

4. R. L. MILLS, W. R. GOOD, and R. M. SHAUBACH, "Dihydrino Molecule Identification," *Fusion Technol.*, **25**, 103 (1994).

5. V. C. NONINSKI, "Excess Heat During the Electrolysis of a Light Water Solution of  $K_2CO_3$  with a Nickel Cathode," *Fusion Technol.*, **21**, 2, Part 1, 163 (1992).

## RESPONSE TO "COMMENTS ON 'CALORIMETRY, EXCESS HEAT, AND FARADAY EFFICIENCY IN Ni-H<sub>2</sub>O ELECTROLYTIC CELLS' "

In reply to Ref. 1 regarding Refs. 2 and 3, the following comments may help Mr. Good and other readers to better understand the significance of the results obtained by the Bose® group.

The notion that the Bose research in light water cells did not produce "excess heat" is simply a mistake (assuming the conventional definition of excess heat, based on the assumption that the Faraday efficiency is unity). The conclusion of the Bose research was not that "excess heat" has not been produced in the light water cells. On the contrary, "excess heat" was produced and measured in all the light water open cells. The results are reported in Tables I through IV in the columns labeled "Apparent Excess Heat (%)" in Ref. 2. In this regard the results agree with the findings of many others who reported positive "excess heat" in light water cells. Again, this is all subject to the assumption that the Faraday efficiency is unity.

The cold-drawn wire cathodes in those cells were indeed cleaned with acetone and methanol and baked at 1100°C. However, what organic residue can survive 1100°C for 2 h as postulated by Mr. Good? The Fibrex® cathodes, on the other hand, were not cleaned or treated in any way. The same Fibrex material also produced "excess heat" for other researchers. Cleanliness of handling was even better than that suggested by Mr. Good. Not even gloves were permitted to touch the cathodes—only specially cleaned stainless steel tools and platinum wire. In either case, both types of cathodes produced the same level of "excess heat." Cell W16E7 (Table III of Ref. 2) was also intentionally contaminated with an organic material. Yet, even the organic contamination could not cause the "excess heat" to disappear.

The difference between the Bose research and all other published research in the field is that once "excess heat" was found, Shkedi et al. did not pause to celebrate but continued the research to identify the source of the "excess heat." To everyone's surprise, including ours, the source of the "excess heat" was identified as unaccounted internal recombination of hydrogen and oxygen. In other words, the common assumption that underlies almost every "successful" light water experiment, i.e., that the Faraday efficiency is unity, was proven to be wrong.

When the "excess heat" data were analyzed, taking into account the actual Faraday efficiency measured in real time, all "excess heat" disappeared, and the energy balance turned out to be exactly zero. The data, the methodology, and the analysis are all presented in Ref. 2. The key point is that "excess heat" has been produced, but its source is shown to be neglected conventional chemistry. Hence, the use of the terms "excess heat" or apparent excess heat rather than simply excess heat.

By contrast, the high "excess heat" ratios claimed to be produced by Mills and Good are predicated on the assumption

stated in Ref. 3, on p. 1699 following Eq. (7): "The net faraday efficiency of gas evolution is assumed to be unity." This is quite a heavy assumption for such a controversial topic.

Apart from many possible errors in determining input power under pulsed current conditions, the erroneous effects of neglected Faraday efficiency are further amplified by the use of pulsed current with a small duty cycle. While input power is assumed to be applied only during the "on" time of the pulse, internal recombination takes place 100% of the time. Thus, the error introduced by neglecting the Faraday efficiency is multiplied by a factor approximately equal to the inverse of the duty cycle.

The need to accurately account for the actual Faraday efficiency in real time is extremely critical. As shown by Eq. (10) in Ref. 2, the apparent excess heat ratio, ignoring the Faraday efficiency, is given by

$$\text{apparent excess heat (\%)} = 100 \cdot \frac{E_{out} - \int (V - 1.481)I dt}{\int (V - 1.481)I dt}$$

Because of the singularity near an electrolysis voltage of 1.481 V, a small favorable error in determining the actual Faraday efficiency can give rise to an erroneous "excess heat" ratio of near infinity, while in reality it is zero!

The objective of the Bose research and publication was not to duplicate, prove, or disprove any other work. The objective was to introduce a new standard of experimental methodology and calorimetric accuracy into the field of "cold fusion." All of us in this universe would be very grateful if anyone could demonstrate long-term real excess heat, free from errors related to Faraday efficiency or duty cycle, or any other error sources.

We have yet to see an excess heat demonstration that lasts continuously for many months in a calorimeter that meets or exceeds the accuracy and stability demonstrated by the Bose calorimeters. The challenge presented at the conclusion of Ref. 2 is still open. "... all reports claiming the observation of excess heat should be accompanied by simultaneous measurements of the actual Faraday efficiency."

Will anyone pick up the glove?

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## REFERENCES

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3. R. L. MILLS and W. R. GOOD, "Fractional Quantum Energy Levels of Hydrogen," *Fusion Technol.*, **28**, 1697 (1995).