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Cold fusion experiments spark heated debate

Marsha Freeman reports on the range of reactions that the scientific community is experiencing over the continuing developments in 'cold' fusion.

In recent weeks, the world has been fascinated by the actual experimental results and possibilities of cold fusion, and by the acrimonious response of some veteran scientists who cannot explain the results of the experiments and are even counseling their colleagues not to try to do so!

Dr. Martin Fleischmann, one of the two original principal investigators along with Dr. Stanley Pons, has reportedly stated that 60 laboratories and experimenters around the world have replicated the famous University of Utah experiment, which produced 100 times more heat in an electrochemical cell than could be predicted by known chemical reactions.

The detailed descriptions of some or all of these experiments, in addition to results from crash-effort research taking place at government national laboratories, should start to become available in a matter of weeks. Already many countries have reported ongoing scientific work and even preliminary positive results from work on cold fusion.

According to Dr. Stephen Dean at Fusion Power Associates in Maryland, Energy Secretary Adm. James Watkins has given the Department of Energy laboratories 90 days to clarify the Utah claims, and has asked Los Alamos National Laboratory to convene an international workshop on cold fusion in Santa Fe, New Mexico from May 22-25.

In addition, the Department of Energy announced that its Energy Research Advisory Board will establish a panel to conduct an independent review of "the entire research situation." This is the fastest the government's scientific bureaucracy has swung into action in this reporter's memory.

Despite all of the heat that is being generated at meetings and in the media, as opposed to the heat from the experiments themselves, one thing remains clear: though there is no theory from the standard chemistry or physics text books that adequately explain what Drs. Fleischmann and Pons have discovered, it only takes one other experiment producing the same results as theirs to verify the fact that they have discovered a new phenomenon. As Dr. Fleischmann has counseled, the researchers who have tried to replicate their experiment but have failed, must also publish the details of their work, so scientific inquiry can be broadened.

It does not matter how many researchers *cannot* confirm the results, as there are likely an infinite number of ways the experiment can be done, different from the way Fleischmann and Pons did theirs. As long as other confirming experiments are successfully done, the scientific community will not be able to escape the challenge to develop new scientific theory to explain this low-temperature fusion phenomenon.

Perhaps one of the most sensible and candid reactions from the stodgy physics community to the puzzling cold fusion experiment was that by Joseph Weneser of Brookhaven National Laboratory, quoted in the *Boston Globe*. "I truly don't understand how the results could have been produced by fusion. But then, there are lots of things I don't understand."

Low-temperature fusion

One of the clearest presentations to date on the difference between "conventional" high-temperature fusion and the new cold fusion results was a discussion by Drs. Fleischmann and Pons before the full House Committee on Science, Space, and Technology on April 26.

Describing the background to their research, Pons explained that in 1984, he and Dr. Fleischmann were discussing the problem of high-energy or high-pressure electrochemical phenomena. "We knew that the concentration and behavior of hydrogen which had been placed in two certain metal lattices by electrochemical means indicated that if one were

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Marjorie Hecht

In hearings before the House Committee on Science, Space, and Technology on April 25, Dr. Martin Fleischmann (with pen) shows experimental "cold fusion" apparatus to Rep. Marilyn Lloyd of Tennessee.

to try to duplicate these processes by hydrostatic means, or pressure . . . enormous, almost astronomical pressures would have to be applied.

"This indicated to us the possibility of many new areas of research such as hydrogen storage or new chemical synthetic methods. The most intriguing implication," Pons continued, "was the possibility that under such high-energy conditions it indeed might be possible to fuse light atomic nuclei—a very unlikely situation, but certainly the science seemed to be there" to imply that.

The scientists then designed and began a simple experiment which has been described in this and many other publications. Inside the palladium electrode of the apparatus, atoms of heavy hydrogen, or deuterium, concentrate as they are separated out from the heavy water. Pons posits that what is formed is a low-temperature plasma, or mixture of positive deuterium ions and negative electrons.

He explained that according to the measurements they took at the University of Utah, the difference in the chemical potential inside and outside the palladium metal lattice was about 0.8 volts. "While this is not a very large voltage, if you think in terms of a battery, for instance, '' Pons stated, "it has very strong implications if we think what we would have to do to recreate the same situation in a chemical sense.

"If indeed you were to try to obtain that same voltage by the compression of hydrogen gas to get that same chemical potential of 0.8 volts, you would have to exert a hydrostatic pressure of a billion billion billion atmospheres—tremendously high pressure."

But the Fleischmann-Pons experiments have not produced the products of known fusion reactions. How do they explain this?

The scientists think they may have a variety of deuterium-deuterium fusion inside the palladium electrode. Deuterium (D) is a hydrogen atom (one proton) with one neutron. Dr. Pons explained that according to accepted theory, this D-D fusion would produce either tritium plus a proton plus energy, or helium-3 and a neutron. In their experiment, very, very few neutrons were found. They did find evidence of increasing amounts of tritium in the heavy water solution adjacent to the electrode. The most important and significant product found in the Fleischmann-Pons experiment is the excess heat, or the calorimetric data.

The scientists reported that the excess heat produced in their experiment arises from a process inside the electrode, not on its surface. Therefore, the quantity of heat depends upon the volume of the electrode, and not the surface area. This is important in designing a scaled-up apparatus to do further testing of the phenomenon.

The heat is generated indefinitely until the
off, Pons reported, and "it is a constant excess heat under the conditions measured here. . . . If we try to explain the magnitude of the heat by the conventional deuterium-deuterium reaction, we find that we have 10^9 times more energy from these thermal measurements than that represented from this neutron and the tritium we observe.

"So, apparently there is another nuclear reaction or another branch to the D-D fusion reaction that heretofore has not been considered," Pons summarized, "and it is that [that] we propose is indeed the mechanism of the excess heat generation."

Compared to high-temperature fusion

As Dr. Fleischmann explained to the House committee, in conventional fusion research, there has always been a series of parameters that had to be reached in order for energy breakeven to take place, in terms of theoretical prediction. This is the point at which there is net energy produced from the fusion reaction, subtracting the energy input required to get the reaction going.

This parameter is a product of the density of the plasma fuel, times the amount of time it is confined in a small area, so the fusion reactions can occur.

In high-temperature fusion, the objective, Fleischmann stated, is to raise the energy of the particles in the plasma to the order of 10 to 100 kilo electron-volts, or at least 100 million degrees Centigrade. "Our experiment is really radically different from that," Fleischmann explained.

"First of all, the energy scale is not measured in kilo electron-volts," he stated, but in single electron-volts. The regime of one electron-volt is "the province of the chemist," he said. The characteristic temperature is about 10,000°, which is considered high-energy chemistry.

What makes up for this low temperature, the scientists believe, is the astronomical confinement parameter, or the amount of time the hydrogen ions are held close to each other in the palladium lattice, according to the way they explain it. In their cold fusion experiment, this "confinement time" is a billion billion times greater than that of a high-temperature plasma, because the deuterium ions continue to accumulate and are apparently trapped inside the electrode, and are not charging off in different directions, as they do in high-temperature fusion.

Dr. Fleischmann warned the committee members that it is a difficult matter to quantify all of these parameters and products at this early stage. "These experiments take quite a long time. They require months and not days to carry out," he said.

Dr. Pons announced at the hearing that 19 new experiments on their cold fusion approach are being set up. "One of those is a demonstration of a previously run experiment, for Los Alamos National Laboratory." The Los Alamos scientists, "will come up [to Utah], make the measurements they want to make on our own system, bring their electrochemists, and . . . go through our method of measuring the thermal output. And when they are satisfied with what they see, then they will take that experiment away" to Los Alamos.

Dr. Pons described the new science that may come to explain their experimental results as a "gray area between chemistry and physics." But he also warned that caution should be taken, and that "theories must be used to explain experimental data, not to criticize experimental data," and that scientists should not be saying "your data must be wrong because the theory doesn't predict that."

The Fleischmann-Pons experiment certainly does throw down the gauntlet to the scientific community. Serious scientists are trying to do experiments, and think about how such an unexplained result can be explained. Unfortunately, the science mafia in the media and prestigious institutions, such as the American Institute of Physics, are not rising to the occasion.

Not science, subterfuge

No literate person would be surprised to find out that the *New York Times* and other major national press are presenting one-sided, negative reporting on the experimental results in cold fusion. Over the decades of this century, the *Times,* in particular, has editorialized against the development of electricity and airplanes, and against going to the Moon or building the Space Shuttle.

On Saturday, April 29, *Times* reporter Malcolm Browne reported that scientists at New York's Brookhaven National Laboratory and at Yale University "failed to confirm the findings" of the Fleischmann-Pons experiment. The "evidence" cited: The scientists surrounded four electrolytic cells they had built with six neutron detectors, but could "see no neutrons." The *Times* gladly omits the fact that Fleischmann and Pons did not find the production of neutrons that would be theoretically predicted from fusion either, which is one of the results that has made their experiment so intriguing.

A similar fallacy of composition has been perpetrated by Dr. Steven E. Koonin and others at the California Institute of Technology, such as Nathan Lewis, who have been ringleaders of the line that "cold fusion can't work." This group has insisted that only "experimental errors" could account for the cold fusion results.

The *Times* has led their coverage with editorials such as, "The Utah Fusion Circus," and actually said, "As for the University of Utah, it may now claim credit for the artificial-heart horror show and the cold-fusion circus, two milestones at least in the history of entertainment, if not of science."

In response to the lynch-mob atmosphere that was created at the spring meeting of the American Physical Society in Baltimore at the beginning of May, Dr. James Brophy, director of research at the University of Utah, responded, "It is difficult to believe that after five years of experiments, Dr. Pons and Dr. Fleischmann could have made some of the errors I've heard have been alleged at the APS meeting."

It is clearly easier to blame new and currently inexplicable results on "errors" than to do the serious work, over a period of months if necessary, to discover what this new phenomenon might indeed be.