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Research Article

Pressurized Plasma Electrolysis Experiments

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Abstract

We have performed a plasma electrolysis experiment for the first time at a pressure of 5×10^5 Pa in a specially designed calorimeter. The cathode was a 2 mm tungsten rod, and the anode was a stainless-steel foil. The electrolyte was 0.6 mol K_2CO_3 in light water. In one instance, we observed excess heat of 20 W for 90 min.
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1. Introduction

In recent years, plasma electrolysis has gained much interest for several reasons: it is easy to implement at a low cost, and very spectacular when the plasma ignites in water. However, in spite of the easy implementation, the measurements call for a lot of care. Ohmori and Mizuno [1] demonstrated the production of excess energy, neutrons and transmutation in a plasma electrolysis experiment with a tungsten cathode in K_2CO_3 light water electrolyte. Mizuno et al. [2] confirmed excess heat production. Mizuno et al. also [3–5] showed an increase in the production of hydrogen by a factor of 80 compared to the Faraday law, due to thermal dissociation of water vapor at high temperature during plasma electrolysis. In some experiments they measured excess heat. Cirillo and Iorio [6], and Cirillo et al. [7] showed by

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Scanning Electron Microscopy the formation of new elements on a tungsten cathode. Mizuno et al. [8], Fauvarque et al. [9] showed the production of excess heat. Cirillo et al. [10] have measured neutron emission during plasma electrolysis, but this was not confirmed by Faccini et al. [11].

This type of experiment has several attractive features: first of all it is very spectacular with the formation of bright plasma in water, which is a show by itself. Second, the cost is low, since it calls for ordinary water, inexpensive K_2CO_3 electrolyte, and standard tungsten welding rods. The power supply can be as simple as the main voltage coming from the wall rectified to produce a more or less direct current voltage.

The results obtained in the various experiments are of four kinds: excess heat; abnormal production of hydrogen; neutrons; and transmutation. Even though the experiments are easy to perform, the various parameters are not simple to measure. Because the plasma is unstable, at constant voltage the current varies greatly, and it becomes difficult to measure the electric input power. Also, it is complicated to measure the heat production, because it comes from the temperature rise of the electrolyte and its evaporation. One of the key issues is the risk of water droplets that are splashed out of the cell in liquid form, and then mistakenly accounted for as vapor, giving rise to a faulty excess heat. Measuring neutrons is not easy, since they are scarce, and they are absorbed by the water. They have been detected only by placing CR39 near the cathode. Finally, the presence of what appear to be new elements could very well

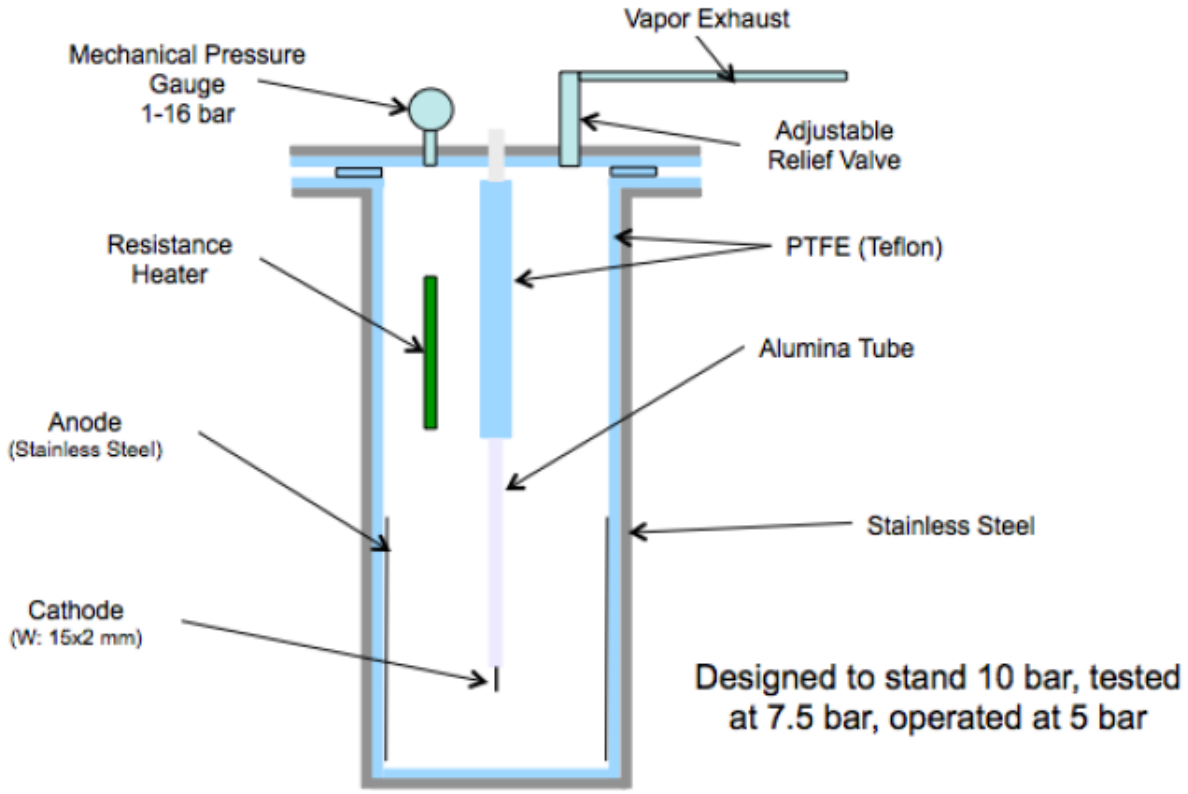

Figure 1. Schematic of the reaction chamber.

be due to contamination from the electrolyte or the various components in the reactor. Only isotopic analysis can be meaningful.

In our experimental work, we focused only on excess heat measurements. For that purpose, we have developed a unique calorimeter enabling us to measure with precision the power input and the heat produced. We assume positive feedback takes place with temperature, so our experimental set-up enables the cell to work under pressure, so that the water temperature is higher than 100°C.

2. Experimental

Figure 1 shows a schematic of the cell. The interior is all Teflon^{TM} covered, so that the electrolyte is never in contact with the external stainless-steel envelope. The lid contains the electrical feedthroughs for the anode, cathode and calibration resistor, a mechanical pressure gauge, as well as a mechanical relief valve that maintains the chamber at constant pressure, and therefore at constant temperature. There is no sensor to measure the temperature of the electrolyte. All measurements of excess heat are made when the pressure reaches a constant value, and a constant temperature is deduced from the pressure. In order to lower the heat loss by convection and conduction, the external stainless steel surface is covered with an insulating blanket.

The cell is positioned on a 6 kg Sartorius balance Signum 1 having a precision of 100 mg (see Fig. 2). The weight loss is converted in heat production assuming that all the water is escaping through the relief valve as dry vapor.

The electric power is measured with a wattmeter (Norma D6100), with a sampling rate of 70 kHz. The cell is operated at constant voltage with a Sorensen DCS 300-3.5E switching power supply, which produces up to 300 V and

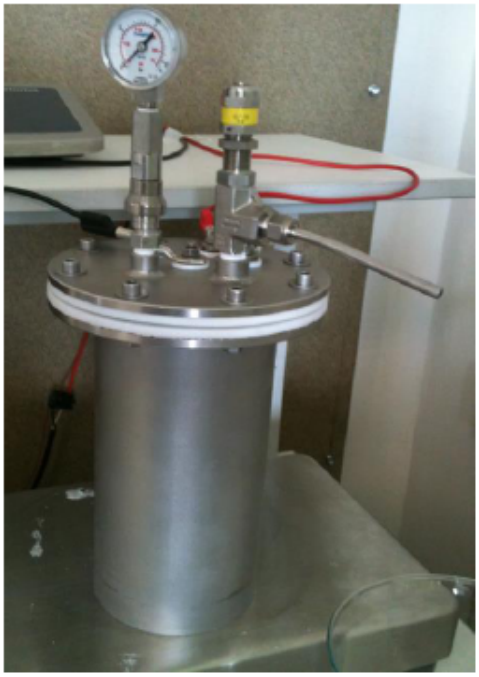

Figure 2. A view of the cell on the balance without the insulation blanket.

3.6 A. When larger voltages or currents were used, two of these power supplies were put in series, or in parallel.

At atmospheric pressure, the heat of vaporization of water is 2258 J/g, and the boiling temperature is 100°C. At five times the atmospheric pressure, the heat of vaporization is 2107 J/g and the boiling temperature is 152°C.

All the data were recorded on a PC with LabVIEW® software. In order to minimize the size of the data files, we averaged the values in 30-second intervals.

3. Calibration

The heat loss of the calorimeter was determined by placing a 300 W resistor in the cell. The difference between the power input and the heat measured through the weight loss corresponds to the heat lost through the walls of the calorimeter. At 5 bar of pressure, this loss was 92 W. In the actual experiments we added 92 W to the heat calculated from the weight loss.

4. Experiments

We have performed a large number of experiments at atmospheric pressure and at 5 bar. We have used tungsten rods of various diameters: 1, 2, and 4 mm. We tested tungsten with and without thorium (2%). We have also tested 2 mm nickel wires. We systematically employed K_2CO_3 as electrolyte. The electrolyte concentration varied between 0.01 and 0.06 mol/l.

Figure 3 shows that the vapor leaving the cell is dry. The condensation cloud forms about 6 mm away from the exit of the exhaust tube.

5. Preliminary Results

Not all experiments were positive. Many failed for various reasons: the cathode was often sputtered away and destroyed by the plasma. There are many parameters to take into account: electrode material; diameter and length of the electrode; concentration of the electrolyte; and voltage applied. At 5 bar, i.e. 152°C, with a 2 mm diameter, 2 cm long cathode, we measured an average excess heat of 19 W. With an average input power of 175 W, for 60 min, the COP is thus 1.11. The voltage was 305 V and the average current was 0.57 A.

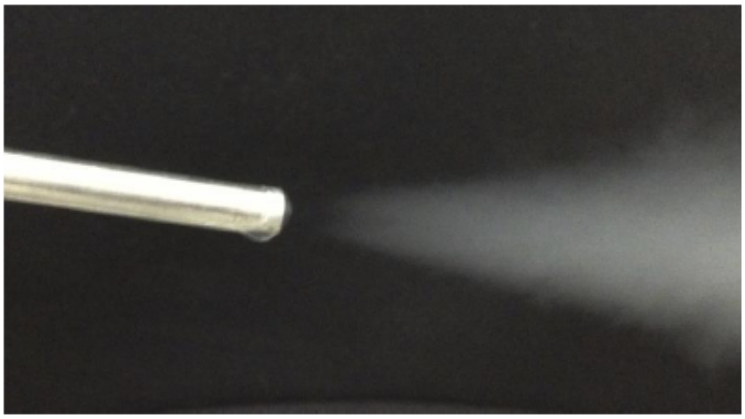

Figure 3. Dry steam coming out of the exhaust pipe.

6. Conclusion

This high-pressure calorimeter has a number of advantages: it operates at constant temperature, above 100°C and it can be easily changed by changing the pressure of operation. With our present design, we can work at up to 10 atm. of vapor pressure. Because the temperature is constant, the time constant of the system when input power changes is short. Our preliminary results confirm the production of excess heat, and we believe that it can be made much higher than what we have obtained so far after tuning the various parameters. Moreover, this design is very well adapted for finding deuterium in the gas if the reaction mechanism is $H + H \rightarrow D$.

There are some disadvantages linked to this design: the duration of the experiment is limited by the quantity of water in the cell, because we cannot add water during operation since we operate under pressure. Also, the cathode gets eroded most of the time, and this also limits the duration of the experiment.

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