

Electric and Heat Measurements in High Voltage Electrolysis Cell Experiments

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Abstract

Experimental research of the heat and high-energy processes occurring in the cathode solid medium in the high voltage electric discharge system (electrolysis cell and glow discharge device) is presented. Excess heat was observed in experiments with high-voltage electrolysis (1000 V or more). Three sets of experiments were carried out: electrolysis in light water with a Cu cathode, electrolysis in light water with a Pd cathode, and electrolysis in heavy water with a Pd cathode. X-rays were registered during the glow discharge and after deuterium glow discharge current was switched off. Presumably, the observed X-ray emission occurs as a result of relaxation of excited energetic levels in the cathode solid medium. A hypothetical process (phenomenological model) of Low Energy Nuclear Reaction (LENR) in the cathode solid medium of the electric discharge systems that may trigger the energy (ranging from 10 - 100 eV and up to 3000 eV) is discussed.

1. Introduction

Previously reported experiments showed that excess heat value from cathodes in electric discharge systems depends of the discharge voltage value (ion flux energy). For most electric discharge experiments (typically electrolysis, or electric discharge electrolysis) are done with low voltage (10 - 100 V). High voltage was used in high current glow discharge experiments [1] and high-voltage electrolysis experiments[2]. These results allow us to estimate the values of excess heat and efficiency. An X-ray emission experiment was made to elucidate the LENR triggering process.

2. Calorimetry in High Voltage Electrolysis (HVE) experiments

Three sets of the experiments were carried out at the different HVE cell operating parameters [1] with light and heavy water. Three methods of calorimetry were used to measure excess heat: calorimetry based on the time it took to bring the electrolyte to boiling; heat capacity calorimetry; and flow calorimetry. These are described in the following sections.

2.1. Calorimetry by the start time of electrolyte boiling

HVE open-type cells were used. The time the electrolyte began boiling was recorded in two experiment data sets with light and heavy water, with equal electrolysis power. It was observed

that the heavy water started boiling 4 to 5 times sooner than the light water control cell. This indicates that much more heat was produced in the heavy water cells.

2.2. Heat capacity calorimetry

A HVE device consisting of a quartz tube with an additional circuit for the working fluid (Fig. 2a) was constructed. The anode and cathode units were placed inside the tube. To circulate the working fluid (40 ml) a mixer was installed inside the circuit. The quartz tube was also provided with a thermocouple.

Four sets of experiments were carried out at the following HVE operating parameters: electrolysis in H₂O with a Pd cathode; electrolysis in H₂O with a Cu cathode; electrolysis in D₂O with a Pd cathode (not pre-treated Pd and pre-treated Pd cathode by saturation in D₂O for a month).

The following experimental procedure was used: In all the experiments the electric power input into the cell was constantly maintained at the same level for all types of cathodes and working liquids. Electrolysis was stopped when the electrolyte temperature reached 80°C. Four different tests were performed, with different electric power levels: 20 W; 40 W; 60 W and 80 W were carried out for each experimental system (with different cathode materials and electrolyte). The electrolyte temperature/time gradient (the electrolyte heating rate) was determined. The data shows that with two systems – D₂O with Pd cathode and D₂O with Pd cathode (pre-treated Pd cathode by saturation in heavy water for a month) – the electrolyte heating rate was several times higher than H₂O. Presumably, this difference of temperature gradient for heavy water with Pd cathode is accounted for by the production of excess heat in the cell.

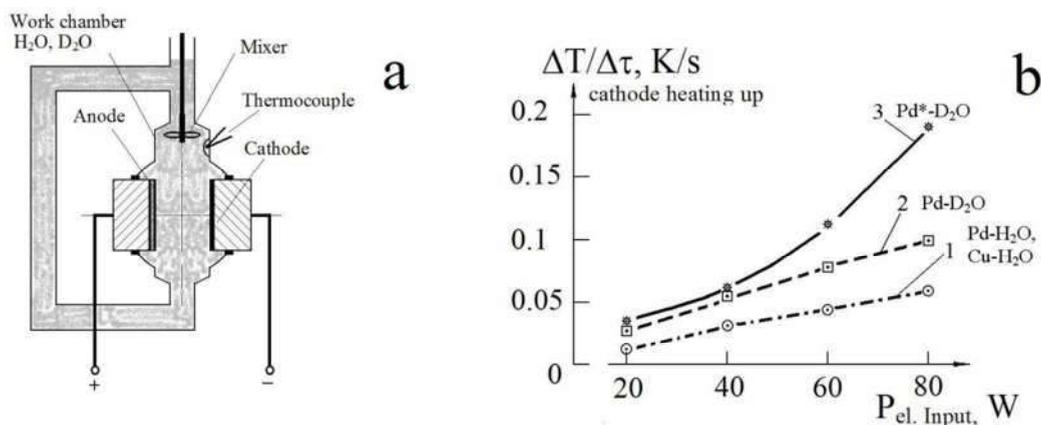


Figure 1. a – A schematic of a High Voltage Electrolysis (HVE) device, set up as a heat capacity calorimeter; b – Dependence of the water heat up value $\Delta T/\Delta \tau$ (in the circuit with the working liquid, (H₂O or D₂O)) upon the input electric power. 1 – electrolysis in H₂O with the Pd and Cu cathode; 2 – electrolysis in D₂O with a Pd cathode (not pre-treated); 3 – electrolysis in D₂O with a Pd cathode (pre-treated Pd).

2.3. Flow calorimetry

The HVE device (as a water-cooled flow calorimeter), consisted of a quartz tube with an additional circuit for a working fluid (Fig. 2a). The anode and cathode units were placed inside the tube. To circulate the working fluid a mixer was installed inside the circuit. One side of the

flat cathode was washed by the working liquid, while the other side of it was cooled by the water flowing in a cooling tube. Thermocouples connected differentially were placed inside the water-cooling passage to take the difference in the cooling water temperature input and output. The cooling water flow rate on the cathode was the same in all the experiments. The experiments were carried out using light and heavy water as a working liquid. By various techniques the voltage in the working liquid between the cathode and the anode was brought up to 800-1000 V. Three sets of experiments were carried out at the following High Voltage Electrolysis operating parameters: electrolysis in H₂O with a Pd cathode; electrolysis in D₂O with a Pd cathode; electrolysis in D₂O with a Pd cathode (pre-treated Pd cathode by saturation in heavy water for a month).

Electrolysis powers were equal in the light and heavy water experiments.

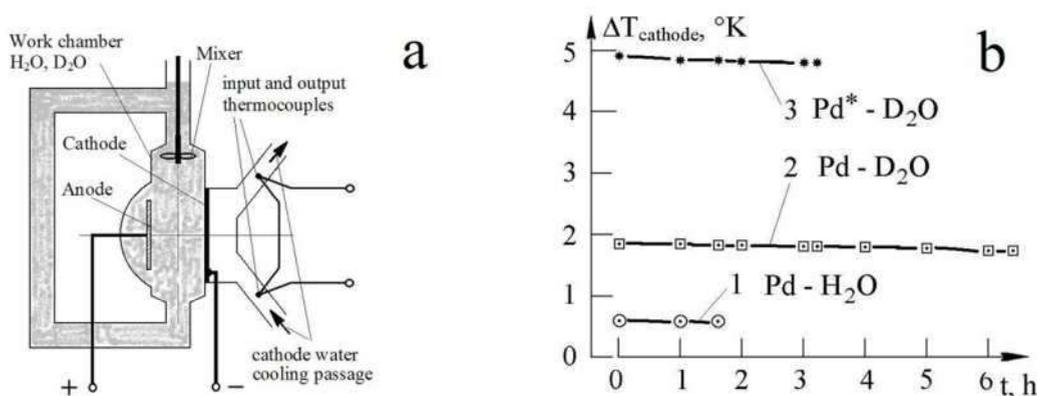


Figure 2. a – The outline of High Voltage Electrolysis device (flow calorimeter); b – Dependence of the cooling water heat up (value Δt in the cathode system) upon the experimental time

3. Estimates of Excess Heat and Heating Efficiency in High Voltage Electrolysis (HVE) Experiments

The above experimental results may be represented in terms of excess heat and efficiency values. The term Heat Efficiency implies correlation between the heat power output into the cathode water cooling system and the electric power input into electrolytic cell during electrolysis.

3.1. Results from calorimetry by the start time of electrolyte boiling

The estimate of Heat Efficiency gives the value up to 800 – 1000% and excess heat up to 80 W.

3.2. Results from heat capacity calorimetry

The following procedure was used to evaluate excess heat and Heat Efficiency: the change in thermal energy of electrolytic cell (ΔQ_{heat}) relative to time ($\Delta \tau$) occurs due to (results from) the

input electric power (P_{el}) and the excess heat power (P_{EH}) produced in the cell.

$$\frac{\Delta Q_{heat}}{\Delta \tau} = m \cdot c_p \frac{\Delta T}{\Delta \tau} = P_{el} + P_{EH}$$

Here m stands for the effective mass of the cell-calorimeter; C_p represents the efficiency coefficient of the calorimeter mass heat capacity; ΔT shows the electrolyte temperature change relative to time $\Delta \tau$.

Assuming that no excess heat is produced in using H_2O with Pd and H_2O with Cu cathode systems we arrive at $P_{EH} = 0$.

Excess heat and Heat Efficiency values are lower in experiments with cell-calorimeter without thermal insulation (from the environment) (Fig. 3a, 3b).

3.3. Results from flow calorimetry

The above experimental results may be represented in terms of excess heat and Efficiency values. The term Heat Efficiency implies correlation between the heat power output into the cathode water cooling system and the electric power input into electrolytic cell during electrolysis. It may be assumed that the electric power input into the electrolytic cell, and the heat power produced in the cell are carried away by the water of the cathode cooling system.

The Heat Efficiency of relative heat output was used:

$$\eta = \frac{\Delta t_{D2O} \cdot P_{el.H2O}}{\Delta t_{H2O} \cdot P_{el.D2O}}$$

Here $\Delta t = (t_{out} - t_{in})$ represents water heat up in the cathode water cooling passage; $P_{el.}$ stands for the electric power input into the electrolytic cell in the experiments with heavy and light water, respectively.

Excess heat produced in the electrolytic cell is determined by the following expression:

$$P_{EH} = P_{el} \cdot (\eta - 1)$$

Experimental data treated with this method is presented in the graphs shown in Fig. 4a and 4b.

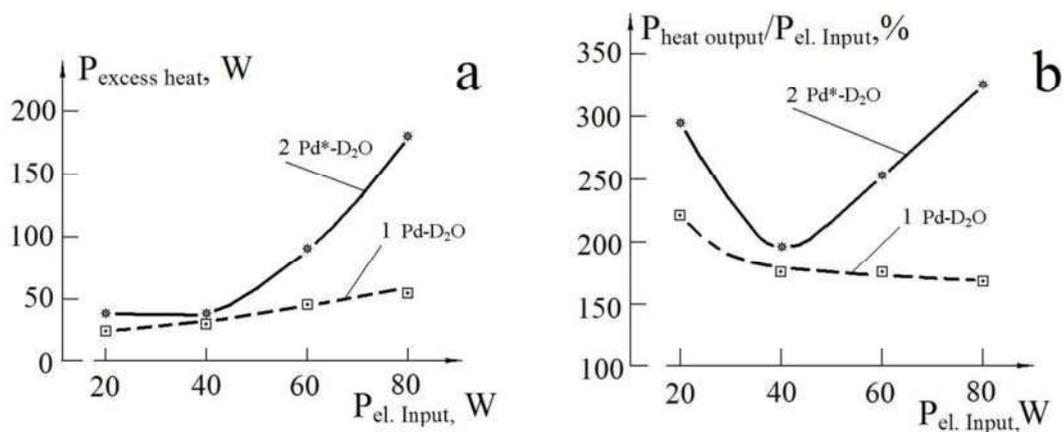


Figure 3. Heat Capacity Calorimeter. a -Excess heat value as a function of the input electric power. b- Dependence of Heat Efficiency value the input electric power. 1 – D₂O with a Pd cathode (not pre-treated Pd); 2 – D₂O with a Pd cathode (pre-treated Pd).

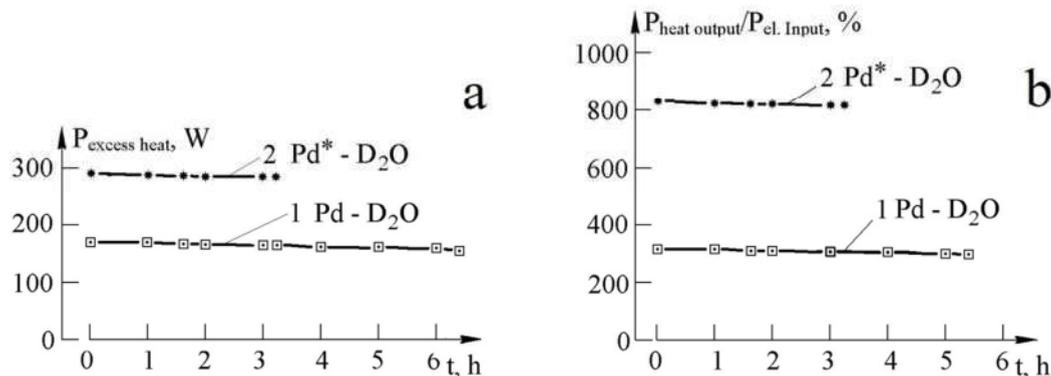


Figure 4. Flow Calorimeter. a – Excess heat value as a function of experimental time. b – Dependence of Heat Efficiency value of experimental time. 1 – D₂O with a Pd cathode (not pre-treated Pd); 2 D₂O with a Pd cathode (pre-treated Pd).

4. Excess Heat in Glow Discharge Experiments

Measurements of excess heat were carried out in experiments with high-current Glow. The excess heat registration experiments were carried out using the glow discharge device. A pulse-periodic electric power supply was used. The big values of excess heat (5 – 15 W) and Efficiency (160%) were observed in conditions when the glow discharge operational voltage ranged from 1000 V to 1300 V (Fig. 5a, 5b). The glow discharge voltage area (D₂ ion energy) with maximum efficiency heating corresponding to the inverse X-ray emission energy area on the Pd cathode (Fig. 5b).

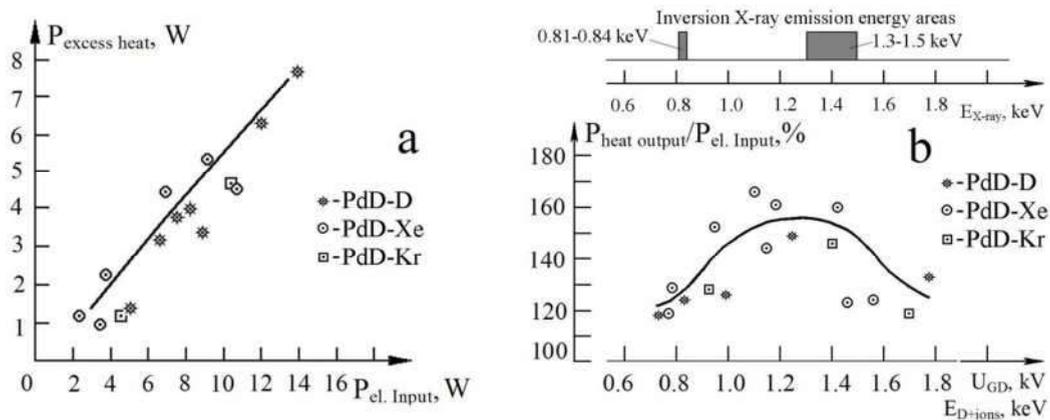


Figure 5. a – The relationship of excess heat to input electric power (glow discharge experiments); b – Dependence of the output heat power and the input electric power ratio of the glow discharge voltage (deuterium ion energy). Deuterium pre-charged Pd cathode samples in D_2 , Xe and Kr discharges. Inversion X-ray emission energy by the curved mica crystal X-ray spectrometer.

5. LENR PHENOMENON THEORY

The totality of experimental results (excess heat production, production of ^4He , nuclides with unnatural isotopic ratios, and X-ray emission) are clues to developing a theory to explain LENR in the solid medium of the electric discharge systems cathodes. One can single out the following electric discharge systems areas and physical phenomena observed within them:

- 1) Ion flux generation in electric discharge systems near cathode area plasma or electrolyte. The transfer of electric discharge energy (1000-2000 eV) to ion flux of deuterium plasma. The cathode surface is bombarded with the ion flux.
- 2) The soft collision D^+ ions flux with surface of Pd cathode solid causes the following processes:
 - a) Low energy modes transfer in solid volume;
 - b) Anharmonic processes of low energy modes conversion to high energy modes (P. Hagelstein process);
 - c) Creation of excited long-lived states with 1000-3000 eV and more energy in solid medium;
 - d) Loading deuterium in Pd solid.
- 3) Triggering and realization of Low Energy Nuclear Reactions in the solid.
- 4) Conversion of nuclear reaction energy into the crystal lattice heat.

6. Conclusion

The development of new nuclear engineering is possible based on low energy nuclear reactions (LENR) in the solid-state medium of the high voltage electric discharge system.

References

1. G. Kazyonov et al., “Experiments of anomalous output heat registration by electrolysis in heavy water”, Proceedings of the 10-th Russian Conference on Cold Nuclear Transmutation of Chemical Element and Ball Lighting, DAGOMYS, CITY OF SOCHI, September 29 – October 6, 2002, RUSSIA, pp. 41 – 49.
2. A. B. Karabut, “Research into Low Energy Nuclear Reactions in Cathode Sample Solid with Production of Excess Heat, Stable and Radioactive Impurity Nuclides”, Proceedings of the 12th International Conference on Cold Fusion, December 2 – 7, 2006, JAPAN, pp 214 – 230.