Energy of the Neutrons Emitted in Heavy Water Electrolysis

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ABSTRACT

The Low/High pulse mode electrolysis has been introduced to carry out the experimental study to clarify the dependency of the L/H pulse modes operation of electrolysis on the neutron emission from the Pd cathodes. Among 6 runs of the electrolysis of L/H pulse mode operations, 3 of them gave appreciable neutron emission. The neutron energy spectra were found to have the two compornents (2.45 MeV peak and a broad band in higher energy region). The intensity of the 2.45 MeV neutron is smaller than that of the higher energy.

1. Introduction

To elucidate the mechanism of the neutron emission in the heavy water electrolysis, we have carried out a series of experiments for 3 years [2,3]. In the series, the constant current electrolysis of the heavy water was employed with different shapes of Pd cathode. In some cases, the anomalous neutron bursts were observed. But the reproducibility has been found to be very poor.

In the present study, the Low/High pulse mode electrolysis reported by Takahashi has been employed [4]. He reported that the L/H pulse mode elestrolysis gave the weak neutron emissions with a high reproducibility and the energy of neutrons consists of a 2.45MeV neutron component and a higher energy component. This pulse mode electrolysis has been introduced to carry out the experimental study to clarify the dependency of the neutron emission from the Pd cathodes on the L/H mode operation of electrolysis. The L/H pulse mode employed in the present work was modified from Takahashi's mode in the pulse repetition period and in the current density, and different shape of the Pd cathode was also employed.

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2. Experimental

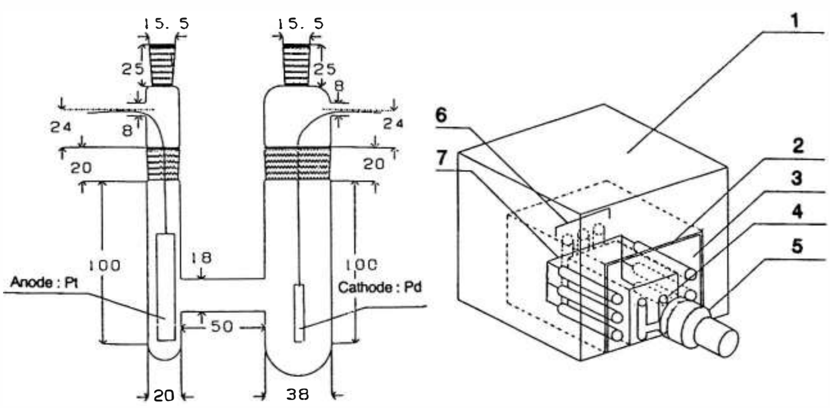
The electrolysis cell is shown in Fig. 1-a. The cell was made of quartz, and its capacity is about 170 cm^3.

Pd cathodes were preloaded with D_2 gas before use. After annealing of the Pd sheet, D_2 gas absorption was carried out repeatedly. After this process, the Pd sheet was placed into the cell and the electrolysis was initiated. In the present experiments, D/Pd ratios were estimated in two methods, one is mass difference method and another is pressure difference method between before absorption D_2 gas and after. The electrolyses were mainly operated with the rectangular pulse mode with rather short repetition period of one hour.

The arrangement of the cell, neutron detectors, and the shielding materials are shown in Fig. 1-b. Enclosing the test cell, three neutron detection systems are employed. One is composed of six ^3He counters, the second is three ^3He counters, and the last is the NE213 liquid scintillation counter (5x5 inches) to measure recoil-proton enrgy spectrum for the fast neutron events with a multichannel analyzer. The background neutrons were slowed down and captured in the solution of borric acid and in a polyethylene shield with cadmium sheets.

An example of the raw data obtained from the three neutron counting systems is shown in Fig. 2. The upper chart shows the signals from the two ^3He counter systems and the lower chart is for the neutron energy spectrum from the NE213 counter. The relation between the neutron energy and the channel number of the multichannel analyzer has been calibrated by use of O5S code [1].

The signal intensities from the two ^3He counter systems are so small, as shown in Fig. 2, to identify the occurence of the neutron emission. In the spectrrum obtained from NE213 spectrometer shown in the lower part, a small but appreciable



UNIT: mm

(a) (b)

Figure 1. (a)Electrolysis cell.
(b)Arrangement of cell, neutron detectors, and shielding materials.
1. Solution of borric acid. 2. Cadmium sheet. 3. Polyethylene shield. 4. Cell. 5. NE213 detector. 6. ^3He counter(channel 1) 7. ^3He counter(channel 2)

edge of the recoiled protons was found at around 2.45 MeV. This edge has not been detected in the background run. The data obtained from NE213 spectrometer were analyzed statistically to evaluate the neutron emission throughout the present study. Even so, the signals obtained by the NE213 detector were so weak to evaluate the neutron energy directly from the spectrum as shown in the figure. The same statistical analysis method reported by Takahashi [5] is employed to evalutate the neutron energy spectrum from the present data. In this analysis, the foreground /background ratios were calculated in each 29 bins for 1024 channels of the PHA. The background data were obtained from the light water electrolysis. When the ratio is over unity, it is concluded that the neutron emissions were detected by the NE213 detector.

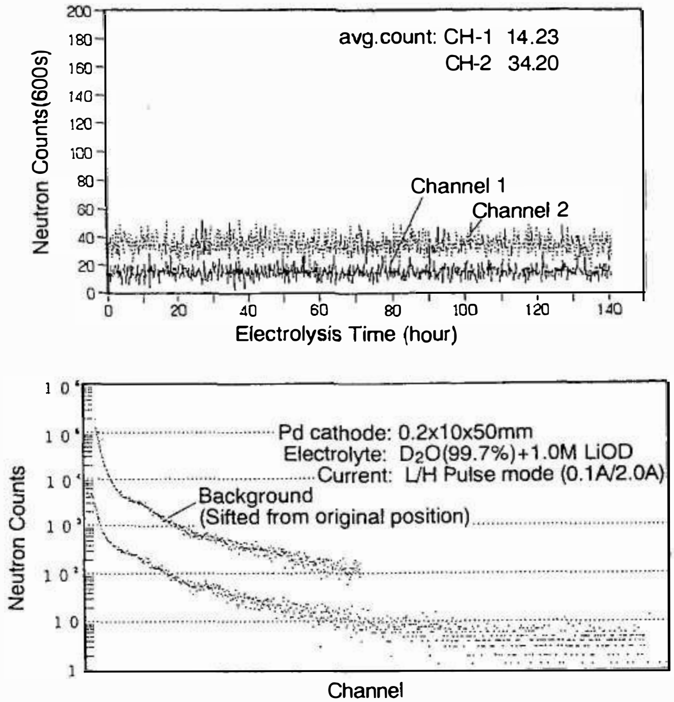


Figure 2. Examples of the neutron counting raw data.
Upper chart : Signal from the ^{3}He counter system.
Lower chart : Neutron energy spectrum from the NE213 detector

3. Results and Discussion

Table 1 shows the summary of the experimental condition - D/Pd ratio, Pd cathode's size, and the current density. The shapes of all Pd cathodes are plate. Among 6 runs of the electrolysis, 3 of them gave appreciable neutron emissions. We confirmed that run 1, run 2, and run 4 were positive experiments.

Table 1. Experimental Condition and Results

Run Number	Size(mm)	L/H Current Density (mA/cm^2)	D/Pd	Neutron Emission
1	0.2x10x50	10/200	2	Yes
2	0.1x10x50	10/200	0.8	Yes
3	0.2x50x50	2/40	0.74	No
4	0.2x10x50	10/200	0.77	Yes
5	0.5x10x50	10/200	0.64	No
6	0.5x10x50	10/300	0.60	Yes

The analyzed data for run 3 are shown in Fig. 3. This run is approximately even in the neutron counts between background and foreground. The abscissa of the graph represents the recoiled proton energy (channel number). The ordinate represents the pulse-height ratio of NE213. In this graph, the ratio is about 1. This indicates that this run was negative.

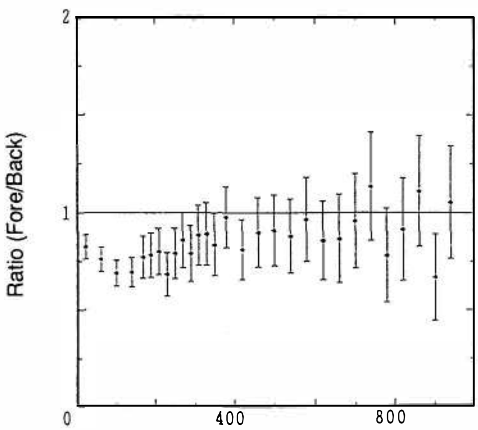


Figure 3. The analyzed data of NE213 detector from run 3

The analyzed data for run 2 are shown in Fig. 4. This run was positive. Lower channel peak indicates the 2.45MeV neutron emission, and higher channel peak indicates the higher energy neutron emissions. The analyzed data for run 1 are shown in Fig. 5-a. This run is also positive. It is seen in these two runs that the neutron emissions at 2.45MeV are smaller than that of the higher energy neutrons. The analyzed data for run 4 are shown in Fig. 5-b. This run is also positive. In this graph, the peak of 2.45MeV neutrons is clear, but the peak of higher energy neutrons is not so clear.

In the present study, we detected the weak neutrons emissions. The energies of the neutrons are 2.45MeV and higher. The relation betweens the neutron emissions and the experimental conditions are shown in Table 1. The relation between emissions and the D/Pd ratio indicates that the D/Pd ratio over 0.77 is necessary to observe Cold Fusion.

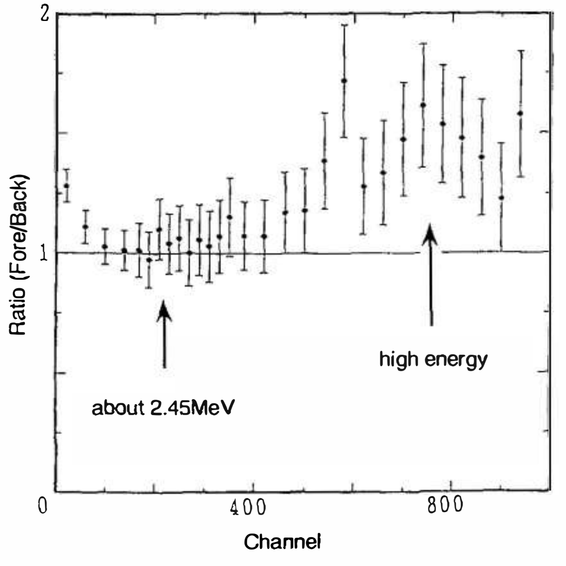


Figure 4. The analyzed data from NE213 detector in run 2.
Data collection for 144 hours after electrolysis started.

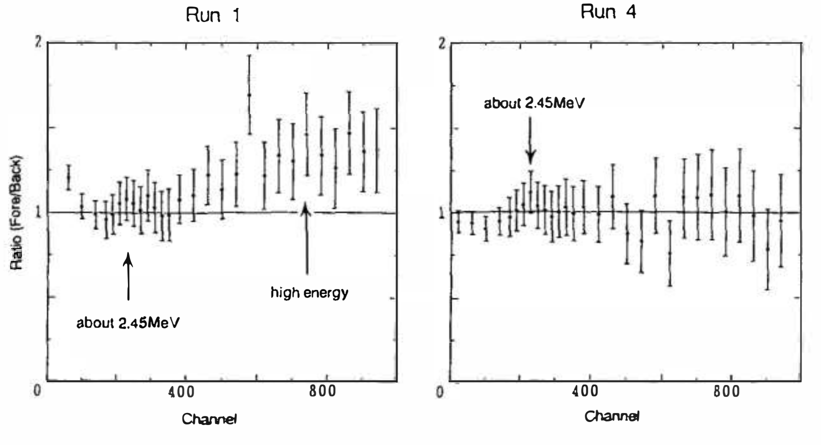


Figure 5. (a)The analyzed data from NE213 detector in run 1
(Data collection for 144 hours after electrolysis starts).
(b)The analyzed data from NE213 detector in run 4
(Data collection for 152 hours after electrolysis starts).

Concerning the relation between emissions and the current density, it is concluded the current density over 120mA/cm^2 is necessary to observe Cold Fusion. D/Pd ratios of run 1 are the extreme case. We observed two compornents of the neutron energy. This fact suggests the possibility of the existence of the unknown nuclear process in the present electrolysis.

4. Conclusion

We performed the heavy water electrolysis with Low/High pulse mode to improve the reproducibility. In this experiment, the reproducibility was 50 percents. The weak neutron emissions with energy of 2.45 MeV and the higer (3-7 MeV) were observed. The intensity of 2.45 MeV neutrons is smaller than that of 3-7 MeV. To observe "Cold Fusion", the high D/Pd ratio (in our study : over 0.77) and the high current density (over 200 mA/cm^2) are needed. The present study completely comfirms the findings on the neutron energy reported by Takahashi et al. [4,5].

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6. References

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