Early Excess Power Using NRL Pd-B Cathodes

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The excess power in cold fusion experiments appears unusually early for Pd-B cathodes prepared by NRL (U.S. Naval Research Laboratory). This early excess power may exceed 100 mW and can be measurable within minutes of the start of the D_2O + LiOD electrolysis. This effect readily exceeds the maximum possible excess power for deuterium loading into the palladium. This unusual early excess power effect was first noted by Martin Fleischmann in his analysis of the Pd-0.5B (0.5 weight % B) data obtained in 1997 at the New Hydrogen Energy Laboratory in Japan [1]. A new experiment in Ridgecrest, California in 2017 using this same Pd-0.5B electrode showed similar early excess power effects. The re-examination of two previous experiments conducted at NRL in 1995 and using two different NRL Pd-B cathodes in a Hart Seebeck Calorimeter also showed early excess power effects. Therefore, this early excess power has been measured using three different types of calorimeters at three different laboratories and using three different NRL Pd-B cathodes. Possible explanations of this early excess power other than LENR (Cold Fusion) have been eliminated such as the change of the thermoneutral potential (E_H) during deuterium loading or errors in any experimental measurements. In fact, a simple equation has been obtained that gives the maximum power for the loading of deuterium into the palladium, $P_{(max)} = (E_H - E_H')I$, where $E_H = 1.5267$ V, $E_H' = 1.3448$ V, and I is the cell current in amps. For example, $P_{(max)} = 0.0273$ W for a cell current of I = 0.1500 A when all of the cell current is used for deuterium loading. Boron added to the palladium may be an essential element for excess heat effects or it may create the special reaction zones such as vacancies, cracks, defects or grain boundaries needed for LENR.

Assuming that boron is essential for the excess heat effects, then the long electrolysis times (weeks, months) reported by Fleischmann and Pons could be due to the leaching of boron from Pyrex glass (mostly $SiO_2 + B_2O_3$) and gradually depositing at the palladium cathode. This may also explain why experiments at the Navy China Lake laboratory often gave larger excess heat effects for repeated experiments that used the same palladium cathode. There is some experimental evidence reported that boron-10 may be the heat source fuel in palladium cathodes [2]. A previous study of a NRL Pd-B cathode has identified helium-4 as the major fusion product [3].

The Fleischmann-Pons differential calorimetric equations were used for determining the early excess power for the isoperibolic calorimetric cells. The largest calorimetric term for these initial measurements is the C_pMdT/dt term which was carefully considered for possible errors. The cell heat capacity (C_pM in J/K) was evaluated by several different methods. Possible errors in dT/dt (K/s) were minimized by numerical integration methods which agreed with results obtained by using C_pMdT/dt directly.

[1]. M.H. Miles, M. Fleischmann and M.A. Imam, "Calorimetric analysis of a heavy water electrolysis experiment using a Pd-B alloy cathode", Naval Research Laboratory Report /NRL/MR/6320-01-8526, March 26, 2001, pp. 25, 51, 52, 81.
(See **http://lenr-canr.org/acrobat/MilesMcalorimetrd.pdf**).

[2]. T.O. Passell, "Search for nuclear reaction products in heat-producing Pd", ICCF-7 Proceedings, 1998, pp. 309-313.

[3]. M.H. Miles in Cold Fusion: Advances in Condensed Matter Nuclear Science, Jean-Paul Biberian, Editor, Elsevier, Amsterdam, pp. 10-11, 2020.