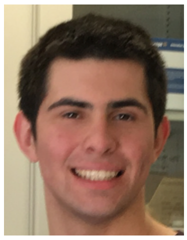
Electrical, thermal and chemical simulations of Ni-H electrochemical cells



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Measurements of LENR experiment have great value in providing information for both scientific and commercialization purposes. However, they are limited by the number of sensors that can be included in an experiment. Usually, sensors provide data at only specific points in space. By contrast, dynamic simulations of LENR experiments can proved information at all points in space and time. In our quest to understand quantitatively the behaviour of N-H electrochemical experiments, we are using a combination of measurements and simulations, as described in this paper. Two companion papers discuss the experiments [1] and analyses of data from them [2].

We are using COMSOL multi-physics finite-element software to perform simulations of the electrical, chemical and thermal behaviour of our cells [3]. The software consists of a basic multi-physics package, plus modules specific to different situations. The simulations were started by putting the geometry and materials of our cells into the software.

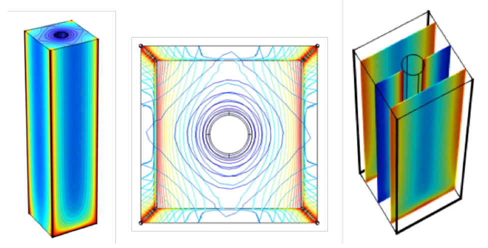

Figure 1. Left: Perspective view showing high fields in red near Pt anodes. Center: Top view showing nearly circular fields close to the Ni cathode. Right: Current density showing current convergence onto

We first used the AC/DC module to compute the electric fields, currents and heating due to the electrolyte current, followed by the Heat Transfer Module to simulate the redistribution of the resistive heat by conduction, convection and radiation. Using this approach, we computed the production and redistribution of heat due to the resistivity of the electrolyte. Figure 1 gives illustrative results. Next, we simulated the additional production of energy by LENR by using an artificial source of heat only on the surface of the submerged Ni cathode. This enabled us to compute the effects of specified amounts of excess power. Example results as a function of time after application of the voltage are shown in Figure 2.

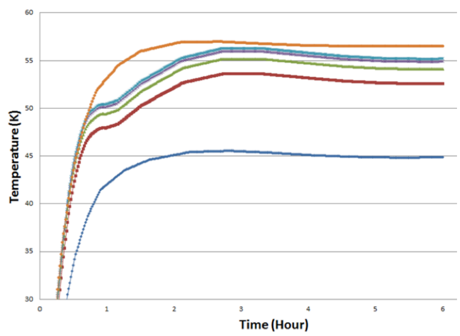

Figure 2. Simulated time histories of the central cell temperature for 6 hours. The lowest curve has no added LENR Power. The successively higher curves have 1.0, 1.2, 1.3, 1.4 and 1.5 W of simulated LENR power from the cathode surface.

The temperatures simulated by the first approach were too high compared to our measurements because the energy needed for electrolysis was not included. Hence, we used the basic program with, first the Electrochemical Module and then the Heat Transfer Module. Results using this approach will be shown in comparison to the first methodology.

[1] E. Gutzmann, J. E. Thompson and D. J. Nagel, "Parametric experimental studies of Ni-H electrochemical cells", This Conference
[2] F. Scholkmann, E. Gutzmann and D. J. Nagel, "Spectral and fractal analyses of currents in Ni-H electrochemical cells", This Conference
[3] https://www.comsol.com/ and https://www.comsol.com/products