

# LETTER TO THE EDITOR



## COMMENTS ON "MEASUREMENT AND ANALYSIS OF NEUTRON AND GAMMA-RAY EMISSION RATES, OTHER FUSION PRODUCTS, AND POWER IN ELECTROCHEMICAL CELLS HAVING PALLADIUM CATHODES"

One of the best reports published so far on calorimetric measurements during the electrolysis of D<sub>2</sub>O with palladium cathodes is Ref. 1, mainly because it contains more details of the data obtained than most publications on the subject and because of the careful way in which the experiments are carried out. However, if the raw data from the calorimetric measurements in Ref. 1 are observed more closely, a different conclusion from that expressed by the authors may be drawn. Here we briefly outline our findings, while a more detailed analysis is contained in Ref. 2. We apply, as is usually done with isothermal calorimeters,<sup>3,4</sup> Newton's law of cooling in its general form:

$$P = AK(T_{cell} - T_{sur}) = AK\Delta T = Am_i c_p \Delta T$$

or

$$\frac{P_i}{m_i} = Ac_p \Delta T = \frac{P}{m - \frac{I\tau M}{2F} \frac{V_{in}^0}{V_{ie}^0}},$$

where

- $P$  = power input into the calorimeter (output from the calorimeter to the surroundings)
- $A$  = Newton's cooling constant
- $T_{cell}$  = temperature of the cell
- $T_{sur}$  = temperature of the surroundings
- $K = m_i c_p$  = heat capacity
- $m$  = initial electrolyte mass
- $m_i$  = mass at the  $i$ 'th hour
- $c_p$  = specific heat, which is practically constant throughout the experiment
- $M$  = molecular weight of D<sub>2</sub>O

$F$  = Faraday's constant

$V_{ie}^0$  = isoenthalpic voltage

$V_{in}^0$  = thermoneutral voltage [at 46°C, it is 1.57 V for D<sub>2</sub>O (Ref. 5) and 1.51 V for H<sub>2</sub>O (Ref. 6)].

It can also be shown that if the problem is treated in terms of pure conduction heat transfer, as the authors of Ref. 1 consider,<sup>7</sup> similar conclusions will be reached. If we assume  $A = \text{const}$ , then  $P/m_i = \text{const}$ . If we also consider that the cell has produced no excess power at 20 h, then the quantity of excess power density  $P_{x,sp}^i$  produced per unit cathode volume  $v_{Pd}$  at the following moments  $i$  can be calculated from

$$P_{x,sp}^i = \frac{P_x^i}{v_{Pd}},$$

where

$$P_x^i = \left( \frac{P_{20h}}{m_{20h}} - \frac{P_i}{m_i} \right) m_i,$$

as shown in Fig. 1. It is seen from Fig. 1 that in the course of the experiment, an additional power source [greater than the sensitivity of the method—0.04 W (Ref. 1)] has acted that is of the order of, and at times even greater than, the value 0.079 W (1.01 W/cm<sup>3</sup>) reported in Ref. 8 for the current density, similar to that used in Ref. 1. It is seen that  $P_x$  is observed exactly according to the predictions of Eq. (3) in Ref. 1.

Clearly, the above analysis gives only conservative estimates of  $P_x$  due to the assumptions that  $A = \text{const}$ , whereas  $A$  is actually increasing in time, and that no excess power has been produced at 20 h. We note that the trivial reasons for the appearance of the observed  $P_x$  asserted in Ref. 1 can hardly serve as a cause for a  $P_x$  effect, if any, of the above order. An important fact to be noted is that the electrolyte mass loss in Ref. 1 is primarily due to electrolysis only, which is confirmed by the excellent coincidence of the  $V_{in}$  measured during the calibration with its theoretical value.<sup>6</sup> This finding especially invalidates the possibility adverted in Ref. 2 of unintentional D<sub>2</sub> + O<sub>2</sub> recombination causing the appearance of  $P_x$ . This recombination has also been observed to be negligible in other studies.<sup>9,10</sup> The excellent result<sup>1</sup> from the calibration indicates that a trivial explanation can hardly be

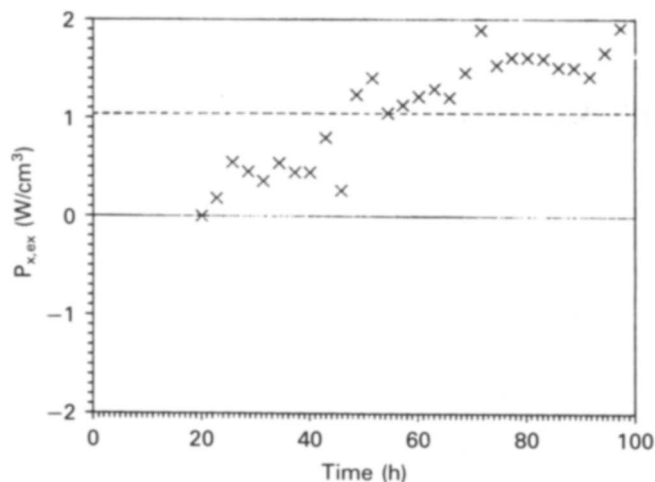


Fig. 1. Excess power density as a function of time calculated for some moments from the raw data in Ref. 1 (0.1- × 9-cm palladium cathode, 69 mA/cm<sup>2</sup> current density). The dotted line represents the level of  $P_{x,sp}$  claimed in Ref. 9 for a 0.1- × 10-cm palladium cathode at 64 mA/cm<sup>2</sup> current density.

found of the fact that, despite the great sensitivity to electrolyte mass changes, at 70.5 h it was possible to maintain the required temperature of a solution containing 1.24 g more than that at 13.8 h, as seen from Figs. 5a and 6 of Ref. 1.

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