Periodically Current-Controlled Electrolysis of D_2O/Pd System for Excess Heat Production

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ABSTRACT

For the purpose of clarifying the correlation between current density and excess heat production in the D_2O/Pd electrolysis, a new measurement system with an open type calorimeter was constructed. An electrolysis cell was specially designed and applied current was changed every few hours. Some palladium plates were electrolyzed with various current densities. A slight excess heat was observed during step-up mode electrolysis of the palladium plate called the 1st batch. No excess heat was observed with other palladium plates. Though the relation between applied current patterns and excess heat level was not clear, this study suggests that palladium material feature has an important role in excess heat production.

Introduction

It has been suggested[1)] that excess heat occurs near surface of Pd cathode. However, the correlation between current density and excess heat level is not clearly understood in the recent studies of cold fusion phenomena[2),3)]. The purpose of this study is to find a critical current density and appropriate current patterns which may trigger the excess heat production or enhance Pd/D ratio in palladium cathode. In the electrolysis, applied current is dynamically changed every few hours to scan various current densities. An open type calorimeter is specially designed to obtain rapid thermal response of the applied power. Multi-point measurement system is also established for the accurate

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evaluation of heat level.

Experimental

Figure 1(a) shows the illustration of an open type calorimeter for an electrolysis cell (D_2O/Pd + 0.3 mol/l LiOD). The cell and the measurement system are specially designed for the periodic electrolysis. An external cooling apparatus is installed to obtain rapid thermal response of the calorimeter. The temperature of water coolant is controlled to be 20°C±0.05°C. The influence of thermal gradient is minimized by a mechanical stirrer and multi-point measurement. Three thermocouples are installed to monitor electrolyte temperature at the top, middle and bottom of electrolyte. Another two thermocouples are installed in the inlet and outlet of cooling glass tube. The difference of coolant temperature is monitored to cross-check heat level. All the thermocouples are sealed with teflon coating.

The electrode assembly is shown in Fig. 1(b). The cathode is palladium plate (25mm x 25mm x 1mm) that was supplied by Tanaka Kikinzoku Kogyo K. K.. The anode is platinum wire mesh (25mm x 40 mm, 50 meshes/inch) that is attached on both sides of the cathode with 6mm spacing. This mesh anode is intended to uniform the deuterium charge into the palladium sheet. This assembly is set in the central part of the cylindrical cell.

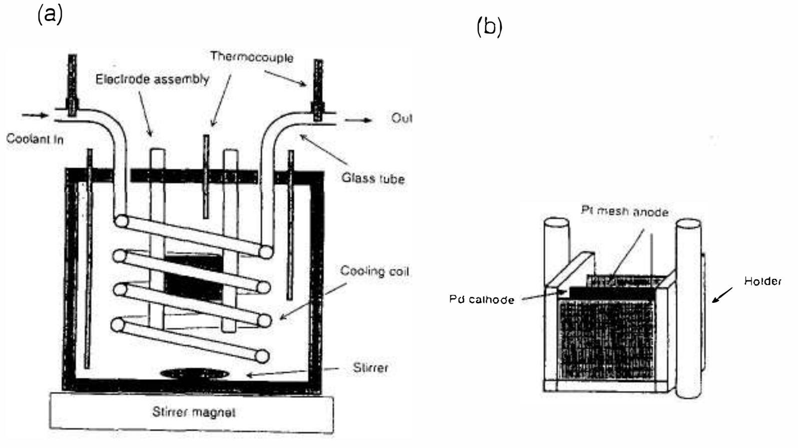

Fig.1(a) Cross sectional view of the calorimeter.
(b) Electrode assembly with an acrylic holder.

A gold plate is substituted for the palladium cathode and electrolyzed to obtain a calibration curve from 0.4 W to 120 W. Another calibration curve is obtained from the difference of the coolant temperature between inlet and outlet. Measured temperature is converted into heat power level.

Results

Some palladium plates called the 1st, 2nd and 3rd batch were studied using this calorimeter and current patterns were changed respectively.

(a) Low-High electrolysis mode (L-H mode)

The palladium sheets of the 2nd and the 3rd batch were loaded with deuterium by L-H mode. Low current (30 mA/cm²) and high current (300 mA/cm²) were applied alternatively in each 5 hours interval. The amplitude of the input power ranged from 0.4 W to 60 W. Figure 2 shows the experimental result of L-H mode. Measured electrolyte temperature was converted into output power by the calibration curve. The bar shown in the figure indicates the output power including ±1 watt error level of this system and broken line indicates input power. No excess heat was observed with each palladium batch during one month run.

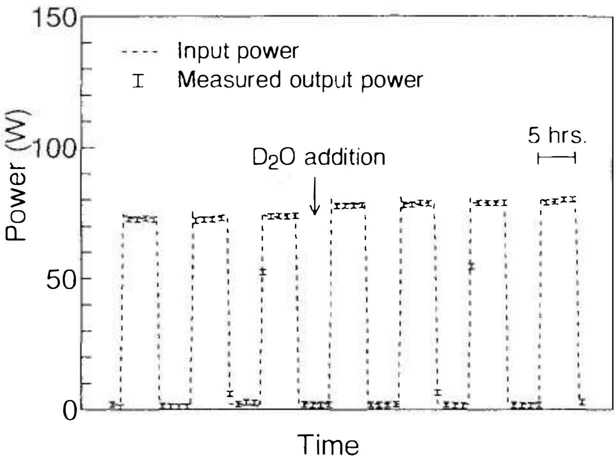

Fig.2 Experimental result of L-H mode (3rd batch)

(b)Step-up mode

Step-up mode electrolyses were performed for the 1st and the 3rd batch Pd cathodes. The current density was stepped up with 2 hours interval from 30mA/cm² to 400 mA/cm² in 6 steps and this cycle was repeated. One of the experimental results of step-up mode electrolysis is shown in fig. 3. A slight excess heat was observed during the electrolysis of the 1st batch Pd. Excess heat level was about 2 W (3 % excess level). However, no excess heat was observed with the 3rd batch.

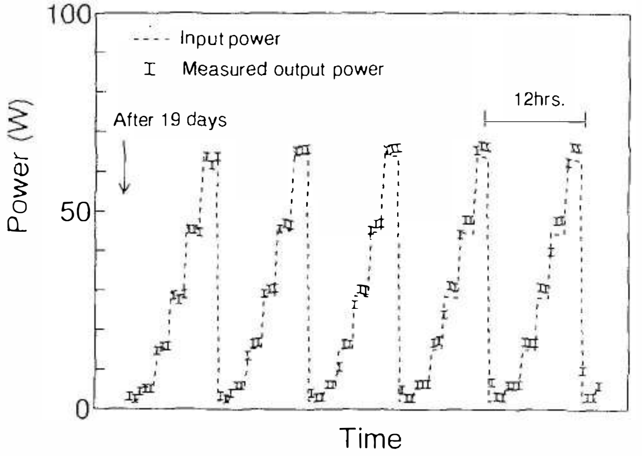

Fig.3 Experimental result of step-up mode (1st batch)

Conclusion

Cell temperature was slightly different at each point. This shows that thermal flow is produced by the bubbling, stirring and thermal conductivity effect in the cell. Since thermal flow path becomes unstable due to turbulent flow in electrolysis for long run, multi-point temperature measurement should be needed and total heat level must be calculated by the integrating heat levels at various points in the cell, so as to make calorimetry in precision.

Slight excess heat was observed during one month electrolysis by using the 1st batch palladium. Although the 3rd batch was treated with the same way of the 1st batch, no excess heat was observed. The relation between applied current density and excess heat production has not been clarified. On the experiments using the 1st batch and the 3rd batch, it is suggested that palladium material feature will have a important role in excess heat production. Qualification of Pd metal fabrication should be established to obtain systematic excess heat data.

Reference

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2) A. Takahashi et al., Int. J. Appl. Electromag. Mat. 106, 1-10 (1992).
3) M.C.H. McKubre et al., "The science of cold fusion" Proc. ACCF2, p419-443 (1992).