Helium-4 as a Measurement of Excess Power in the Palladium-Deuterium System

[#]Melvin H. Miles
University of LaVerne, LaVerne, CA 91750, USA
Email: mhmiles1937@gmail.com

It was often noted in many electrochemical experiments on the Pd/D_2O system that the measurements of helium-4 also served as a check on our calorimetry. Recently, an accurate equation was derived that related the He-4 production with the excess power (P_x) and the cell current(I) as shown in Equation 1:

$$\text{He-4 (ppb)} = 55.91\ (P_x/I) \quad (1)$$

where P_x is in Watts and I is in Amps [1]. This equation can readily be rearranged to give the excess power based on the He-4 measurements in ppb.

$$P_x\ (W) = (\text{He-4})\ I / 55.91 \quad (2)$$

However, accurate He-4 measurements are required. For example, at a cell current of 0.500 A, an error of ±5.0 ppb in measurements of He-4 would result in a calorimetric error of ±45 mW, but an error of only ±0.1 ppb He-4 would give a small calorimetric error of only ±0.9 mW.

Some unknown retention of He-4 within the palladium is another significant error source, but based on many experiments, this retention was generally about 20% for our palladium cathodes used. Therefore, an approximate correction would be to simply multiply the measured helium by 1.20.

The use of He-4 as a calorimetric measurement was applied to an experiment were the He-4 measurements were accurate to ±0.1 ppb [1]. The excess power values from Eq. 2 were 0.082 W and 0.053 W for two experiments at I = 0.525 A and 0.043 W for a third experiment at I = 0.500 A. These values are reasonably close to the reported calorimetric measurements of 0.100 W, 0.050 W and 0.020 W [1]. In this example, the check provided by the He-4 measurements suggests a significant error for the 0.020 W calorimetric value, probably because of the neglected work term, $P_w = -RT\ (0.75\ I/F)$, that would add about 0.010 W (a 50% increase) to the 0.020 W calorimetric value.

Other results will be presented, including the collection of gas samples in metal flasks [1]. The Pd-B result is of special interest because the He-4 measured (4.9 ppb) is significantly less than the 13.4 ppb predicted by the calorimetric power of 0.120 W at I = 0.500 A. Perhaps boron atoms in the grain boundaries significantly slow the rate of He-4 escaping from the Pd-B electrode as previously found for the escape of deuterium.

The reasonable agreement for the excess power calculated directly from the He-4 measurements rules out any significant energy carried away from the calorimetric cells by gamma rays or neutrons. These results also show that He-4 is the dominant fusion product in the Pd/D_2O electrochemical system [1].

[1] M.H. Miles in "Cold Fusion: Advances in Condensed Matter Nuclear Science", Jean-Paul Biberian, Editor, Elsevier (2020) pp. 3-15.