

CRITICAL ANALYSIS OF COLD FUSION CALORIMETRIC DATA REPORTED BY CALTECH SCIENTISTS

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Most scientists have dismissed cold fusion as a pathological science or as another polywater episode (1), yet the third international conference on this subject will take place in Japan later this year. Furthermore, considerable experimental evidence has quietly accumulated that supports the occurrence of nuclear reactions in a metal lattice near room temperature (2).

The presentations and publications by N. Lewis et al. (3,4) were obviously major factors in turning the scientific and public opinion against the concept of electrochemically induced cold fusion (5). Ignoring any debate about cold fusion, there are apparently major flaws in the calorimetric experiments reported by N. Lewis et al. (3,4) that have been brought to my attention by V. Noninski and reported in detail elsewhere (6). These apparent errors need to be presented to the scientific community and considered in any cold fusion discussions.

The fundamental error in the calorimetric experiments of N. Lewis et al. (3,4) was the variation of both the electrolysis and resistor power while maintaining a constant total power. This error can readily be seen by the following simple algebraic notation:

$$P_T = P_{EI} + P_X \quad (\text{when } P_R = 0) \quad [1]$$

$$P'_T = P'_{EI} + P'_R + P'_X \quad (\text{when } P_R \neq 0) \quad [2]$$

where P_T is the total power, P_{EI} is the electrolysis power, P_R is the resistor power, and P_X is the excess power (if any). Thus

$$\Delta P_T = P_T - P'_T = P_{EI} - P'_{EI} - P'_R + P_X - P'_X \quad [3]$$

If the cell temperature is kept constant, $\Delta P_T = 0$, hence

$$P_X - P'_X = P'_{EI} + P'_R - P_{EI} \quad [4]$$

The experimental observation by N. Lewis et al. that $P'_{EI} + P'_R - P_{EI} \approx 0$ can only prove that $P_X - P'_X = \Delta P_X \approx 0$, i.e., the excess power (if any) did not change significantly with the change in P_{EI} (current density). It definitely does not follow that P_X or P'_X is zero. Contrary to the claims of the authors (3,4), a study of this nature is completely incapable of proving that no anomalous power was produced.

The increasing heating coefficients (h.c.) reported by N. Lewis et al. (4) from 14.0 to 15.9°C/W (Table 3) suggest an excess enthalpy effect of over 13% in D₂O/LiOD. The heating coefficient can be expressed as h.c.

$$\text{h. c.} = \frac{\Delta T_J + \Delta T_X}{P_T} \quad [5]$$

where ΔT_J is the Joule heat contribution to the cell temperature change produced by $P_{EI} + P_R$ and ΔT_X is the cell temperature change due to any excess power (P_X). In H_2O or early stages of D_2O experiments, $P_X = 0$, thus $\Delta T_X = 0$ and the true heating coefficient is obtained. If excess power is present, $\Delta T_X > 0$ hence a larger heating coefficient is obtained. This error is due to the neglect of the unknown amount of P_X and using only $P_{EI} + P_R$ to determine the total power. Recalibrations with the load-resistor method used by Lewis et al. (3,4) would not be valid when an unknown amount of anomalous power is present. If heating coefficients in $H_2O/LiOH$ are used (Table 3 of Reference 4) where no anomalous power is expected, then an even larger excess enthalpy is suggested for the $D_2O/LiOD$ studies. The largest amount of excess power suggested by Table 3 is 1.1 W/cm^3 at 140 mA/cm^2 . This is in excellent agreement with results reported by M. Fleischmann et al. (7).

A closer examination of Table 2 of Science (3) and Table 3 of *Nature* (4) shows that the sum of $P_{EI} + P_R$ required to maintain a constant cell temperature in $D_2O/LiOD$ is always greater for the experiment at the lower current density. Although this effect is small, it is consistent with the presence of an anomalous power that increases with current density as reported by M. Fleischmann et al. (7).

Possible calorimetric errors due to D_2-O_2 recombination or due to the rate and/or form of gas evolution proposed by N. Lewis et al. (3,4) are simply not valid. Many recent studies (2) have shown that D_2-O_2 recombination is insignificant for flooded Pt and Pd electrodes as used in the Lewis experiments. Recent studies in our laboratory show essentially the same cell temperature versus applied heating power relationship for electrolysis power as found for resistor power where no gas evolution occurs. Gas evolution, therefore, does not significantly affect the heat transfer coefficients in electrochemical calorimetric cells as suggested by N. Lewis (3,4).

Finally, the 1 ppm detection limit for helium measurements in the effluent gases reported by N. Lewis et al. (4) is far too insensitive to measure the ^4He yield from the $^2\text{H} + ^2\text{H} \rightarrow ^4\text{He} + 23.8 \text{ MeV}$ fusion reaction. ¹ Assuming an excess power of 1 W/cm^3 (Pd volume was 0.31 cm^3) would yield only 0.043 ppm of ^4He in the effluent gas for the N. Lewis study at 64 mA/cm^2 . The detection of ^4He in the effluent gases from cells producing excess power has been reported for cold fusion studies using more sensitive methods (8).

REFERENCES

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¹ The detection of He-4 in such experiments requires a detection limit of 1 ppb. The Lewis detection limit of 1 ppm = 1000 ppb would require about 10 Watts of excess power that would cause the contents of most calorimetric cells to BOIL. The excess power would then be very obvious even without using calorimetry.

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