Neutron emission from D_2 gas under magnetic field at low temperature

Tadahiko Mizuno, Kenichi Himoro, Tadashi Akimoto,
Tadayoshi Ohmori, Yoshiaki Aoki[1]

Division of Quantum energy engineering, Graduate School of Engineering,
Hokkaido University, Kita 13 Nishi 8, Kita-ku, Sapporo 060-8628, Japan
1: Center for advanced Research of Energy Technology,
Hokkaido University, Kita 13 Nishi 8, Kita-ku, Sapporo 060-8628, Japan
mizuno@qe.eng.hokudai.ac.jp

Abstract

We observed neutron emissions from pure deuterium gas after cooling in liquid nitrogen followed by compression under a magnetic field. The neutron count, and duration of the release, and the time of the release after treatment was initiated all fluctuated considerably. Neutron emissions were observed in ten test cases out of ten. Compared to the experiments in which neutrons were observed with electrolysis in a heavy water solution, repeatability was highly good and the neutron count was high.

Keywords; neutron, D_2 gas, magnetic field, Low temperature

1. Introduction

In 1989, Fleischmann and Pons (1) reported that excess heat from palladium cathode electrolyzed in heavy water, so-called cold fusion reaction. However, reproducibility and control of the phenomenon have been difficult, and although many researchers attempted to replicate, most failed. If we assume the reaction is some form of a normal d-d reaction, there should be a much higher neutron flux. However, there are few reports of the neutron observations in the literature of (2,3,4,5,6,7,8). The authors have examined many of the reports made until now of neutrons and have reached the following conclusions.

First, neutrons and excess heat are rarely observed, but when they are observed, they occur suddenly after electrolysis and discharge have continued for a long time. Second, many instances have been reported in which these effects began when some triggering reaction occurred. Third, it is well known that almost all cold fusion experiments have been performed by absorbing the deuterium into the reaction system at first; the electrolyte contains almost pure deuterium gas.

Based on these considerations, we conclude the cold fusion reaction must be something quite different from conventional d-d fusion. Furthermore, the reaction must involve factors other than absorption of deuterium. Especially after electrolysis and discharge of deuterium has continued for a long time and the deuterium has been replenished, some trigger is very likely to be added in with it. Also, in view of these considerations, we predict that certain triggers will be needed to give rise to the reaction.

We produced an anomalous neutron burst, using what seems to be a rather simple method. We introduced pure D_2 gas into a glass tube, keeping the pressure at several atmospheres. The glass tube was cooled to the temperature of liquid nitrogen. Then a magnetic field was formed around the tube. At that point, we observed the strong neutron burst.

2. Experiment

Figure 1 shows schematic representation of the measurement system. We used pure D_2 gas for the reaction material. The reaction cell was a Pyrex glass tube of 6mm diameter, 3 mm inner diameter and 100mm in length. Another Pyrex glass vessel of 50mm diameter was put around the reactor tube, and filled with liquid nitrogen. A coil wound in a spiral around the reaction tube produced a magnetic field. The magnet coil is 1.5mm diameter of copper wire, 300m long, and the turn number was about one thousand. The entire system was put inside a stainless vessel with the outer surface insulated by Styrofoam insulation, which in turn was covered with outer stainless steel plates, 1.5mm thick, to prevent electromagnetic noise from reaching the neutron measurement system. Liquid N_2 gas was supplied into the vessel to cool the reactor tube.

The maximum magnetic field was 10kG in the center of the reaction tube. The current for the magnetic coil was supplied by a stable direct current power supply through a resistive wire. The magnetic field passes through the reaction tube along the length. The height of the magnetic coil is 100mm, that is, the same as tube length. The current passing through the coil was changed from 0 to 100A; the intensity of the magnetic field was changed from 0 to 10kG.

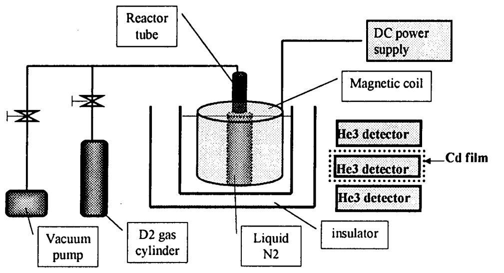

Fig. 1 Schematic representation for the experimental system

Neutrons were measured with three external He3 detectors, each 2cm diameter and 10cm in length, placed around the cell, separated 20cm from the cell. All the detectors were surrounded by cylindrical plastic neutron moderators, 12cm diameter and 15cm high. The detectors were placed inside cylindrical moderator, with the open end of the cylinder facing the cell. To reduce noise, the detectors were covered by electromagnetic shielding. After calibration, neutrons and noise were distinguished by covering one of the detectors (C-Cd) with 0.5-mm thick Cd film. A neutron entering through the plastic moderator will lose energy and be absorbed by the foil, while electromagnetic noise easily passes through the Cd material. The detectors were calibrated with a standard Cf252 neutron source (2.58 x 10^4 decay/s).The background count was estimated as under 0.008 ± 0.003c/s. A typical count under these conditions was 5 ± 1c/s from the standard neutron source. This means the total counting efficiency is estimated as 0.0002.

3. Result

The reaction was triggered by a dynamic change in experimental conditions. A particularly striking example is shown below. Fig. 2 shows the background counts after the reactor tube was cooled with liquid N2, but before deuterium gas into the tube or a magnetic field was imposed. The background count for each 10min was 1.61 +/- 0.5 counts.

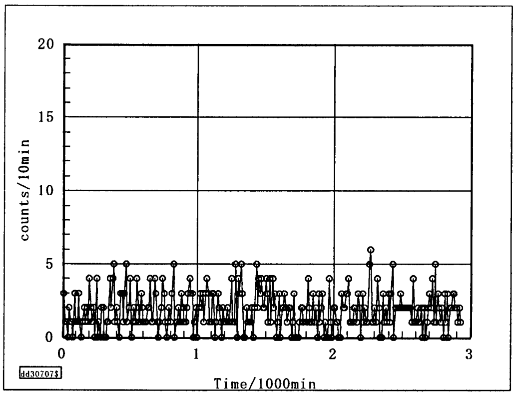

Fig. 2: Background neutron count

The number of the background count and the fluctuation were same in the absence of one or two of the three factors: the deuterium gas in the reactor tube, the magnetic field and cooling by liquid nitrogen.

Figure 3 shows the typical neutron counting rate in 10min after 3 atmospheres of D_2 gas filled the tube, a magnetic field of 8kG was imposed, and the cell was cooled in liquid nitrogen. The magnetic field was changed to 10kG at 1200s, by increasing the current. About 20 seconds, a low-level neutron emission began, and after 50 seconds, a sudden neutron burst was observed. In this experiment, the reactor tube was filled with the pure deuterium gas up to 3 atmospheres, and the liquid N_2 was put into the vessel holding the reactor tube, and the magnetic field was imposed in the last step. In other experiments, these steps were taken in a different order. In this example, cooling of the deuterium gas was continued for a considerable time and neutron emission was sporadically observed when the electromagnetic field was changed. However, in other runs, neutron emissions were observed immediately after liquid N_2 was added.

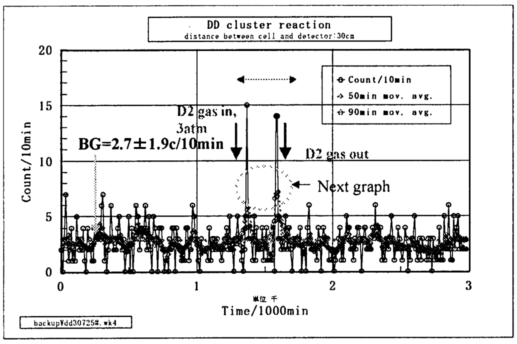

Fig. 3: Typical neutron counts averaged 2 counters for 10min, D_2, 8kG and liq. N_2 temp. C-Cd showed no increase. of neutron.

Figure 4 shows the neutron count that was calculated from Fig. 3. Here, the neutron emission occurred in a few seconds. Fig. 3 was not exact because the count rate was averaged in 10min segments. Fig. 4 shows the burst that occurred from 1300s to 1600s in Fig. 3. The neutron burst of 5.5c/s is 1000 times higher than the background counts. Bursts occurred twice within 300 seconds. The total neutron emission can be estimated from the counting efficiency of 1.7% and geometrical factor of 1.18%, and it is 27500c/s.

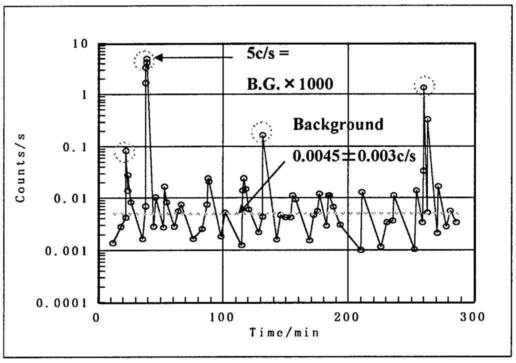

Fig. 4: Recalculated neutron count for Fig. 3.

Figure 5 shows another typical result of neutrons emitted when the tube was first supplied the magnetic field and then cooled by liquid N_2. Here, the neutron emission occurred immediately after liquid N_2 was added. The count rate increased up to a peak within a few seconds and decreased a few seconds later. Total neutron emission for this brief period is estimated as 5×10^5. However, no more neutron emissions were observed after that, even when the input magnetic current was increased up to 100A for 4000s. In other examples, the total neutron count ranged from 10^4 to 10^5, and emissions lasted 1 ~ 4000 s. All cases were marked by a characteristic high level of neutron emissions at first, which gradually declined.

Figure 6 shows the neutron count that was calculated in the burst time from Fig. 5. Here, it shows the neutron burst during 0s to 120s in Fig. 5.

Figure 7 shows the case of hydrogen gas under 8kG of magnetic field at −196℃. First, the tube was evacuated and the magnetic field was fixed at 8kG. After that, at 220s, hydrogen gas was introduced into the tube, and the hydrogen gas was removed at 3430s. No neutron burst was observed during the time hydrogen gas was present in the tube.

Figure 8 shows an example where the temperature was kept at room temperature, 20℃. Deuterium gas was kept in an 8kG magnetic field.

The neutron emission measurements under various conditions are shown in Table 1. The necessary condition to make the neutron burst was deuterium gas, magnetic field and temperature. Neutrons were not generated when one of these conditions was not met. The generation of the neutron when the intensity of magnetic field was changed has not been examined systematically. We usually kept the intensity of the magnetic field constant to avoid noise from the current change and magnetic influence on the measurement system. We cannot reach a conclusion about correlation between the magnetic field intensity and the neutron emission. However, when a magnetic field was not imposed at all, neutrons were not emitted. We conclude that deuterium gas, a magnetic field, and a low temperature are all necessary for the neutron generation.

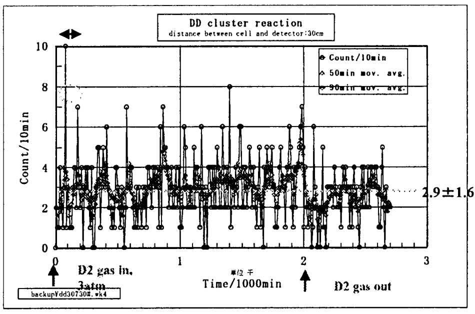

Fig. 5: Averaged neutrons count for 10min.

Neutron emissions from the cooled D_2 gas following a change in a magnetic field are very difficult to explain by the models proposed heretofore, which involve d-d fusion reactions. These models assume that neutron emissions occur when deuterium gas alone is present; they suggest nothing about a magnetic field or low temperature; and they predict that emissions must be accompanied by excess heat and tritium production.

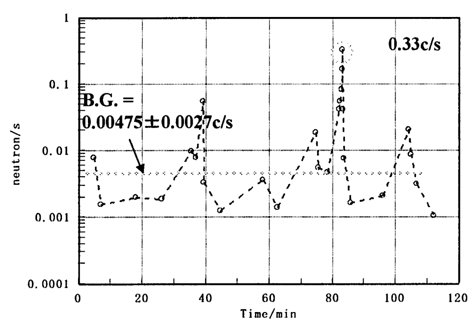

Fig. 6: Recalculated neutron count after supplied the magnetic field of 5kG; the tube was filled with 3 atmospheres D_2 gas under room temperature and cooled to liquid N_2 temperature. After tube was cooled by liquid N_2, the neutron emissions suddenly occurred.

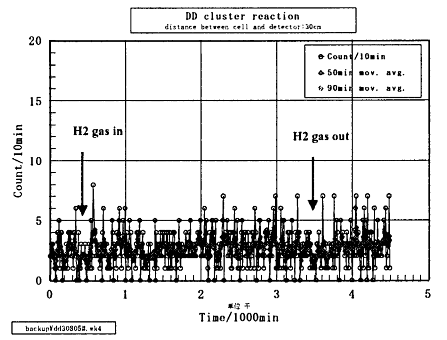

Fig. 7: Neutron count for H_2

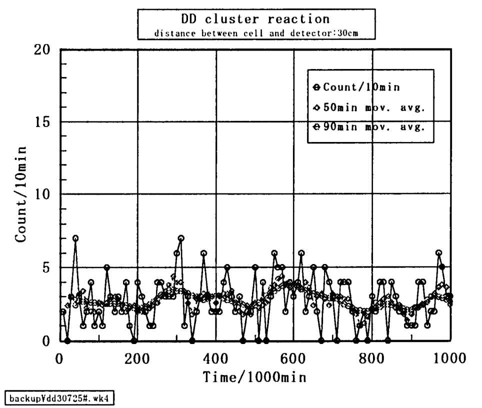

Fig. 8: Neutron count for D_2 gas at normal temperature.

The reaction we observed came about after cooling by liquid temperature in the magnetic field, and the reaction appears to be highly reproducible. We conclude that the models proposed heretofore based upon d-d reactions are inadequate to explain our present results, which must involve the magnetic field for the nuclear reactions.

4. Discussion

Many theoretical models have been proposed to explain anomalous results from cold fusion or LENR (Low Energy Nuclear Reactions) as it is now sometimes called. That no observable fusion rates (e.g., d+d fusion rates) can take place in stationary states of metal deuterides is almost proved. Possibilities may exist in transient states of deuteron motion in solids (9,10,11). If we require a very drastic enhancement of any fusion rates that can reach the observed heat level, the following three conditions should simultaneously be fulfilled:

1. A dynamic mechanism should exist for forming close clusters of more than two deuterons within 0.02-nm (comparable to a de Broglie wavelength of 1-eV deuteron) space in solids.
2. Quantum mechanical tunneling through the Coulomb barrier, i.e., barrier penetration probability should be enhanced very much, should be more than 10^{-6}. In other words, we need super screening. To depress the Coulomb repulsive potential this much, squeezing of quasi-free electrons in metal deuterides during the transient dynamics should occur in local points where deuteron clustering is taking place.

The present LENR experiment result can be explained by the following mechanism. The deuterium atom that was coherent in a metal forms a cluster, and it induced the nuclear transmutation, and generated heat and other products. Deuteron causes the D-D nuclear reaction under a specific condition and formed the D-cluster in the metal. The cluster generated a nuclear reaction by a collapsing reaction and then generated a light element (atomic weight 3-12). At the time, a magnetic flux was spontaneously emitted from the reaction and caused a nuclear transmutation on the host metal atom. The generation of excess heat is considered followed product of the nuclear fission of a metal atom by a nuclear collapsing of D-cluster and the transmutation.

Neutrons are assumed either to be present in the lattice within a stabilizing structure (12) or to be created by collapse of an electron (13,14,15,16,17,18,19,20,21,22) into the nucleus of a hydrogen or deuterium. The latter collapse makes a di-neutron (23,24) The importance of a neutron presence is suggested by the unusual effects observed when an external neutron flux is applied to electrolyte cell. (25,26,27,28,29) Apparently, the environment acts like a neutron amplifier. In addition, one might ask why more neutrons are not detected, as they are being released or created within the cell, especially when thin cathodes are used?

Fisher (30,31) has proposed that large, stable neutron clusters can form and that these can attach themselves to normal nuclei to produce super-heavy atoms. A small concentration of such atoms is proposed to be present in all matter. Under the right conditions, these neutron clusters are released, thereby causing novel nuclear reactions. The work of Oriani (32) supports the existence of super-heavy carbon in electrodes subjected to chemical assisted nuclear reaction processes.

5. Conclusion

We have confirmed clear neutron emissions from pure deuterium gas after cooling in the liquid nitrogen followed by compression by the magnetic field. The neutron count and duration of the emission and the time during test was fluctuated considerably. The repeatability of the phenomenon was excellent and the neutron count was high.

Table 1. Neutron counts in various conditions

Gas	Magnetic field	Temperature	Neutron counts
Air	8kG	20℃	0.60c/min
Air	8kG	-196℃	0.58c/min
Vac.	5kG	20℃	0.59c/min
Vac.	8kG	-196℃	0.54c/min
H2	8kG	20℃	0.52c/min
H2	8kG	-196℃	0.82c/min
D2	8kG	-196℃	5c/s

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