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Hadronic Nuclear Energy: An Approach Towards Green Energy

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Abstract. Nuclear energy is undoubtedly the largest energy source capable of meeting the total energy requirements to a large extent in long terms. However the conventional nuclear energy involves production of high level of radioactive wastes which possesses threat, both to the environment and mankind. The modern day demand of clean, cheap and abundant energy gets fulfilled by the novel fuels that have been developed through hadronic mechanics/chemistry. In the present paper, a short review of Hadronic nuclear energy by intermediate controlled nuclear synthesis and particle type like stimulated neutron decay and double beta decay has been presented.

Keywords: Intermediate controlled nuclear synthesis, stimulated neutron decay, double beta decay, hadronic chemistry.
PACS: 33.15Fm, 13.40.-f, 23.40.-s, 75.50.-y

INTRODUCTION

Atomic nucleus and sub-nuclear particles have always been considered an unlimited source of energy. The discovery of nuclear fission by Otto Hahn and Fritz Strassmann [1] paved the way for conventional nuclear energy. However, nuclear fission generates large amount of nuclear waste that risks ecosystem whereas nuclear synthesis is known to create much less pollution, thus is green. It is also comparatively more inexhaustible energy source. Hence, harnessing energy through nuclear synthesis reactions has been so far the Holy Grail. With the discovery of stellar nucleo-synthesis by Hans Bethe paved the way for nuclear synthesis of two or more light nuclei into a heavier nucleus [2]. Of course, the energy released in this process could be harnessed.

Nuclear energy conventionally obtained by fission reaction generates high energy ionizing radiation and radioactive waste. The shielding from these radiations is cumbersome as well as expensive. Disposal of the radioactive waste poses environmental risk.

The fission reactions apparently could be adequately explained by quantum mechanics by considering the fragments as point mass. However, the same theory fails to explain nuclear synthesis because considering the reacting nuclei as point mass is not possible. Hence, the use of hadronic mechanics to explain nuclear synthesis is necessary [3, 9]. Hadronic nuclear energy has been broadly christened as Intermediate Controlled Nuclear Synthesis (ICNS) and hadronic energy of particle type [9].

INTERMEDIATE CONTROLLED NUCLEAR SYNTHESES (ICNS)

Intermediate Controlled Nuclear Syntheses (ICNS) as proposed by Prof. Santilli are systematic energy releasing nuclear syntheses. The reaction rate is controllable via one or more mechanisms capable of performing the engineering optimization of the applicable laws.

Basic assumptions of Hadronic mechanics as proposed by Prof. Santilli are-

i) Nuclear force: Nuclear force is partly represented by a Hamiltonian and partly by the non-potential type terms that is the latter cannot be represented with a Hamiltonian.
ii) Stable nuclei: According to Heisenberg-Santilli Lie-isotopic equations the sub-nuclear particles are in contact with each other (technically, in conditions of mutual penetration of about 10^{-3} of their charge distributions). Consequently, the nuclear force is expected to be partially of potential and partially of nonpotential type, with ensuing nonunitary character of the theory, and related applicability of hadronic mechanics.
iii) Unstable nuclei and nuclear fusion: In case of Heisenberg-Santilli Lie-admissible equation (1) for the time evolution of a Hermitean operator A, in their infinitesimal and finite forms

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$$i\frac{dA}{dt} = (A \hat{;} H) = ARH - HSA \tag{1}$$

where Hermitean, H represents non-conserved total energy; the genotopic elements R and S represent non-potential interactions. Thus, irreversibility is assured.

Irreversibility is assured in this case by the different values of the genounit for forward (f) and backward (b) motions in time by equation (2)

$$I^{>} = 1/R \neq {}^{<}I = 1/S \tag{2}$$

Lie-admissible branch of hadronic mechanics is ideally suited to represent the decay of unstable nuclei and also nuclear synthesis, since both are irreversible over time.

iv) Neutron synthesis: Neutron is assumed to be compressed hydrogen atom (as originally conjectured by Rutherford) as shown by reaction (i).

$$p^{+} + a + e^{-} \rightarrow n \tag{3}$$

where 'a' is Santilli's etherino (It represents in a conventional Hilbert space transfer of 0.782 MeV and spin ½ missing in the synthesis of neutron from the environment to the neutron structure.)

Don Borghi's experiment and Santilli's hadronic mechanics appropriately explains the Rutherford's conjecture of neutron as a compressed hydrogen atom.

Thus, the CNS is governed by Santilli's laws of controlled nuclear synthesis [3]:

- The orbitals of peripheral atomic electrons are controlled such that nuclei are systematically exposed.
- CNS occurs when nuclei spins are either in singlet planar coupling or triplet axial coupling.
- The most probable CNS is those occurring at threshold energies and without the release of massive particles.
- CNS requires trigger, an external mechanism that forces exposed nuclei to come in femto-meter range.

The CNS has been realized using magnecules [3, 9]. The magnecules have systematic and controlled exposure of nuclei which have singlet planar or triplet axial coupling [4-6]. In case of ICNS, proposed by Prof. Santilli energy supplied is of threshold value just sufficient to expose the atomic nuclei from within the electron cloud. Since the energy is not very high the production of ionizing radiations or sub-nuclear particles are avoided. The reaction is carried out in sealed tanks called hadronic reactors [3, 7-10].

SYNTHESIS OF NITROGEN FROM CARBON AND DEUTERIUM BY ICNS

Nitrogen synthesis from carbon and deuterium takes place in nature due to lightning which is an ICNS [9]. The proposed reaction (4) is-

$$\begin{aligned} &C\ (12,\ 6,\ 0^{+},\ 12.0000) + D\ (2,\ 1,\ 1^{+},\ 2.0141) + TR \rightarrow N\ (14,\ 7,\ 1^{+},\ 14.0030) + \text{Heat} \\ &\Delta E = 0.0111\ \text{amu} = 0.339\ \text{MeV} \end{aligned} \tag{4}$$

where TR is trigger mechanism (high voltage DC arc).

However, in laboratories as proposed by Prof. Santili, the threshold energy supplied (by the high voltage DC arc -Trigger) to the partially exposed nuclei reacting magnecules / atoms is just sufficient to push them into the hadronic horizon (within 1 femtometre range) where the fusion reaction is inevitable. As the initial energy of the reacting magnecules is not very high, the resulting compound nucleus has excitation energy lesser than that required for particle- or gamma- emission. The above reaction is carried out in sealed tanks called hadronic reactors. This synthesis is of industrial importance because it yields 10^{10} BTU of energy per hour (10^{30} ICNS per hour). The electric arc polarizes carbon and hydrogen atoms by forming the C × H × H magnecule, having triplet axial spin coupling. Under a suitable trigger, the magnecule C × H × H should yield a nucleus with A=14, Z=8, $J^{P}=1^{+}$ However, that does not exist (since O (14, 8) has spin J = 0). So, according to Prof. Santilli the nature synthesizes a neutron from proton, electron and etherino [9] (obtained from two magnecular hydrogen) as shown in reaction (5),

$$C \times H \times H \rightarrow C\ (12,\ 6,\ 0) + 2.p^{+} + e^{-} + a \rightarrow C\ (12,\ 6,\ 0) + H\ (2,\ 1,\ 1) \rightarrow N\ (14,\ 8,\ 1) \tag{5}$$

The fusion reaction taking place in hadronic reactor using deuterium as fuel have shown to yield clean energy without formation of any radioactive species or ionizing radiations, hence green.

HADRONIC REACTORS

Hadronic reactors designed by Prof. Santilli are sealed tanks that can withstand high pressure, vacuum and temperature. It is provided with electrodes capable of creating high voltage arc that acts as a trigger mechanism that facilitates nucleosynthesis. The hadronic reactors are classified depending on the reactant or product formed.

The simplest type of the reactor is **hadronic oxygen reactor** as it does not require spin polarizations for the conservation of the angular momentum. 50-50 mixture of oxygen 16 and helium at 3,000 psi, is re-circulated through a 50 kW DC electric arc between carbon electrodes, creating magnecules of the type O × He. The trigger is a pulse DC with 100,000 V and 5 mA and other means. The heat dissipation is done by the external heat exchanger.

The **hadronic nitrogen reactor** uses D_2 gas at 3,000 psi and is re-circulated through graphite electrodes. The reaction taking place in this reactor is similar to reaction (4) occurring in nature during lightning. The reaction in the reactor is triggered by pulse DC of 100,000 V and 5 mA and other means. The heat dissipation is also done by the external heat exchanger.

Apart from this, there are various other types of hadronic reactors such as lithium reactor, helium reactor and so on. Thus, ICNS provides green path for nuclear synthesis as the partially exposed nuclei are magnetically stabilized due to formation of magnecules. This provides an added advantage of nuclei coming near to each other without any appreciable coulomb repulsion, consequently increasing chances of synthesis of a heavier nucleus. However, the reaction needs to be quantified using energetic parameters like reaction cross-section etc.

HADRONIC ENERGY OF PARTICLE TYPE

Hadronic energy of particle type can be further classified as stimulated neutron decay and double beta decay. Low binding energy of ${}^{2}_{1}\mathrm{H}$ and ${}^{9}_{4}\mathrm{Be}$ nuclei results in their photo-disintegration due to 2.22 MeV and 2.62 MeV photons respectively and stimulated decay of neutrons are well-known phenomenon [1]. The prediction and their quantitative treatment can be done by hadronic mechanics. According to Prof. Santilli, neutron is an unlimited source of energy because it decays releasing highly energetic electron and neutrino that can be easily trapped with a metal shield. An isolated neutron is unstable and has half life of ~15 minutes. However, as a constituent of nuclei, it shows high stability which has been attributed to a strong nuclear force of attraction. The neutron as a constituent of a nuclei shows stimulated decay as given in reaction (6)

$$\mathrm{TR} + \mathrm{n} \rightarrow \mathrm{p}^{+} + \beta^{-} \tag{6}$$

where β^{-} has spin zero for the conservation law of the angular momentum.

β^{-} particle can also be considered either as an electron and a neutrino or as an electron and an antietherino with opposing spin ½. This difference is irrelevant for the stimulated decay of the neutron.

MECHANISM FOR STIMULATED DECAY

When a resonating photon hits a nucleus, it excites the isoelectron inside a neutron irrespective of whether the photon penetrates the neutron or not. The excited isoelectron leaves the neutron structure, thus causing its stimulated decay. This is due to the fact that hadronic mechanics predicts only one energy level for the proton and the electron in the conditions of total mutual immersion (as in neutron).

Thus, the excited isoelectron excites the proton and reassumes its conventional quantum features when moving in vacuum. Numerous additional triggers are predicted by hadronic mechanics such as photons with a wavelength equal to the neutron size. Here, the whole neutron is excited, rather than the isoelectron in its interior, but the result is always the stimulated decay.

DOUBLE BETA DECAY

In case of double beta-decay, first reaction is stimulated and the second is spontaneous [9]. For instance, as shown by reaction (7)

$$\begin{aligned} &\gamma_{r}\ (0, 0, 1) + \mathrm{N}\ (\mathrm{A}, \mathrm{Z}, \mathrm{J}) \rightarrow \mathrm{N}\ (\mathrm{A}, \mathrm{Z}+1, \mathrm{J}+1) + \beta^{-}(0, -1, 0) \\ &\mathrm{N}\ (\mathrm{A}, \mathrm{Z}+1, \mathrm{J}+1) \rightarrow \mathrm{N}\ (\mathrm{A}, \mathrm{Z}+2, \mathrm{J}+2) + \beta^{-}(0, -1, 0) \end{aligned} \tag{7}$$

The original isotope undergoes stimulated decay of at least one of its peripheral neutrons via one photon. The daughter nucleus that is formed undergoes spontaneous beta decay so that one photon produces two electrons whose kinetic energy is trapped with a metal shield to produce heat. The original metallic isotope following the emission of two electrons; acquires an electric charge suitable for the production of a DC current between the metallic isotope and the metallic shield. The energy balance is positive. The initial and final isotopes are light, natural and stable elements so that the new energy is clean (since the electrons can be easily trapped with a thin metal shield), and produce non-radioactive waste.

For instance, in case of double beta decay of the Mo (100, 42, 0) as shown by reaction (8)

$$\begin{aligned} &\gamma_r\ (0, 0, 1) + \mathrm{Mo}\ (100, 42, 0) \rightarrow \mathrm{Tc}\ (100, 43, 1) + \beta^-(0, -1, 0) \\ &\mathrm{Tc}\ (100, 43, 1) \rightarrow \mathrm{Ru}\ (100, 44, 0) + \beta^-(0, -1, 0) \end{aligned} \tag{8}$$

Mo (100, 42, 0) is naturally stable with mass 99.9074771 amu whereas Tc (100, 43) has mass 99.9076576 amu and is naturally unstable which spontaneously decays to Ru (100, 44, 0) having half life of 15.8 s. However, daughter nucleus Ru (100, 44) is naturally stable with mass 99.9042197 amu.

Although the mass of Mo (100, 42, 0) is smaller than that of Tc (100, 43, 1), yet the conservation of energy can be verified with a resonating frequency of 0.16803 MeV [9] (obtained for iso-normalization constant, n=1/7). But the mass of the original isotope is bigger than that of the final isotope for a value much bigger than that of the resonating photon, with usable hadronic energy (HE) power nuclear reaction as given below-

$$\begin{aligned} \mathrm{HE} &= \mathrm{M}\ (100, 42) - \mathrm{M}\ (100, 44) - \mathrm{E}(\gamma) - 2 \,.\, \mathrm{E}(e) \\ &= 3.034 - 0.184 - 1.022\ \mathrm{MeV} = 1.828\ \mathrm{MeV} \end{aligned}$$

where Santilli subtracts the conventional rest energy of the two electrons because it is not usable as a source of energy in this case.

Under the assumptions of using a coherent beam with resonating photons hitting a sufficient mass of Mo (100, 42, 0) suitable to produce 10^{20} stimulated nuclear transmutations per hour, the following can be obtained-

- Hadronic production of heat is: 2×10^{20} MeV/h = 3×10^{4} BTU/h
- Hadronic production of electricity: 2×10^{20} e/h = 200 C/h=55 mA

CONCLUSIONS

ICNS seems to be more promising than hot or cold nuclear synthesis in terms of reproducibility and energy input to output ratio. The successful achievement of ICNS with industrial relevance depends on the proper selection of the hadronic fuel.

- The original and final nuclides are light, natural and stable isotope.
- The nuclear syntheses cause no emission of ionizing radiations, hence is green.
- The energy produced ΔE is much bigger than the total energy used by the equipment for its production.

Preliminary studies indicate that stimulated neutron decay as well as double beta decay holds promising results in harnessing clean and green energy.

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