Cold Fusion Research

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A Report of the Energy Research Advisory Board to the United States Department of Energy

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F I G U R E S

EXECUTIVE SUMMARY

As a result of the startling announcements in March 1989 by Utah scientists claiming the attainment of cold fusion, the Secretary of Energy requested (see Appendix 1.A) that the Energy Research Advisory Board (ERAB) convene a panel to assess the possibility of cold fusion. Since early May 1989, the Panel or subgroups thereof have participated in the Workshop on Cold Fusion in Santa Fe, have visited several laboratories, have studied the open literature and numerous privately distributed reports, and have participated in many discussions. The Panel meetings and schedule of laboratory visits are summarized in Appendix 1.B.

Since the above announcement, many laboratories worldwide have initiated research in cold fusion. In the United States, a major effort has been undertaken to search for cold fusion by a large number of research groups at university and national and industrial laboratories. Some laboratories support the Utah claims of excess heat production, usually for intermittent periods, but most report negative results. Those who claim excess heat do not find commensurate quantities of fusion products, such as neutrons or tritium, that should be by far the most sensitive signatures of fusion. Some laboratories have reported excess tritium. However, in these cases, no secondary or other primary

nuclear particles are found, ruling out the known D+D reaction as the source of tritium. The Panel concludes that the experimental results on excess heat from calorimetric cells reported to date do not present convincing evidence that useful sources of energy will result from the phenomena attributed to cold fusion. In addition, the Panel concludes that experiments reported to date do not present convincing evidence to associate the reported anomalous heat with a nuclear process.

Neutrons near background levels have been reported in some D_2O electrolysis and pressurized D_2 gas experiments, but at levels 10^{12} below the amounts required to explain the experiments claiming excess heat. Although these experiments have no apparent application to the production of useful energy, they would be of scientific interest if confirmed. Recent experiments, some employing more sophisticated counter arrangements and improved backgrounds, found no fusion products and placed upper limits on the fusion probability for these experiments, at levels well below the initial positive results. Hence, the Panel concludes that the present evidence for the discovery of a new nuclear process termed cold fusion is not persuasive.

The Panel also concludes that some observations attributed to cold fusion are not yet invalidated.

The Panel recommends against the establishment of special programs or research centers to develop cold fusion. However, there remain unresolved issues which may have interesting implications. The Panel is, therefore, sympathetic toward modest support for carefully focused and cooperative experiments within the present funding system.

Following an introductory chapter, calorimetry, fusion products and materials are assessed in the next three chapters. Conclusions and recommendations are summarized in the final chapter.

[[1]]

CONCLUSIONS AND RECOMMENDATIONS

A. PREAMBLE

Ordinarily, new scientific discoveries are claimed to be consistent and reproducible; as a result, if the experiments are not complicated, the discovery can usually be confirmed or disproved in a few months. The claims of cold fusion, however, are unusual in that even the strongest proponents of cold fusion assert that the experiments, for unknown reasons, are not consistent and reproducible at the present time.

However, even a single short but valid cold fusion period would be revolutionary. As a result, it is difficult convincingly to resolve all cold fusion claims since, for example, any

good experiment that fails to find cold fusion can be discounted as merely not working for unknown reasons. Likewise the failure of a theory to account for cold fusion can be discounted on the grounds that the correct explanation and theory has not been provided. Consequently, with the many contradictory existing claims it is not possible at this time to state categorically that all the claims for cold fusion have been convincingly either proved or disproved. Nonetheless, on balance, the Panel has reached the following conclusions and recommendations.

B. CONCLUSIONS

1. Based on the examination of published reports, reprints, numerous communications to the Panel and several site visits, the Panel concludes that the experimental results of excess heat from calorimetric cells reported to date do not present convincing evidence that useful sources of energy will result from the phenomena attributed to cold fusion.
2. A major fraction of experimenters making calorimetric measurements, either with open or closed cells, using Pd cathodes and D_2O, report neither excess heat nor fusion products. Others, however, report excess heat production and either no fusion products or fusion products at a level well below that implied by reported heat production. Internal inconsistencies and lack of predictability and reproducibility remain serious concerns.

In no case is the yield of fusion products commensurate with the claimed excess heat. In cases where tritium is reported, no secondary or primary nuclear particles are observed, ruling out the known D+D reaction as the source of tritium. The Panel concludes that the experiments reported to date do not present convincing evidence to associate the reported anomalous heat with a nuclear process.

3. The early claims of fusion products (neutrons) at very low levels near background from D_O electrolysis and D_2 gas experiments have no apparent application to the production of useful energy. if confirmed, these results would be of scientific interest. Recent experiments, some employing more sophisticated counter arrangements and improved backgrounds, found no fusion products and placed upper limits on the fusion probability for these experiments at levels well below the initial positive results. Based on these many negative results and the marginal statistical significance of reported positive results the Panel concludes that the present evidence for the discovery of a new nuclear process termed cold fusion is not persuasive.
4. Current understanding of the very extensive literature of experimental and

theoretical results for hydrogen in solids gives no support for the occurrence of cold fusion in solids. Specifically, no theoretical or experimental evidence suggests the existence of D-D distances shorter than that in the molecule D_2 or the achievement of "confinement" pressure above relatively modest levels. The known behavior of deuterium in solids does not give any support for the supposition that the fusion probability is enhanced by the presence of the palladium, titanium, or other elements.

5. Nuclear fusion at room temperature, of the type discussed in this report, would be contrary to all understanding gained of nuclear reactions in the last half century; it would require the invention of an entirely new nuclear process.

RECOMMENDATIONS

1. The Panel recommends against any special funding for the investigation of phenomena attributed to cold fusion. Hence, we recommend against the establishment of special programs or research centers to develop cold fusion.
2. The Panel is sympathetic toward modest support for carefully focused and cooperative experiments within the present funding system.
3. The Panel recommends that the cold fusion research efforts in the area of heat production focus primarily on confirming or disproving reports of excess heat. Emphasis should be placed on calorimetry with closed systems and total gas recombination, use of alternative calorimetric methods, use of reasonably well characterized materials, exchange of materials between groups, and careful estimation of systematic and random errors. Cooperative experiments are encouraged to resolve some of the claims and counterclaims in calorimetry.
4. A shortcoming of most experiments reporting excess heat is that they are not accompanied in the same cell by simultaneous monitoring for the production of fusion products. If the excess heat is to be attributed to fusion, such a claim should be supported by measurements of fusion products at commensurate levels.
5. Investigations designed to check the reported observations of excess tritium in electrolytic cells are desirable.
6. Experiments reporting fusion products (e.g., neutrons) at a very low level, if confirmed, are of scientific interest but have no apparent current application to the production of useful energy. In view of the difficulty of these experiments, collaborative efforts are encouraged to maximize the detection efficiencies and to minimize the background.