

Excess Heat Production in Electrolysis of Potassium Carbonate Solution with Nickel Electrodes

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ABSTRACT

With the aim of realizing the potassium-proton cold fusion, the electrolysis of light water solution of potassium carbonate was carried out by means of porous nickel cathode. The cell was cooled by a constant rate air stream and maintained at 20°C during all the electrolysis. Typical results indicated that the excess heat production rate was proportional to the input power in the range of measurements (up to 2W) and the excess heat observed was 3 to 4 times greater than the input power, after corrected for the thermo-neutral potential.

After the electrolysis, the calcium ion concentration in the electrolytes was measured by flame photospectrometry and the increases of calcium concentration in the electrolytes due to the electrolysis were found to be 3.2 to 4.4 ppm. These amounts are comparable to the amounts of the excess heat calculated within the same order of magnitude.

1. Introduction

It was a shocking news that nuclear reactions of deuterium occurred on paradium cathode at room temperature¹. The study of "cold fusion" has burst into flame throughout the world. Moreover, the novel type of the cold fusion in light water was suggested by Mills et al², last year. The majority of scientists still are doubtful about them, because of little reproducibility and consistence among the amounts of

their products, heat emission and radiation. However, these systems are essentially the most popular ones for hydrogen evolution reaction. Matsuda's group had shown in their works³ that several active metals for hydrogen evolution reaction, for example, nickel, formed considerable amounts of the alkali metallic intermediates during electrolysis of alkaline solutions. On the basis of them³, the nuclear reaction of potassium was sufficiently likely and therefore warranting further investigation. The aim of this work was to obtain the unequivocal evidence of this nuclear reaction.

2. Experimentals

An electrolytic cell made of Pyrex glass was used for the experiment and equipped with 3 electrodes, these being, a 1 x 0.5 x 0.1 cm sintered nickel test-electrode, platinum counter and platinum reference electrodes. A 20 milli-liter light water's solution of potassium carbonate with a concentration of 0.5 mol per liter was used as the electrolyte, and stirred by bubbling hydrogen gas, with gas stream rate of 1.5 ml/min during the electrolysis. The nickel electrode was cathodically polarized by a stationary constant current from 0.01 to 0.70 ampere and the temperature of the electrolyte was measured. A standard nichrome heating wire with a resistance of 15 ohm was put in the cell for comparison. The electrolysis was carried out using the twin celled simultaneously, in order to confirm that the heat discharged was only by electrolysis. The twin cells were placed a thermostat chamber of the temperature held at $20.00 \pm 0.01^{\circ}\text{C}$ during the electrolysis by air convection.

3. Results and Discussion

Figure 1 shows the typical relationship between the input power, W_{input} , given by electrolysis and the increase of electrolyte temperature, T . The input power, W_{input} is given by the following equation:

$$W_{\text{input}} = I(E - 1.482 \text{ V}), \quad (1)$$

where I and E denote the current and the potential difference between the test electrode and the counter electrode. The 1.482 V value is due to the enthalpy change for $\text{H}_2\text{O} \rightarrow \text{H}_2 + (1/2)\text{O}_2$ ⁴. Figure 1 shows the electrolyte temperature increase for the standard resistor(2) and that for electrolysis. It was found that the electrolyte temperature increased up to

54.2°C from the initial temperature of 20°C with the input power of 2.70 joule/sec and this temperature rise was proportional to the input power W_{input} , within the input power range of 0 to 2.7 joule/sec. The figure shows a linear relationship between the temperature increase and the input power W_{input} with a correlation coefficient of more than 0.999 for both lines. The line gradient for the cell is remarkably greater than that for the standard resistor.

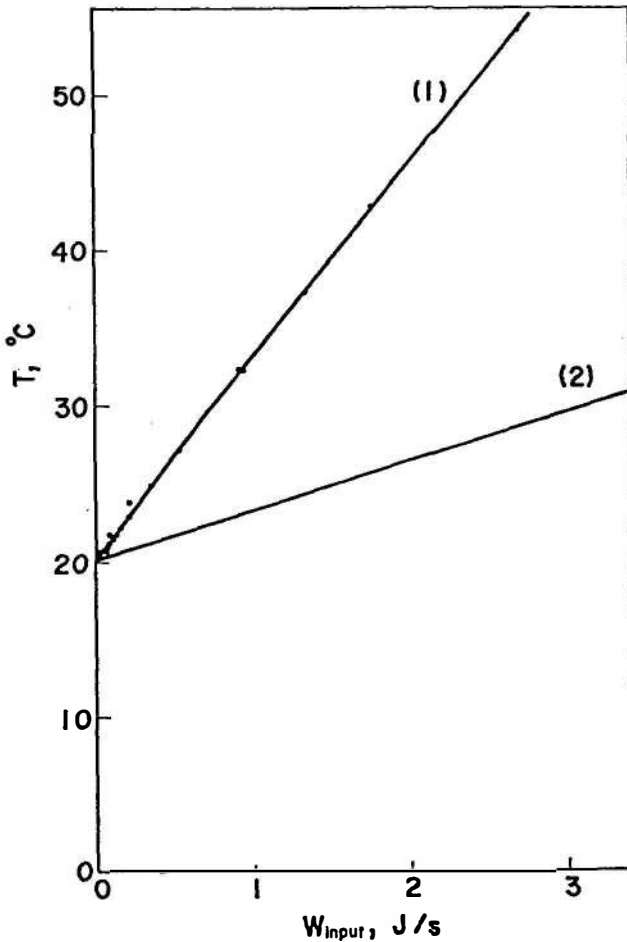


Figure 1. a. Relationship between temperature increase of electrolyte and input power W_{input} in the cell-(1) and as compared with the standard resistor-(2).

The difference in the value of input power W_{input} between two lines at a given temperature, shown in this figure, can be defined as the excess heat. Figure 2 shows the relationship between the excess heat ΔW_{output} and the input power W_{input} observed in the cell. The excess heats determined from ten time-repeated experiments were found to be from 2.7 to 3.4 times more than W_{input} .

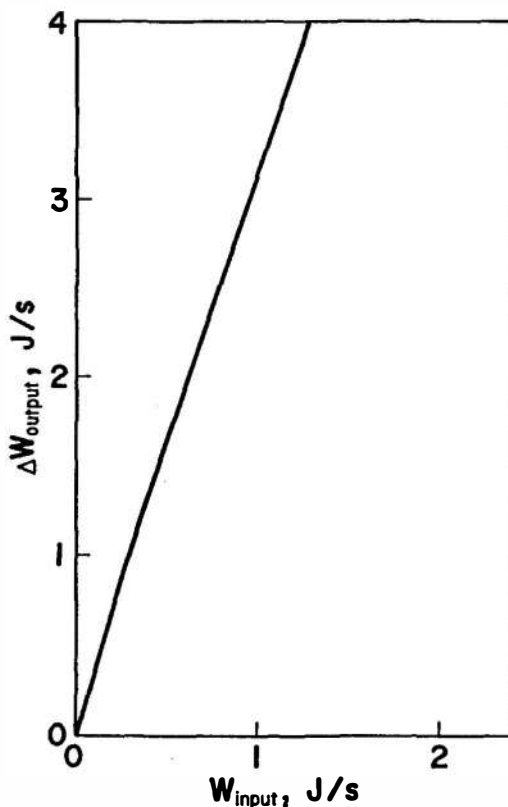


Figure 2. Amount of excess heat ΔW_{output} evolved during the electrolysis with input power W_{input} in 0.5 M K_2CO_3 .

The calcium ion concentration in the electrolyte was measured by flame photospectrometry with an accuracy of ± 0.02 ppm. In the same solution of 0.5 mol per liter potassium carbonate as the electrolyte, calcium ion was not detected, before use. In order to determine the background value, the calcium ion concentration in the solution of 20ml was poured into the electrolytic cell vessel equipped with the three

electrodes and the standard heater and put at 20°C without electrolysis, during the electrolysis of the working cell, which was made exactly the same as the former. The calibration line of the intensity of the spectrum for calcium plotted against its concentration is shown in Figure 3. On the basis of this line, the calcium concentrations in the three samples of electrolyte after different conditions of electrolysis were found to be 24.7, 25.1 and 26.2 ppm when the background values, to be 21.5, 21.5 and 22.0. The increases of calcium concentration in the samples of electrolyte due to the electrolysis were determined to be 3.2, 3.6 and 4.2 ppm by use of these data. These increases of calcium concentration in the electrolytes are comparable to the total amounts of excess heats evolving in these electrolytes, within the same order of magnitude.

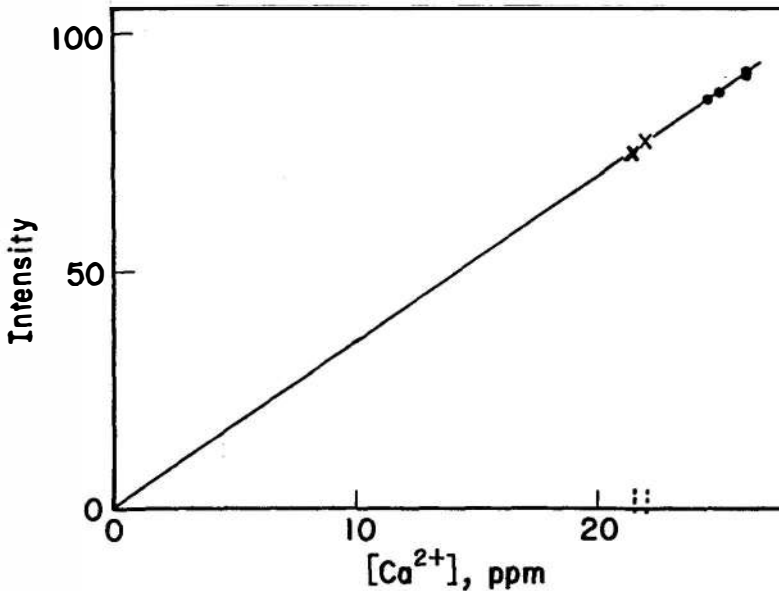
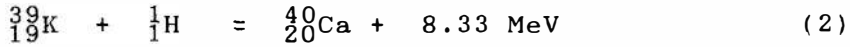
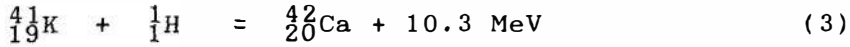


Figure 3. Intensities of flame photospectra of calcium with concentrations of calcium ion in the electrolytes after electrolysis(●) and in electrolytes put in cell without electrolysis(x). A line shown in this figure is the calibration line for the calcium ion concentration.

Bush et al⁴ proposed the possibility of nuclear reactions between potassium and proton as follows,



and



From the present work, it is not clear which of the 2 reactions, (2) or (3), was predominant in this system. A further investigation is being conducted at present to verify this.

4. List of Symbols

W_{input} = Input power, joule/sec

I = Current, amp

E = Potential difference, volt

T = Temperature, °C

ΔW_{output} = Excess Heat, joule/sec

5. References

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2. Mills, R. and Kneizys, K., 1991, Fusion Technol., 19, 65.
3. Notoya, R. and Matsuda, A., 1966, J. Research Inst. Catal., Hokkaido Univ., 14, 198.
4. Bush, R.T., 1991, Fusion Technol., 22, 301.