EXTRACTING NUCLEAR ENERGY FROM HEAVY WATER WITH THE AID OF ELECTROCHEMISTRY

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KEYWORDS: heavy water, electrochemistry, low-energy fusion

INTRODUCTION

Heavy water, chemically known as **deuterium oxide**, is usually used as a moderator in nuclear reactors. However, two chemists, Stanley Pons and Martin Fleischmann, reported excess heat four times the energy output by electrolysing heavy water with the use of Palladium and Platinum electrodes and Lithium Deuteroxide as electrolytes. They believed that nuclear fusion occurred in their experiments. (Pons and Fleischmann, Ref.#3)

Did the two chemists made a mistake in their experiments? Or did Ernest Rutherford made a mistake in his theory of thermo-nuclear fusion reaction? Should experiments fit into a conventional theory? Or should theory fit experimental results?

What are the principles underlying nuclear fusion at low temperature?

In this paper, the author explains the theoretical foundations of nuclear fusion at low temperature with the aid of electricity and the new models of nuclear fusion.

METHOD

Electrolysis

The electrolysis of heavy water will yield two deuterium ions (D^+1) and oxygen ions (O^-2). Electrolysis is an endothermic reaction. About 118 kilojoules of energy must be supplied to form one gram of hydrogen. (Masterton p.97)

$$\text{Electricity} + D2O \rightarrow (2D+) + O\text{-}2 \qquad \text{eq.1}$$

RESULTS

Electrochemical Reactions

The following are electrochemical reactions that occur in the Platinum anode and Palladium cathode in the Pons-Fleischmann experiment using the electrolyte Lithium Deuteroxide:

1. Deuterium Oxide (D2O)

Anode : O^-2 → O + 2e- eq.2
Cathode: 2(D^+1) + 2(e-) → D*2 eq.3

2. Lithium Deuteroxide (LiOD)

Anode : (OD-) → O + (D) + 1e- eq.4
Cathode: (Li^+1) + e- → Li eq.5

3. Lithium Deuteroxide (LiOD) and Deuterium Oxide (D2O)

Anode: O-2 + (OD-) → 2O + D + 3e- eq.6
Cathode: 2(D^+1) + (Li^+1)+ 3(e-) → D*2 + Li eq.7

Note: D*2 refers to a diatomic deuterium molecule.

Pons and Fleischmann reported excess heat energy four times the energy output. (Pons and Fleischmann, Ref#3) How is nuclear fusion possible in the Palladium cathode at low temperature/low energy?

DISCUSSION

A. What is the most important factor involved in Low-Energy Fusion?

In **muon-catalyzed nuclear fusion,** the muon (which is more massive than the electron) replaces the electron and induces the fusion of two nuclei. (Steven Jones, Ref. #2). In **electron-catalyzed nuclear fusion,** the electron must have an effective mass which will induce the fusion of two nuclei. (Barbara Levi, Reference #4)

K Capture is an important nuclear process which involves the increase of electron mass. Hence, K Capture is an essential process in electron-catalyzed nuclear fusion. K Capture, therefore, is the most important factor involved in Low-Energy Fusion.

B. What is K Capture?

K Capture is the nuclear process whereby the nucleus absorbs its electron in the K Shell, the nearest energy shell. (Weber p. 868)

C. When does K Capture occur?

Conventional theory states that heat induces K Capture. The author gives an alternative theory whereby electricity induces K Capture.

The author theorizes that K Capture occurs when electricity increases the mass of electron in the K shell at a critical level that the binding energy (hf) needed in maintaining the massive electron in the K shell is not sufficient anymore. Consequently, the repulsive force barrier of the nucleus collapses and the electron is absorbed by the nuclear proton forming a new neutron or, **neo-neutron** (n-1) to differentiate it from the old neutron in the nucleus. Meanwhile, if deuterium undergoes K Capture, the by-product is called **di-neutron** (n-2) which is simply a fused neutron pair.

D. How does K Capture occur?

Let us use Hydrogen as our example. The energy that prevents the absorption of electron by the nucleus is the binding energy of the photon (hf) possessed by the atom. If the Hydrogen atom is treated with electricity, the electron mass will increase in direct proportion to the current amperage and time. The resulting electron that increased in mass is called a **superelectron** or **heavy electron.** As the electron's mass increases, the atom's binding energy (hf) needed in maintaining the heavy electron at the K shell is not sufficient anymore since the kinetic energy of the heavy electron has increased due to an increase of electron mass. The kinetic energy (1/2 mv^2) of the heavy electron has become greater than the atom's binding energy (hf). At a certain critical electronic energy (qV) and critical mass (m) of the electron, the atom's repulsive force will collapse and the heavy electron will be absorbed by the nuclear proton to form a new neutron or **neo-neutron** (n-1). When the nucleus absorbs the heavy electron, the binding energy (hf) will be emitted by the nucleus.

E. An example of K Capture Equation

The reaction-equation of the K Capture of Deuterium is as follows:

$$3\text{MeV} + \text{D} \longrightarrow \text{n-2} \qquad \text{eq. 9}$$

Legend: D stands for deuterium, n-2 stands for dineutron particle.

F. What are the Laws of K Capture?

The author formulates mathematical equations called the Laws of K Capture to explain the mechanism of K Capture as induced by electricity.

i). First Law of K Capture: The new electron mass (m) is equal to amperage (I) multiplied by time (t), then, multiplied by J.J. Thomson's ratio (k) of electronic mass to electronic charge (q).

$$I \times t \times k = m. \qquad \text{eq. 10}$$
$$q \times k = m \qquad \text{eq. 11}$$

The first Law of K Capture was derived as follows:

$m \alpha I$ eq. 12
$m \alpha t$ eq. 13
$m \alpha It$ eq. 14
$m / It = \text{constant}$ eq. 15
$It = q$ eq. 16
$m / q = \text{constant}$ eq. 17
$m / q = k$ eq. 18
$q \times k = m$ (eq. 11)

The first Law of K Capture is called the **Law of Electron Mass Accretion**.

ii). Second Law of K Capture: The net kinetic energy of the absorbed electron is equal to the electronic energy (qV) minus the energy (W) needed to overcome the repulsive energy barrier of the nucleus.

Net K.E. (absorbed electron) = qV– W eq. 19

The Second Law of K Capture is called the **Law of Electronuclear Effect.**

iii). Third Law of K Capture: The net kinetic energy of the absorbed electron is transferred to the new neutron formed. Thus, the net kinetic energy of the new neutron is equal to the net energy of the absorbed electron.

Net K.E.(neo neutron) = Net K.E.(absorbed electron) eq. 20

iv). Fourth Law of K Capture: The net kinetic energy of the neo-neutron formed is equal to the electronic energy (qV) minus the energy (W) needed to overcome the repulsion barrier. From eqs. 12 and 13, we derive:

Net K.E. (neo neutron) = q V – W. eq. 21

v). Fifth Law of K Capture

Now, the following condition show when K Capture will occur or will not occur.

i). If $qV = W$, then K Capture will not occur. eq. 22
ii), If $qV < W$, then K Capture will not occur. eq. 23
iii). If $qV > W$, then K Capture will occur. eq. 24

The author introduced the Laws of K Capture in a paper presented in an international conference in Sta. Fe, New Mexico, U.S.A. (See Reference #1.)

G. What are electro-nuclear fusion models?

K Capture can be used to explain and unify the diverse unconventional results obtained in deuterium-related experiments by Steven Jones, Stanley Pons, Martin Fleischmann, Japanese scientists Yoshiaki Arata and Yue-Chang Zhang, etc.

Let us now introduce the new models of nuclear fusion. These are **K Capture-based nuclear reactions** called **electro-nuclear reactions** to differentiate it from Rutherford's thermo-nuclear reaction models of nuclear fusion:

a.) 3 MeV (electricity) + D*2 → n-2 + D → H-4 → T + n + 6.2 MeV eq. 25
b.) 3 MeV (electricity) + D*3 → n-2 + D2 → He-6 → 2T + 12.4 M eV eq. 26
c.) 3 MeV (electricity) + D*3 → n-2 + D2 → He-6 → He-4 + n-2 + 25 MeV eq. 27
d.) 3 MeV (electricity) + D*3 → n-2 + D2 → He-6 → He-3 + 3n + 4.15 MeV eq. 28

Note the following: **Eq. 9** shows that neutrons are formed but no excess nuclear energy is produced, thereby, explaining the negative energy result in the experiments of **Steven Jones.** (See Ref.#2) Eqs.18 shows that Tritium and neutrons are formed and nuclear energy is produced. **Eq. 26** shows that the energy output is four times the energy input which is exactly reported by **Stanley Pons and Martin Fleischmann** in March 1989. (See Ref. #3.) **Eqs. 27 & 28** show that Helium-4 and Helium-3 and excess energy are produced which explain the experiments of **Yoshiaki Arata and Yue-Chang Zhang.** (See Ref. #5)

H. What about the conventional thermo-nuclear fusion models?

The conventional thermo-nuclear reaction models of nuclear fusion of Ernest Rutherford cannot unify and explain the diverse experimental results of Steven Jones, Stanley Pons, Martin Fleischmann, Yoshiaki Arata and Yue-Chang Zhang.

Perhaps, we have to say good-bye to the following thermo-nuclear fusion reactions:

$$D + D \rightarrow T + p + 4.03\ \text{MeV} \qquad \text{eq. 29}$$
$$D + D \rightarrow \text{He-3} + n + 3.27\ \text{MeV} \qquad \text{eq. 30}$$
$$D + T \rightarrow \text{He-4} + n + 17.59\ \text{MeV} \qquad \text{eq. 31}$$

I. Why is Plasmic State - Hot Fusion unsustainable?

Plasmic State - Hot Fusion Theory is feasible but not sustainable in accordance to the following argument:

a. Let us review the **Ideal Gas Law** which is well-known to chemists and physicists alike (equation 32) :

$$PV = nRT \qquad \text{eq. 32}$$

b. Let us derive "concentration density" from the Ideal Gas Law. How?

Let us define **concentration density** as the number of moles of an element per unit volume. We use the symbols C or n/V for concentration density.

$$n / V = P / R T \qquad \text{eq. 33}$$
$$C = n / V \qquad \text{eq. 34}$$
$$C = P / RT \qquad \text{eq. 35}$$

R is the Rydberg Constant,
P is Pressure,
T is temperature,
n is the number of moles,
V is the Volume.

c. Equation 34 and 35 are called the **Laws of Concentration Density** which is one of the underlying principles of the Low-Temperature Nuclear Fusion Theory or Low-Energy Nuclear Fusion Theory.

d. High Concentration density is more achievable for hydrogen in a gaseous state in a solid state medium rather than hydrogen in a plasmic state confined in a magnetic bottle.

e. Plasmic state- Hot Fusion Theory is a **physical violation** of Equations 34 and 35. Plasmic state- Hot Fusion Theory can never achieve a sustainable nuclear fusion because the high temperature of a plasmic state induces a very low concentration density. Consequently, the probability of nuclear fusion is very low.

Consequently, the physics world must accept the Low-Temperature Nuclear Fusion Theory or Low-Energy Nuclear Fusion Theory.

CONCLUSION

The controversial claims of chemists Stanley Pons and Martin Fleischmann that they achieved nuclear fusion at low temperature in the historic year 1989 is clearly justified on the basis of new models of nuclear fusion called electro-nuclear reactions. Hence, physicists and chemists must welcome the theory of low energy - nuclear fusion and the new electro-nuclear reaction models of nuclear fusion.

We have to say good-bye to Rutherford's thermo-nuclear reaction models of nuclear fusion since the energy input, energy output, reactants and by-products observed in deuterium-related experiments do not commensurate if we use Rutherford's thermo-nuclear reaction models of nuclear fusion.

Indeed, heavy water is a good source of nuclear energy with the help of electrochemistry. Eventually, mankind is assured of a cheap, limitless and clean source of energy.

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