6A. Addendum to NEPS Blog # 6 (21 July 2020):

Blog 6 indicated, in the paragraph under the first equation, that "higher energy gamma ray photons, such as 23.8 MeV from d-d fusion would have much less probability of interacting with the material". It should be noted that, although excited He-4 may be produced, there would be little-to-no possibility for gamma radiation to be emitted from the excited He-4. (Reference information in the above addendum to Blog 2). Instead, the energy could be released by internal conversion electrons and pair production electrons. Energy from these electrons would be expected to be absorbed by cathodes and surrounding material in cold fusion experiments.

The following equations indicate examples of possible ways in which energy, helium-3 (He3), helium-4 (He4), protons (p), neutrons (n), and tritium (T3) could be produced in cold fusion:

p + d → He3 + E (5.5 MeV)
d + d → He3 + n + E (3.3 MeV)
d + d → T3 + p + E (4.0 MeV)
d + d → He4 + E (23.8 MeV)
d + T-3 → He4 + n + E (17.6 MeV)

Tritium in the 5th equation is from the 3rd equation. The relative probabilities of each reaction in cold fusion are not actually known (and could vary with local conditions and amounts of hydrogen and deuterium loading, for example). One can assume, however, that probabilities of the 2nd and 3rd reactions are about the same due to their physical similarity. And, although the probability in hot fusion for the 4th reaction to be very low (10^{-7} , or only 1 in 10 million), this is not necessarily true for cold fusion. Some scientists are persuaded that all cold fusion is of the 4th type.

With this information, it is possible to write the following equation to estimate the amount of energy and numbers of particles involved in cold fusion reactions:

8d + p → a [He3 + E (5.5 Mev)] + b (He3 + n + E(3.3 MeV)] + c[T3 + p + E (4.0 MeV)] + d[He4 + E (23.8 MeV)] + e [He4 + n + E (17.6 MeV)] ,

where a, b, c, d and e are probabilities of the different paths, and can be adjusted as desired by interested cold fusion scientists.

Since energy and helium are two products of cold fusion reactions that have been quantified in various experiments, it may be useful to combine these from the different reaction paths, as follows:

8d + p $\rightarrow$ (aHe3 + bHe3 + cT3 + dHe4 +eHe4) + (b + e)n +cp + (5.5a + 3.3b + 4.0c + 23.8d +17.6e) MeV .

Consider a special case where a, b, c, d, and e take on an equal and average value of X = 20%, then a = b = c = d = e = X, and a + b + c +d + e = 1. The right-hand term would be:

0.20 (5.5 + 3.3 + 4.0 + 23.8 +17.6) MeV.

Also consider a case when tritium in the 3rd equation above has decayed to He3, and it is difficult (in mass spectrometry, for example) to differentiate between He3 and He4, so that:

8d + p $\rightarrow$ He (combined) + (b + e)n +cp + 10.8 MeV (average).

For this special example, about 11 MeV of energy would be expected in cold fusion experiments for every helium atom detected. Or, for each watt of excess energy, about 5.8 x 10^{11} helium atoms should be expected.

In the early 1990s, M.H. Miles et al. were able to show experimentally that a watt of excess power (heat) should correlate with production of 6 x 10^{11} to 4 x 10^{12} atoms of helium per second (see “Correlation of Excess Power and Helium Production during D2O and H2O Electrolysis using Palladium Cathodes,” Journal of Electroanalytical Chemistry, vol. 346, pp. 99 -, 1993; and “Correlation of Excess Enthalpy and Helium-4 Production,” 10th International Conference on Cold Fusion, 2003). The actual amount of He-4 produced should be larger than this, as all of the helium was not expected to have escaped from the cathode.

By comparison, if only the 4th reaction were considered, as some scientist believe, then 23.8 MeV should be produced per reaction, along with one He-4. Or, for each watt of heat energy, only 2.6 x 10^{11} He-4 atoms would be produced. The amount of helium detected should be smaller than this, as all of the helium would not be expected to escape from the cathode.