2004 Paper Excerpts Regarding Source of Helium From Sample 4.

3.2. *Reaction Q Value*

As the loss of deuterium in association with excess heat is not presently observable, and since there are no commensurate energetic reaction products, the argument in support of reaction mechanisms consistent with $D+D \rightarrow {}^4He$ is indirect. One can measure energy production, and assay for ^4He in the gas stream or the solid, with uncertainties introduced in the reaction energy Q because all of the helium produced may not be accounted for in the measurement. Experiments are prefered in which a total inventory of the helium is made in order to improve the accuracy of the reaction Q value measurement. To this end, we discuss briefly an experiment in which helium was measured in the gas stream, and an additional effort was made to drive the helium out of the metal.

The experiment under consideration was performed at SRI, and the excess heat measured is illustrated in Figure 5. The experiment was performed in a helium leak-tight, all-metal and metal gasketed calorimeter. Samples were transferred in metal gas sample flasks to be analyzed for ^4He by the U.S. Bureau of Mines at Amarillo, Texas.[70] The initial value of ^4He was 0.34±0.007 ppmV/V in the D_2 gas used to charge the cell.

Figure 7 traces the history of the cell, M4, from four helium samples taken after excess power was observed. The upper solid line is the expectation for helium concentration presuming: (i) an initial value of 0.34 ppmV/V, and (ii) that ^4He is produced in a reaction which delivers 23.8 MeV of thermal energy to the calorimeter. The first gas sample taken shortly following the second heat burst of Figure 5 yielded a value of 1.556± 0.007 ppmV/V ^4He, which is about 62% of its expected value, and consistent with the earlier observations by Miles, Bush and collaborators,[55] and also Gozzi and collaborators.[71] A second sample taken about six days after the first showed a measurable increase in ^4He content instead of the decrease that would be expected since, to maintain positive cell pressure, the gas taken for the first sample had been replaced with cylinder D_2 containing a lower level of ^4He (0.34 ppmV/V). These findings support earlier observations that helium is released slowly from the palladium after an initial delay.

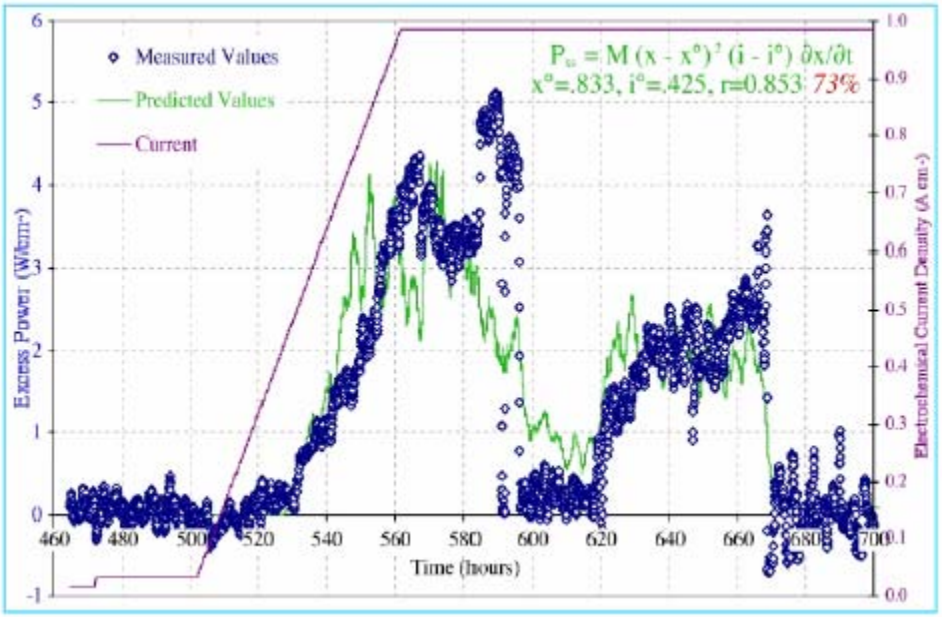
After making these measurements, an attempt was made to dislodge near surface ^4He either thermally or by D atom motion by subjecting the cathode to a period of compositional cycling, while still sealed in the calorimeter. Square and sine wave modulations of varying period and amplitude were imposed on the DC (negative) potential at the Pd electrode in an attempt to flux deuterium atoms through the interface and thus act to dislodge near-surface ad- or absorbed ^4He atoms. At the end of this period, the potential was reversed to withdraw all deuterium atoms from the Pd bulk. No excess heat was observed during the periods of oscillation although calorimetric uncertainties were large due to the strong departures from the steady state that accompanied the pulsing.

Gas samples were taken before this procedure, again after purging the cell and refilling with D_2 from the gas bottle with 0.34 ppmV ^4He, and once more after cycling. The latter sample exhibited the highest concentration of ^4He measured in this cell, specifically 2.077±0.01 ppmV/V. By making a proper mass balance of the helium lost through sampling and purging, and that gained through make-up from the gas bottle, it is possible to assess with defined uncertainty the results of deuterium fluxing in freeing lightly trapped ^4He. The final integral mass balance yielded a value of 104± 10% of the expected value if the excess power in Figure 5 is due to a reaction of the sort $D+D \rightarrow {}^4He$ + ~ 23.8 MeV (heat).

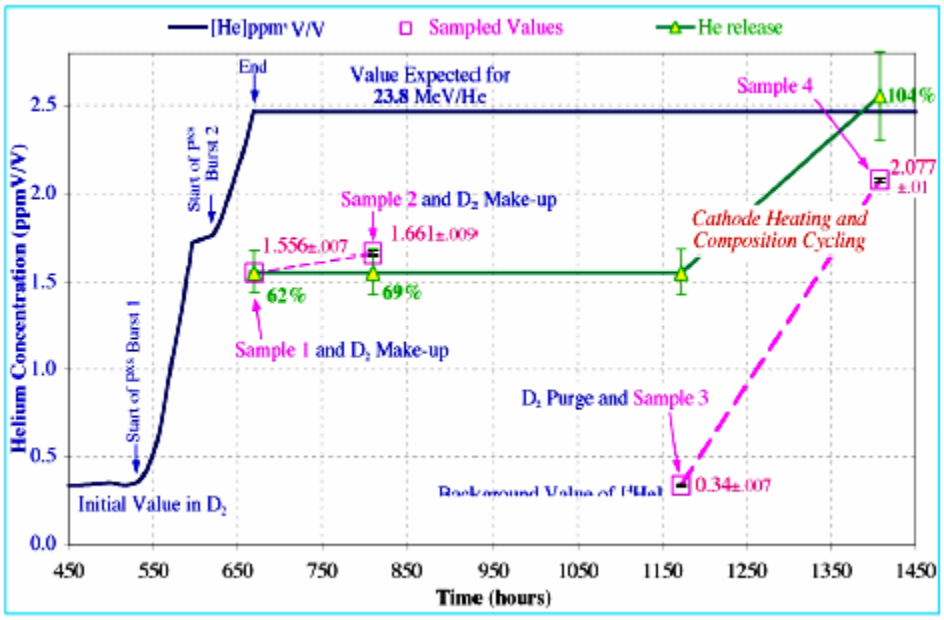
This value remains the most accurately determined in this field (in the sense that contributions from both the gas stream and the metal are included), but it suffers from the criticisms that the numbers of samples were few, and the largest value of ^4He measured was less than 50% of that in air. We note that ^4He has been produced numerous times in excess heat experiments at levels above that of the concentration in air. One example is shown in Figure 6. This plot illustrates the real-time correlation between excess heat and the growth of ^4He concentration in a metal-sealed, helium leak-tight vessel. The *Q* value of 31 ± 13 and 32 ± 13 MeV per ^4He atom measured is also consistent with the reaction $D+D \rightarrow {}^4He$ + ~ 23.8 MeV (heat). Because of the importance of this result, it is discussed further in Appendix B.

Reference for 2004 Paper:

Peter Hagelstein, Michael McKubre, David Nagel, Talbot Chubb, Randy Hekman, "New Physical Effects In Metal Deuterides," Submitted to the 2004 U.S. Department of Energy LENR Review



M4-ExcessPower-1998



M4-TheoreticalPrediction-2004