli, R.M. Experimental Confirmation of Nitrogen Synthesis from deuterium and Carbon without harmful radiations. *New Adv. Phys.*, **2011**, *4*, 29.

[13] Brenna, R.; Kuliczkowski, T.; Ying, L. Verification of Santilli intermediate Controlled Nuclear Fusions without harmful radiations and the production of magnecular clusters. *New Adv. Phys*., **2011**, *5*, 9.

[14] Santilli, R.M. Additional Confirmation of the "Intermediate Controlled Nuclear Fusions" without harmful radiation or waste: Proceedings of the Third International Conference on the Lie-Admissible Treatment of Irreversible Processes, C. Corda, Editor, Kathmandu University: Kathmandu, Nepal, **2011**, pp. 163-177.

[15] Rossiter, D. ONEIDA gas chromatographic report. http://www.santilli-foundation.org/docs/Oneida-analyses.zip

[16] Lynch, C.; Yang, Y. Collected recorded data on the Nitrogen synthesis. http://www.santilli-foundation.org/docs/Collected-recorded-data.zip

[17] Panton, R.L. Incompressible Flow, 2nd ed., John Wiley & Sons, Inc., **1996**.

[18] Gandzha, I.; Kadeisvili, J. New Sciences for a New Era: Mathematical, Physical and Chemical Discoveries of Ruggero Maria Santilli: Sankata Printing Press: Nepal, **2011**.

Received: August 07, 2013 Revised: October 07, 2013 Accepted: October 15, 2013