



Research Article

Unexplained Explosion During an Electrolysis Experiment in an Open Cell Mass Flow Calorimeter

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Abstract

While running an electrochemical cell designed to measure excess heat with a hollow palladium cathode and a platinum wire anode in heavy water, an explosion occurred. The Dewar that contained the experiment shattered. It is unlikely that the explosion was due to a deuterium oxygen recombination explosive reaction, since the cell was open, the amount of deuterium and oxygen gas was very limited in the cell and any pressure created by recombination should have escaped through the unsealed open end of the cell. It is very likely that under some not yet understood conditions, chain reactions occur in highly loaded palladium samples giving rise to an explosion. Several experimentalists before have already observed this same phenomenon.

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1. Introduction

Pons and Fleischmann [1,2] have shown that performing the electrolysis of heavy water in the presence of LiOD, with palladium cathode and platinum anode, excess enthalpy is observed that cannot be explained by normal chemical reactions. Later they worked on a cell that worked continuously in the boiling regime [3]. The idea of working at 100°C is coming from their observation that there is a positive feedback with temperature. The higher the temperature, the more excess heat was observed [4]. The experiment described in this paper has been designed to operate anywhere from room temperature to boiling with low input power. In the course of an experiment using a palladium tube as a cathode, an explosion occurred, and the whole cell got shattered into pieces. The conditions of the explosion cannot be explained by deuterium oxygen explosive recombination.

2. Experimental set up

The Pyrex electrolytic cell is a Dewar 50 cm long, 25 mm inner diameter, 40 mm outer diameter as shown in Fig. 1. Both Pyrex walls of the cell are 2.5 mm thick. The electrodes and the electrolyte are positioned in the bottom section.

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In the upper section, a coaxial water-cooled condenser 31 cm in length, 22 mm in diameter absorbs the heat produced during electrolysis by condensing the water vapors due to the heat generated by electrolysis and also possible excess heat. Power output is calculated with the water mass flow circulating in the condenser and the difference between inlet and outlet temperatures. Temperatures are measured via two thermistors. The condenser is laying by its own weight on the upper part of the Dewar cell. It is not sealed.

The cathode is a 10 cm hollow palladium tube 2 mm outer diameter and 200 μm thick walls closed at the bottom, opened at the top. The anode is a 200 μm diameter platinum wire wrapped around the cathode. The electrolyte is 0.1 N LiOD in D₂O. The volume of electrolyte is at most 100 ml. In case the cell runs dry, this is also the maximum amount of D₂ and O₂ gases present in the cell and available for a chemical explosion.

Data are collected via a Labview software with a frequency of one set of data points every minute. Therefore, events occurring in a shorter time scale are not recorded.

The temperature of the electrolyte is not measured. The only thermal data available is the outlet temperature of the cooling device. The time constant of the heat measurement is about 10 min.

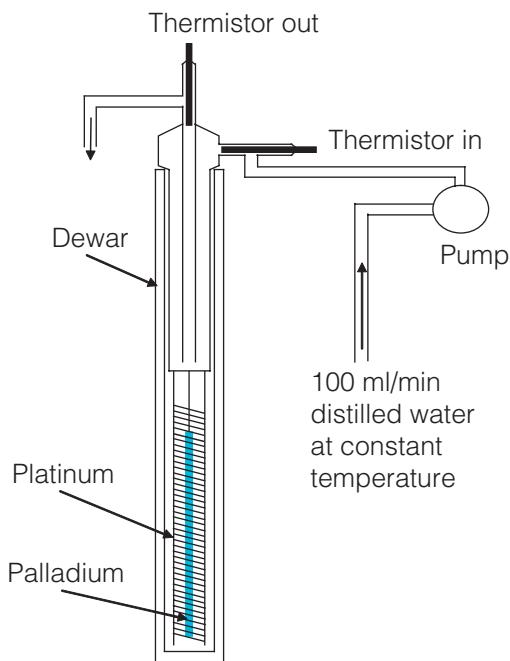


Figure 1. Schematic of the electrolytic cell.

3. Experimental results

The experiment lasted 30 days, and ended by the explosion of the cell. Figure 2 shows input and output power versus time.

In the first part of the experiment, the current applied is increased up to an input power of 34 W (3 A, 13.2 V). No excess heat is observed during this time period. Input power is then decreased and increased again with observation of

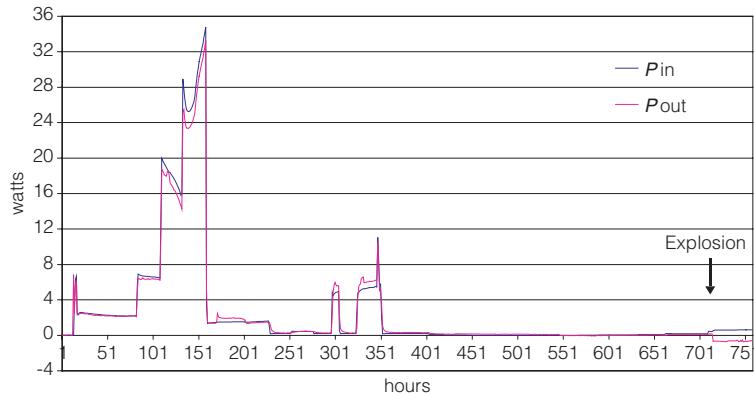


Figure 2. Power in and out (W) vs. time (h).

excess heat. Finally the input power is decreased and slowly increased again. However, when the explosion occurred, the current was only 0.2 A and 3.7 V. After the explosion the current remained the same, since the power supply was operating in constant current mode, however, the voltage increased to 4.5 V because there was still some electrolyte left at the bottom of the cell.

Figure 3 shows details of voltage and current at the time of the explosion. The explosion occurred 5 h after the current was raised from 0.1 to 0.2 A. The voltage increased with the current, then decreased steadily until the explosion. This is possibly an indication of a temperature rise in the cell, and probably simply correlated to the power increase inside the cell. There is no abnormal behavior in the voltage just before the explosion. It is not possible to know the exact level of electrolyte present in the cell at the time of the explosion, but probably low, knowing that no heavy water had been added in order to compensate for any loss by electrolysis.

Figure 4 shows the photographs of the cell and the Dewar before the explosion, and the condenser with the attached

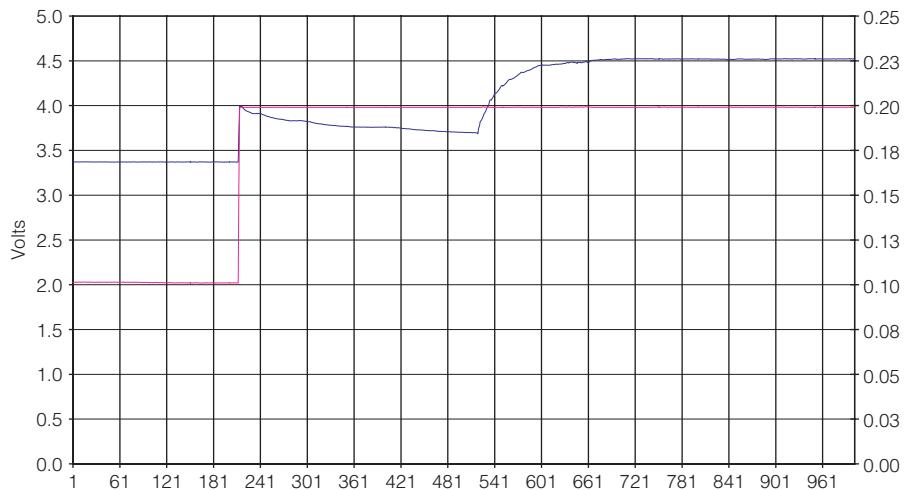


Figure 3. Details of voltage and current at the time of the explosion.



Figure 4. Top: a view of the Dewar. Bottom: views of the condenser and the cathode anode.

anode and cathode after the explosion. Figure 5 shows a picture of the remains of the Dewar after the explosion. As data points are acquired every minute, there was no indication of any change at the time of the explosion. Moreover, the cell temperature is not measured, only the water flow temperatures are monitored. The overall heat measurement time constant of the system being 10 min as mentioned above. Any sudden excess heat rise could not be detected.



Figure 5. Remains of the Dewar cell after the explosion.

It is very unlikely that the explosion was due to a deuterium oxygen recombination. As mentioned above, the amount of gases in the cell that could produce an explosion was only 100 ml. It is hard to believe that the Dewar will breakup by a recombination reaction knowing that the cell is not sealed.

In order to check the possibility of a violent recombination of deuterium and oxygen gas, an experiment was set up. A similar Dewar with similar electrodes was used. In addition a platinum wire was added on top of the cell where a current could be passed so that a gas explosion could be triggered. Electrolysis was performed long enough to make sure that there was no more air in the cell, and that only hydrogen and oxygen remained. The first test produced an explosion that raised the inner part of the cell by about 2 cm. The second experiment was performed in a similar fashion except that before triggering the explosion, the top of the cell was sealed with silicone glue. When the explosion was triggered, no damage was observed on the cell.

4. Conclusion

On several occasions, experimentalists have endured explosions. Pons and Fleischmann [5] have told that in one case, the palladium melted and fell down, producing damage on the concrete floor of their garage, Zhang et al. [6] using a hollow tube palladium cathode observed three explosions in an open cell. On January 2, 1992, an unfortunate explosion also occurred at SRI in a closed cell [7,8] that killed a scientist. The explosion was attributed to an oxygen deuterium violent recombination. More recently, 13 years later on the same day on January 2, 2005, Mizuno [9] experienced an explosion in an open cell that wounded him and deafened him and co-workers for several days.

These explosions seem to indicate that under certain circumstances, a sort of chain reaction is possible, and large quantities of heat are produced in a very short period of time. This type of behavior recalls heat bursts that are regularly observed during Cold Fusion experiments, and that are not reproducible. It seems that there are two regimes in Cold Fusion, one is steady at low level of excess heat, and the other one is fast and energetic.

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