FUSIONfacts

A Monthly Newsletter Providing Factual Reports On Cold Fusion Developments

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A. SCOREBOARD ON F-P EFFECT REPLICATION

DATES EVENTS

1986-1989 Prof. Steven E Jones at Brigham Young Univ. speculates and proves that fusion events occur within metal lattices.

3/24/89 Profs. Martin Fleischmann and B. Stanley Pons announce the discovery of solid-state fusion producing excess energy, (F-P Effect.)

3/25/89 Gov. Bangerter calls special session of Utah legislature.

3/30/89 Prof. Jones announces previous work that demonstrates fusion can occur at room temperatures in metal lattice.

4/1/89 April Fool's day announcement by University of Utah phyicist that FP Effect is not fusion.

4/2/89 Profs. Gyula Csikai and Tibor Sztaricskai at Kossuth Lajos Univ. in Debrecen, Hungary announce the detection of neutrons is replication of F-P Effect.

4/5/89 Brookhaven National Laboratory tentatively confirms solid-state fusion similar to BYU.

4/7/89 Jrnl. of Electroanalytical Chem. accepts Fleischmann, Pons, Hawkins paper for publication.

4/8/89 Utah Legislature approves $5 million for fusion funding and requires committee approval.

4/9/89 Skeptical scientists begin publishing information on why F-P Effect can't be fusion.

4/10/89 Michael Hall at Texas A & M announces replication of excess heat in F-P Effect.

4/12/89 Mathews et al, Indira Gandhi Centre for Atomic Research at Kalpakkam, India, has first success in temperature rise in F-P Effect.

4/12/89 Tass reports that Runar Kuzmin of Moscow University's Physics faculty replicates F-P Effect.

4/13/89 Peter L. Hagelstein, MIT (among others), announces theory that explains the F-P Effect.

4/14/89 Van L Edden and Wei Liu at Univ. of Washington announce replication of F-P Effect with possible detection of tritium.

4/14/89 Report that experiment at Lawrence Livermore National Laboratory "blew up".

4/15/89 Gov. Bangerter appoints members of Utah Energy/Fusion Advisory Committee.

4/17/89 Fusion Information Center incorporates under laws of the State of Utah.

4/18/89 Wall Street Journal reports that Fusion Fever hits Japan - emergency scientific conference call at Yokohama National University with 600 attending.

4/18/89 Scientists at Italy's National Agency for Alternative Energy announce evidence of cold fusion similar to F-P Effect.

4/20/89 Governor Bangerter signs Utah fusion funding bills.

4/20/89 Nature agrees to publish Jones' paper but not one submitted by Fleischmann and Pons (without further data).

4/21/89 Successful replication of F-P Effect reported by Huggins at Stanford and by a team of physicists in Czechoslovakia and by India scientists.

4/25/89 U.S. Secretary of Energy James D. Watkins directs his 10 national laboratories to set up cold fusion efforts. DOE to sponsor Cold Fusion Workshop.

4/26/89 Pons briefs the House Science, Space and Technology Committee on the reality of cold fusion.

4/28/89 Deseret News, page A-2, reports that two national labs have confirmed FP Effect but withheld public announcement pending publication in a scientific journal (Los Alamos and Oak Ridge?). More than 100 scientists have been assigned by Japanese Ministry of International Trade and Industry (MITI) to do cold fusion research.

4/29/89 Dr. Landau, Case Western Reserve University in Cleveland, confirmed F-P Effect.

4/30/89 Nature speculates that F-P experiment is fatally flawed and will never be verified by other scientists.

Apr/May University of Utah Review gives reasons for choice of media release by Pons/Fleischmann.

5/2/89 Attendees at American Physical Society spring meeting in Baltimore cheer Koonin of U. Calif. at Santa Barbara when he states, "Based on my knowledge, the experiment is wrong. It suffers from the incompetence and delusions of Drs. Pons and Fleischmann." (Deseret News, May 2, 1989).

5/4/89 Third team at Texas A & M, headed by Bockris, confirms F-P Effect.

5/7/89 Lengthy article in The Indian Post, Bombay, reports on the enormous progress made by India scientists in replicating the F-P Effect.

5/9/89 Pons and Fleischmann provide additional cold fusion data at meeting of the Electrochemical Society in Los Angeles. Considerable skepticism.

5/10/89 U/U legal staff prevent completion of agreement between U/U and Los Alamos National Laboratory. Pons and Fleischmann restricted by legal staff on what they can say.

5/13/89 Johnson Matthey picks up palladium rods from U/U to assay.

5/15/89 "Cold Fusion Appears Dead," says nuclear physicist Peter D. Zimmerman in special to the LA Times.

5/15/89 Wall Street Journal reports on publication of Dr. Steven Jones (BYU) paper in Nature (vol.338, pp.737ff) and the subsequent negative comments by Nature's editor.

5/18/89 Indian scientists meet at Bhabha Atomic Research Centre (BARC) near Bombay to report on cold fusion findings. India News, June 1989, pg 8.

5/18/89 Dr. Chase Peterson, Pres U/U and Dr. Brophy, V.P. U/U, reiterate that a national effort is needed to keep solid-state fusion from being exploited by foreign competitors. S.L. Tribune, pg. B1.

5/22/88 Dr. Chase Peterson, Pres U/U, reports that Case-Western Reserve, Texas A & M, U. of Washington, U. of Florida, and the Italian Frascati Labs have all confirmed crucial parts of the F-P experiment.

5/23/89 Times of India report "Cold Fusion generates heat in Madras", an article by G. V. Krishnan reports on experimental results from research teams at IGCAR (Kalpakkam), BARC, and Tata Institute of Fundamental Research in India.

5/24/89 WSJ reports on reports of fusion successes at Texas A & M.

5/23-5/25/89 DOE/Los Alamos National Lab. sponsor workshop of cold fusion phenomena at Santa Fe, N.M. Prof. Jones (BYU) work is thoroughly verified by several papers. PF Effect strongly supported by Texas A & M group. Many negative reports (could not replicate) and many negative theories showing that FP Effect could not occur. Some 20 papers supportive of FP Effect. Jones' work at BYU fully substantiated.

5/25/89 "Los Alamos Reports Burst of Neutrons From Fusion Test," says an article in S.L. Tribune.

5/25/89 A team of Mexican scientists report confirmation of solid-state fusion; Swedish physicists at Manne Siegbahn Institute for Physics; and Stanford report fusion successes. Deseret News, pg A2.

6/2/89 Prof. Wadsworth, U/U metallurgist, reports measurement of excess heat from replication of F-P Effect.

6/2/89 Members of U.S. Dept of Energy Committee visit Pons/Fleischmann laboratory at U/U to view fusion experiments in process.

6/3/89 "DOE panel says U. research merits further study," states article in Deseret News, quoting Norman Ramsey, a Harvard physics professor.

6/4/89 U of U Chemistry Department ranks first in the nation in terms of federal research funding per faculty member, says American Chemical Society. Reported in Deseret News.

6/5/89 Fusion Power Associates annual meeting in Washington hears from a panel of fusion scientists that they doubt that the Fleischmann-Pons effect is fusion. Deseret News.

6/6/89 Prof. A. John Appleby, Texas A & M, reports to conference of the American Public Power Association (in Orlando), "We are now very comfortable that what we are seeing here is something that is not chemical, it is something nuclear taking place." Los Alamos director, Sig Hecker, said researchers have also confirmed large tritium production results from Texas A & M experiments. Deseret News.

6/10/89 Prof. George Basalla (special to The Baltimore Sun) explains that cold fusion is a myth. Reprinted in S. L. Tribune pg A11.

6/11/89 Fusion Information Center announces that cold fusion is real and has commercial possibilities. Deseret News.

6/16/89 British scientists at Harwell Laboratory report failure in replicating F-P Effect and call it a "mad idea." S.L.Tribune pg A1.

6/23/89 Edmund K. Storms and Carol Talcott, staff members at Los Alamos National Laboratory in New Mexico, announced they have found tritium in "significant amounts" in two F-P cells. Deseret News.

6/28/89 U of U signs working agreement with General Electric to further investigate cold fusion. Deseret News.

7/1/89 Dr. Tom Barton, director of the Ames National Laboratory in Iowa (one of 10 national labs operated by the Department of Energy), states publicly they are giving up on trying to reproduce the F-P effect. S. L. Tribune.

7/8/89 Article and picture tell about demonstration device that could provide hot water for homes from laboratory of Prof. B. Stanley Pons. Deseret News.

7/10/89 Bockris sends scorecard to Nature magazine: NEUTRONS REPORTED BY: Texas A & M; Indira Center, India; U of Sao Paulo, Brazil; U of C. at Santa Barbara; U of Fla. at Gainesville; Cai, Chinese Academy of Science; and Rome scientists. TRITIUM REPORTED BY: Texas A & M (2 teams); Rome scientists; Los Alamos National Lab; and Mexico scientists. EXCESS HEAT BY: Texas A & M (3 teams); Tata Institute; Stanford U; Portland State U; Independent U team; Rome scientists; and Los Alamos National Lab.

7/12/89 "GE Scientists Give U. Fusion Claims New Life," says headline in Salt Lake Tribune pg B1. GE report said, "after long and careful study...concludes that the basic calorimetric theory of Pons and Fleischmann is correct and shows excess energy."

Second article cites Richard W. Giauque, attorney for U/U cold-fusion research stating that the U.S. Patent Office has received more than 50 patent applications in the field of "nuclear claims."

7/13/89 "There is no persuasive evidence that a new nuclear process was discovered last winter by University of Utah cold fusion researchers, according to preliminary draft report released Wednesday, July 12, 1989, by a Department of Energy panel," states article in Deseret News.

7/21/89 Utah's Fusion/Energy Advisory Committee votes to allot $4.3 million of Utah funds (as set aside by the legislature) to University of Utah.

8/1/89 A cold fusion conference was held in Japan on 7/31/89, and on 8/1/89 an announcement was made that 80 scientists from 15 Universities in Japan were selected to work on cold fusion. This organized effort assigned the scientists to three working groups: experimental, theoretical, and applications. Report from Ramtanu Maitra, Editor of Fusion Asia.

8/5/89 Utah Board of Regents approve establishment of "National Cold Fusion Institute" by Univ. of Utah. Deseret News pg B3.

8/8/89 U/U's National Cold Fusion Institute begins moving into facilities at University of Utah Research Park.

8/15/89 Gad Shani, a fusion researcher from Hebrew University in Jerusalem, visited in Utah to exchange information on cold fusion research. Shani reports results of measuring neutrons similar to Prof. Steven Jones at BYU. The Universe (BYU publication).

8/21/89 Professor Peter Jeschofnig of Colorado Mountain College reports that the college's high altitude experiments in testing for cold fusion did appear to generate fusion. Work was supported by Rockwell International. Reported in Community College Week.

8/24/89 Japan has organized an Institute of Fusion Science under the leadership of Hido Ikegami, a respected Japanese scientist. From S.L.Tribune article interviewing Ramtanu Maitra, Editor of Fusion Asia.

B. NEWS FROM ASIA - SOLID-STATE FUSION DEVELOPMENTS

The following information is from Ramtanu Maitra, New Delhi, India.

The following organizations are involved in cold fusion research and development in India:

IGCAR...Indira Gandhi Centre for Atomic Research, Kalpakkam, India.

BARC....Bhabha Atomic Research Centre, Bombay.

TIFR....Tata Institute of Fundamental Research, Bombay.

VECC....Variable Energy Cyclotron Centre, Calcutta.

AEC.....Atomic Energy Commission. This organization is the equivalent in India of our AEC in the United States.

FROM TIMES OF INDIA.

Dr. C.K. Mathews (head of radiochemistry program at IGCAR), G. Periaswami, K.C. Srinivas, T. Gnanasekaran, S. Rajan Babu, C. Ramesh, and B. Thiyargarajan have submitted a 12-page paper to the Indian Journal of Technology. This paper details the early results of the on going study of the F-P experiment. The report confirms that surplus heat was generated by the electrolysis of heavy water. The level of neutrons found was too low to account for the heat generated. In some of the experiments, no neutrons were detected, reports Dr. Mathews.

Dr. Mathews reports that they used a platinum mesh anode in the form of cylinder and a palladium cathode in the center. The palladium cathode was made from melting and casting palladium powder. In some experiments a cylinder of titanium mesh was used as the cathode.

Mr. S.R. Balasubramaniam (head of fuel reprocessing development for IGCAR) is looking into cold fusion heat exchange systems to extract heat developed in the fusion cells. We assume it is this group that has designed the five-foot palladium mesh cathode for experimental work.

Reportedly, some Indian scientists have determined that the current level of heat produced by cold fusion is sufficient to warrant further scaled-up experiments. Their studies indicate that the heat density from a power plant design is currently competitive with the heat density in a commercial coal-fired power plant.

Planned studies include the conditions by which surplus energy production can be sustained. These studies involve the nature of the electrodes, the time and current required to start and sustain the heat production; the size of the cathode; and the contents of the heavy water solution.

Note: See Times of India, May 23, 1989, "Cold Fusion generates heat in Madras." by G. V. Krishnan.

FROM INDIA NEWS.

On May 18, 1989 a secret seminar of physicists working on cold fusion was hosted at BARC. These physicists were from several of the Department of Atomic Energy laboratories in India and exchanged information on their work on cold fusion. India News, June 1989, pg 8-9 reports the following:

"In one such experiment, scientists with the VECC, Calcutta, took a small glass beaker filled with heavy water flown from BARC, Bombay, and passed an electric current for about seven hours through electrodes made of palladium and platinum.

"They were stunned by the rise in the temperature of the palladium electrode (where deuterium was supposed to collect) from 25 degrees Centigrade to 50 degrees Centigrade. Moreover, their detectors recorded a burst of the subatomic particle neutron in almost the same time as was taken by the palladium electrode to increase its temperature."

The article includes, "Given the immense implications of cold fusion, it is certain that India's attempts will not be liked by the West. The activities in Indian laboratories, however, prove that the country is not merely in the business, but is quite ready to move ahead."

Directions for further research that arose at the conference include finding answers to the following:

What is the minimum density distribution of deuterium in palladium that initiates the so-called fusion? Are there any alternative mechanisms to pump in more deuterium into palladium? What is it that caused the distance between two rules (sic) of deuterium to be minimized so much as to cause fusion? Is it the so-called "effective electron mass increase" that reduces the distance?

FROM THE INDIAN POST, BOMBAY.

The Indian Post, in it's May 7, 1989 edition, has a special report on cold-fusion under two headlines: "The greatest discovery since fire?", and "India and the new world of fusion." The following are highlights from those articles:

Within three weeks of the announcement of cold fusion by Fleischmann and Pons, four groups at BARC, four groups at IGCAR, and a team at TIFR had replicated the experiment and validated the process. The BARC team not only demonstrated excess heat but also proved that the cells could produce neutrons well above background level.

The Indian Post states, "And while scientists elsewhere in the world are busy squabbling about whether cold fusion is illusion or fact, BARC scientists have already launched a massive and ambitious research programme to crack the cold fusion mystery and translate the process into commercial-scale technology as quickly as possible. The stakes in the quest for cold fusion are high. For India, it will mean electricity so cheap that even the poorest will be able to afford it. For the scientists it will mean high honour at home and abroad, and possible unlimited financial reward."

Shortages of equipment or funds are not anticipated in India's cold fusion research and development efforts. BARC, for example, has superbly equipped labs and liberal grants. BARC scientists has a history of working with nuclear reactors for over forty years. P.K. Iyengar, director of the BARC, is quoted as saying, "...but as of now we are very excited about the process and we have launched a series

of experiments to find out how the output of the cells can be stabilised and maximised and how problems such as corrosion of electrodes can be eliminated."

The Indian Post also states, "Iyengar's team of over 40 scientists are probably amongst the first anywhere in the world to have started working on making cold fusion cells a commercial reality even as they and others around the world are burning the midnight oil to unravel the physics behind the process. ...experiments in BARC and elsewhere show that the palladium and titanium electrodes used in the cells tend to burn and corrode ... If the electrode problem can be solved through the use of alloys or by passing coolants through the electrode, it might be possible to operate the process at above the boiling point of water in a pressure vessel."

In discussing the power-plant applications, the Indian Post states, "If and when this happens electricity will become so cheap that it will probably replace other forms of energy in most uses. Exact costs are difficult to predict as yet. ... (In such a reactor) the preferred metal is likely to be titanium) ... (With current costs of titanium and heavy water) the power station (would cost under) a third to a quarter of the current cost of a thermal power station in India."

The Indian Post continues, "Cold fusion reactors do not have to be of any minimal size as nuclear reactors do, so even small power stations to serve local needs are conceivable. That would mean the elimination of distribution losses which currently account for up to 20 percent of all power generated in India, and more importantly the elimination of expensive high tension lines which account for almost 40 percent of total capital costs in electric energy utilisation. For both these reasons, electricity from cold fusion will cost even less. Consumer costs of under 20 percent of current prices are conceivable. At such prices, electricity will be cheaper than kerosene and LPG as a source of heating energy in the home, and cheaper than diesel for train transportation."

"... More importantly, the industry and transport sectors which currently consume oil products valued at over Rs 12,000 crores will switch to electricity in a big way, which will mean greatly reduced oil imports or possible oil self-sufficiency. The implications for the balance of payments and political independence are heady."

"India and the New World of Fusion" is the title of an article by Michael Neri in The Indian Post. The initial statement is, "As the rest of the world debates whether cold fusion is reality or illusion, several teams of Indian scientists have got ahead in the race to translate the process into commercial-scale technology as quickly as possible."

Neri introduces the background of the Utah discovery and then makes the following observation: "Hundreds of laboratories around the world have attempted to replicate the Fleischmann-Pons experiment. The reasons for this frenzied anxiety are clear. If cold fusion actually occurs, the age of unlimited, cheap power would be at hand and nuclear fision, coal and oil would become redundant as sources of energy. Environmentally friendly -- fusion generates no radioactive wastes or chemical pollutants -- cold fusion will banish the spectre of the greenhouse effect, make oil spills a thing of the past and remove man's dependence on fossil fuels. It is this utopian vision that have motivated fusion researchers and driven governments to pour millions of dollars into 'hot fusion' research programmes, which till Fleischmann and Pons (F&P came) on the scene, was believed to be the only route to fusion power."

Neri states, "Possibly the most rigorous confirmation of the F&P experiment has come

from the BARC, a world leader in atomic energy research and one of the best equipped nuclear laboratories in the world. 'We have no doubt that heat and neutrons are generated when a current is passed through a cell containing palladium or titanium electrodes in heavy water. The indications are that these effects are the results of fusion though we have not yet ruled out the possibility that some other process such as the Wigner effect (which is seen in fission reactors) is at work. But whatever the explanation, the effects themselves have been confirmed beyond doubt.' says Dr. P.K. Iyengar, Director of BARC at Trombay."

Other excerpts from Neri's article: "Dr. K.S.V. Santhanam, head of the Chemical Physics Department at TIFR, Bombay, said, `We also read the first reports of the experiment in the newspapers and decided to attempt it immediately but changed two important parameters of the Utah experiment -- titanium in place of palladium and simple sodium chloride for lithium.' On the TIFR's third attempt (they wrecked two temperature measuring thyristors while trying), a phenomenal temperature rise of 1 degree C per minute was recorded."

Neri quotes Dr. R Chidamberam, head of the Physics group at BARC, as saying, "Even we are not certain under what conditions it (the experiment) can be reproduced in our own laboratory, so it is not surprising that other laboratories are having difficulty replicating the results. But like ceramic superconductors, we may be onto something that may be a long way away from practical use. If the process was simple and straightforward, we should have struck gold by now with our resources. We haven't. On the contrary, we are still trying to find out the basic parameters of the experiment."

Neri also observes, "In laboratories around the world neutron emission has proved difficult to detect which explains why there is so much skepticism for Fleischmann and Pons' claim. Yet, if Peter Hagelstein, a theoretical physicist is right, skeptics who have been looking only at neutron emission levels could be wasting their time. Hagelstein has postulated that the excess energy from the fusion of deuterium nuclei goes not into the radiation or subatomic particles but into the structure of the palladium electrode, eventually appearing as heat. The novel hypothesis has few buyers as yet, though no one has shown that it is impossible."

Editor's Note: Although it is not our policy to base our reports to our subscribers on reports from the news media, this is the first printed information that confirms what we have been hearing about work in India. We thought the material to be of considerable interest. Here are the names that we have gleaned from our reading that may be appearing in the technical literature: Dr. C.K. Mathews; V.R. Raman; G. Periaswami; K.C. Srinivas; T. Gnanasekaran; S. Rajan Babu; C. Ramesh; B. Thiyagarajan; Balasubramaniam; Dr. Raja Ramanna (defense adviser to the Prime Minister); Dr. Bikash Sinha; Dr. Y.P.Vyogi; Dr. G.S.N. Murthy; Dr. D. Muthukrisman; Dr. D.K. Srivastav; Dr. Subhasis Chatterjee; Dr. K.S.V. Santhanam; Dr. P.K. Iyenger; and Dr. R. Chidambaram.

C. CORPORATIONS ADVANCING FUSION TECHNOLOGY

Fusion Facts would like to pay special tribute to those corporations who are supporting research into solid-state fusion.

Eaton Corporation is reportedly supporting some research work in cold fusion at Case Western University.

Readers are asked to let us know of other corporations which are supporting research work in this exciting new technology.

D. SOLID-STATE FUSION -- SOLID-STATE SEMICONDUCTORS.

It has been suggested by several investigators that the solid-state fusion technology is comparable to the semi-conductor technology of the late 1940's.

Some of the common parameters are the following:

* The science is new and has few trained professionals.

* Experimental results are not easily replicated.

* The apparent same treatment of an experiment produces different outcomes.

* Different persons performing the same experiment have different results.

* Frustrated workers mumble about "black magic."

* Control parameters are found. For example, raising the cell current above a critical current level will stop neutron production.

* A gradual learning curve is established as the technology matures.

Some suggestions that may help researchers:

* Maintain great cleanliness. One worker in hydrides found that a touch of a finger to an electrolytic solution could stop the flow of hydrogen into a metal cathode.

* Work from the known to the unknown by changing only one parameter at a time.

* Use identical materials for a series of experiments.

* Communicate fully with others who have had successes.

* Read all of the technical reports of successes, but don't believe all you read. For example, one researcher states that the palladium must be cast. Another researcher is having a series of successes with extruded palladium wire (but better success after annealing).

* Don't expect nature to observe previous theories. You may be working on a new discovery. For example, many researchers are looking for neutrons to occur in a fusion cell based on "received learning" from plasma physics. Some researchers have found that in an F-P experiment it is much more difficult to produce a cell that will produce neutrons than to make a cell that will produce tritium or excess heat.

* Great purity is not necessarily the optimum. For example, one research group has reported that coin palladium gave them better results than palladium of higher purity. (Here is a case to not believe everything you read. There may have been other workers who achieved better results with higher purity materials.)

* There are many parameters that affect the F-P experiment. Do not assume that you have provided suitable values for all of them. Here is a partial list of parameters that will affect the results: Pd purity; cell current; cell chemistry (especially contamination); cathode metal; cathode size; cathode shape, methods of connecting conductors to the cathode, type and cleanliness of stoppers, gaskets, spacers, etc.; purity of heavy water; surface treatment of the cathode; chemical treatment of the cathode (poisoning); and others that haven't been identified and reported.

* Determine the ratio of D/Pd. The critical ratio is considered to be higher than .67 (which

is the D/Pd ratio expected with simple electrochemistry). Some researchers suggest that the D/Pd ratio must be greater than 0.9 which requires special surface treatment of the cathode to achieve.

* Charge the cathode at low currents for a suitable length of time. Low charging currents allow the palladium lattice being loaded with deuterium to expand slowly without too many fractures.

* Some researchers measure the change in physical dimensions of the Pd rod (or wire) as an easy way to determine when the appropriate D/Pd ratio has been achieved. If the dimensions of the Pd do not increase sufficiently, fusion reactions cannot be expected to occur.

* The success of the F-P experiment is highly dependent on careful adherence to proper electrochemical procedures. The research team should include a highly skilled electrochemist. Many unsuccessful teams have made an incorrect assumption that all the details for the experiment were given in the original paper by Fleischmann, Pons, and Hawkins. [J. Electroanal. Chem. 261 (1989) 301-308]. Skilled electrochemists and skilled materials scientists have had more successes than physicists in achieving success in replicating the F-P experiment.

RECOMMENDED PAPERS TO STUDY CAREFULLY

Fleischmann, Pons, and Hawkins, "Electrochemically induced nuclear fusion of deuterium." J. Electroanal. Chem. vol 261 (1989), pgs 301-308. Note that the work on measuring neutrons was later withdrawn. Note the warning to avoid sharp edges on the Pd cathode.

Appleby, et al, "Evidence for excess heat generation rates during electrolysis of D_2O in LiOD using a Palladium cathode - a microcalorimetric study." Presented at Workshop On Cold Fusion Phenomena, May 23-25, 1989, Santa Fe, New Mexico. (Note: Proceedings being published. Authors from Texas A & M.)

Wolf et al, "Neutron emission and the Tritium content associated with Deuterium loaded Palladium and Titanium metals." Presented at Workshop On Cold Fusion Phenomena, May 23-25, 1989, Santa Fe, New Mexico. (Note: Proceedings being published. Authors from Texas A & M.)

Packham, Wolf, Wass, Kainthla, and Bockris, "Production of Tritium From D_2O electrolysis at a Palladium cathode." Presented in part by Bockris at the 13th Annual Utah Conference on Energy, Mining, and New Technology, Sept 8, 1989, Univ. of Utah. Publication date and journal not yet identified.

Belzner et al (including Huggins, R. A.), "Two Fast Mixed-Conductor Systems: Deuterium and Hydrogen in Palladium -- Thermal Measurements and Experimental Considerations," invited Huggins to talk at Stanford on work with excess heat measurements using cast palladium cathode. Presented at Workshop On Cold Fusion Phenomena, May 23-25, 1989, Santa Fe, New Mexico. (Note: Proceedings being published.)

Paolo, Peroni, Letter to Editor in Scientific Correspondence, Nature, vol. 338, 27 April 1989, page 711. Note: Paolo references the Oppenheimer and Phillips (1935) observation that when the kinetic energy is small that the neutron from one deuterium atom can be captured by the target nucleus of another deuterium atom while the proton, which remains outside the Coulomb barrier, will fly off. Paolo states that one should expect no neutron emission and a reaction rate much higher than that evaluated on the basis of high-energy model.

Note: Video tapes were made of all talks presented at Workshop On Cold Fusion

Phenomena, May 23-25, 1989, Santa Fe, New Mexico.

The "Highlights of Papers Presented at the Workshop on Cold Fusion Phenomena." has just been published. Reference LA-11686-C Conference.

Available to the public from: National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161. Price Code A03. Microfiche A01. Available to DOE contractors through OFTI.

Other excellent success papers are pending publication. Fusion Facts will provide references as soon as we have the information. Free copies of FF to the first reader who sends information about papers published or to be published. Ed.

E. FUSION IMPACT ON THE AUTOMOTIVE INDUSTRY

BACKGROUND

The Model T Ford that could be disassembled and assembled with one wrench has evolved into a complex vehicle having thousands of precision parts. The demands of anti-pollution have engendered a complex vehicle that costs as much as a house and lot of 20 years ago.

Government regulations to help diminish the atmospheric contaminants have impacted the design of cities (to reduce traffic), have impacted mass transit (to reduce vehicular traffic), and have changed the design of automobile engines (to reduce pollution).

The advent of solid-state fusion will strongly impact the automotive industry as well as the entire transportation industry. This impact article discusses some of the expected changes in the automotive industry.

THE FUSION - ELECTRIC AUTOMOBILE

Three technologies are expected to combine to create a non-polluting automobile that will strongly impact the transportation industry, the oil and gasoline industry, and the automobile manufacturing and service industries.

These three technologies are solid-state fusion, space-age batteries, and semi-conductor thermal-electric devices. Space-age batteries can store up to 50 times the energy per pound of battery as the familiar lead-acid automobile battery. However, these batteries work well only at elevated temperatures. Solid-state fusion reactors are expected to provide the continuous output of elevated temperatures for the space-age batteries and in addition provide a thermal source for conversion to electricity. An accelerated emphasis on the development of more efficient means of converting low-level heat energy to electrical energy is expected to result in the improvement of semi-conductor thermal-electric systems to become a part of the new generation of vehicle power plants for the forthcoming fusion-electric automobile.

BENEFITS OF THE FUSION-ELECTRIC AUTOMOBILE

The fuel source for the fusion-electric car is the deuterium in heavy water. As heavy water occurs in the ratio of one gallon of heavy water to 7,000 gallons of normal water (sea water, river water, rain water, world wide), the supply of deuterium is sufficient for a few million years.

Under projected nuclear reaction controls, no neutrons and no tritium would be produced in a properly designed fusion cell (stay tuned for this development). Deuterium costs are currently about one cent for the energy equivalent of one gallon of fuel oil. However, the energy conversion efficiency of the projected fusion-electric system may be about 1/10th that of the current internal combustion engine. Fuel

costs would then be about ten cents for the energy equivalent of one gallon of fuel oil.

Manufacturing costs for the fusion-electric automobile would be considerably smaller because the design and fabrication of the power plant and the power train would be much simplified. However, the cost of the fusion reactor cathode could be a significant investment. If palladium is the only suitable cathode material, then there could be a few hundred dollars investment to be made in the initial fusion reactor. Such palladium cathode could be reclaimable and would probably be recycled and restored on an annual basis.

Maintenance costs for the fusion-electric automobile should be relatively less as compared to the maintenance of the gasoline engine vehicle of today. The major reason would be the great reduction in the number of moving parts.

The most important benefit to be enjoyed is the lack of atmospheric pollutants. This would mean a considerable change in the way we try to control traffic. Money now spent on limiting traffic to reduce metropolitan pollution could be spent on increasing the handling of traffic (multi-level freeways, improved parking facilities, and expanded access to factories and businesses). Such freedom from pollutants is predicted on the ability to control fusion reactor nuclear reactions so that no damaging fusion by products occur or if these products occur that they can be easily trapped or shielded.

PROBLEM AREAS TO BE RESOLVED

POSSIBLE SCARCITY OF PALLADIUM

Although scientists in India have found means to create fusion cells using titanium (verbal communication from our corresponding consultant in New Delhi), no published articles have been received by which the use of titanium can be assessed. If palladium were to be the sole material to use as the fusion reactor cathode, there would be strongly escalating prices for palladium and a shortage of supply until we could mine the asteroids for palladium.

POSSIBLE DANGERS

Some sources of information have already been extolling the dangers of fusion cell use. Such sources talk about the dangers of neutrons and the dangers of tritium gas. One nuclear physicist claims that solid-state fusion reactors could never be used in an automobile because of these dangers.

If one wants to talk about dangers, consider the dangers involved in traveling around carrying ten to twenty gallons of highly inflammable, toxic gasoline in a thin walled metal tank at the rear end of a vehicle.

It has already been discovered (Texas A&M) and confirmed (Florida State) that the fusion cell nuclear reactions can be controlled to prevent the emission of neutrons. (Personal communications with K.L.Wolf.) We are assured by FIC scientists that the production of tritium can be controlled and/or contained by good engineering design. One only has to consider that the size of a fusion cell (to be protected in the case of an accident) is much smaller than the gasoline tank we carry in today's automobile. Protection of the fusion cell to prevent spillage of any tritium-containing fluids is a relatively simple engineering task because the size of such containment vessel could be less than a cubic foot and could be designed to withstand vehicle demolition.

Solid-state fusion engineers are projecting an energy density for a palladium cathode to be in the range of 100 to 1,000 watts per cubic centimeter. Engineering studies of the size and weights of heat exchange equipment and other vehicle power subsystems are expected to show that a complete fusion power system for an

automobile (or a truck) would weigh less than the equivalent internal combustion engine used in today's vehicles.

THE ROLE OF TODAY'S SERVICE STATION

It is expected that the fusion reactor of a fusion-electric automobile would require servicing and electrolyte replacement two to four times a year. In addition, regular servicing of batteries, tires, wheels, and brakes would be similar to today's automobile. Therefore, there would be a place for a reduced network of service stations (as contrasted with gasoline-delivery stations) to support the fusion-electric automobile.

It is expected that the existing service stations would adapt to the introduction of the fusion-electric automobile. However, the grocery-gasoline delivery stores would probably decline in number.

RETRAINING OF AUTOMOTIVE MECHANICS

One of the big problems that would result from a rapid changeover to fusion-electric automobiles would be the need for re-education of automobile mechanics. There would be a net reduction in the need for engine mechanics but an increase in persons handling the maintenance of electric motors, batteries, brakes, and fusion reactors.

The freedom from pollution coupled with a smaller fuel cost of operating a fusion-electric automobile is expected to increase the demand for automobiles. It is likely that the greatest increase would be for recreational vehicles. The end result is expected to be a strong demand for trained personnel. This demand could be met by retraining existing mechanics.

CHANGES DUE TO ENVIRONMENTAL BENEFITS

As compared to today's polluting automobiles and trucks, the fusion-powered vehicle will contribute almost zero atmospheric pollutants. The result will be a change in the way we design our cities. Recently some cities have had to redesign downtown areas to limit automobile access because of clean air standards imposed by the federal government. Cities will have an option to build their businesses to handle either mass transit systems or to handle increasingly larger numbers of automobiles. In the U.S. it is expected that the automobile will win over mass transit as fast as we design and build new non-polluting automobiles.

Note: Future editions of Fusion Facts will report on the potential solid-state fusion impact on other aspects of the transportation industry.

F. LATEST NEWS AND OCTOBER ISSUE

PAPER FROM MIT

D. Albagli, R. Ballinger, V. Cammarata, X. Chen, R. M. Crooks, C. Fiore, M.J.P. Gaudreau, I Hwang, C.K. Li, P. Linsay, S.C. Luckhardt, R.R. Parker, R.D. Petrasso, M.O. Schloh, K.W. Wenzel, and M.S. Wrighton from the MIT Departments of Chemistry, Nuclear Engineering, Materials Science and Engineering and the Plasma Fusion Center have prepared a paper, "Measurement and Analysis of Neutron and Gamma Ray Emission Rates, Other Fusion Products, and Power in Electrochemical Cells Having Pd Cathodes." The paper was prepared for publication in the Journal of Fusion Energy.

The paper is well written, well documented, and contains 32 references. The one page section describing the preparation of electrodes and electrolyte solutions makes no mention of the critical D/Pd ratio required to support cold fusion reactions nor any mention of the electrochemical treatment of the palladium cathode required to obtain high D/Pd ratios. The abstract concludes,

"Within estimated levels of accuracy, no excess power output or any other evidence of fusion products was detected."

PAPER FROM BARC

P.K. Iyengar, "Cold Fusion Results in BARC Experiments," presented at Fifth International Conference on Emerging Nuclear Energy Systems (ICENES V), Karlsruhe, Federal Republic of Germany, July 3-6, 1989. Dr. Iyengar is the Director of the Bhabha Atomic Research Centre, Trombay, Bombay, 400 085, India.

The abstract of Dr. Kyengar's paper ends with this statement: "On the whole the Trombay experiments have unequivocally confirmed the occurrence of cold fusion reactions both in Pd and Ti metallic lattices loaded with deuterium."

PUBLISHED PAPERS

T. Mizuno, T. Akimoto, and N. Sato, "Neutron Evolution from Annealed Palladium Cathode in LiOD - D2) Solution," Electrochemistry, Vol. 57, No. 7, July, 1989). This short two-page paper reports the measurements of neutrons from an annealed palladium electrode. The introduction states, "This communication reports the results of our preliminary examination and confirms the evolution of 2.5 MeV neutrons which correspond to one of the reaction products of the nuclear fusion, D + D --> ^{3}He + n."

The September 1989 issue of "Fusion Technology" (A Journal of the American Nuclear Society) has the following articles:

1. "Virtual-State Internal Nuclear Fusion in Metal Lattices," by Robert W. Bussard.

2. "On the Possibility of a Nuclear Mass Energy Resonance in D + D reactions at Low Energy," by J. Rand McNally, Jr.

3. "Advanced Energy Conversion Methods for Cold Fusion," by Mark A. Prelas.

4. "On the Possibility of Deuteron Disintegration in Electrochemically Compressed D= in a Palladium Cathode," by Magdi Ragheb and George H. Miley.

5. "Preliminary Experimental Study on Cold Fusion Using Deuterium Gas and Deuterium Plasma in the Presence of Palladium," by Albert G. Gu, Robert K. F. Teng, Mark S. Miller, and Wayne J. Sprouse.

6. "A Novel Apparatus to Investigate the Possibility of Plasma-Assisted Cold Fusion," by David N. Ruzic, Kenneth D. Schatz, and Phi Long Nguyen.

7. "Isotopic Hydrogen Fusion in Metals," by Vern C. Rogers and Gary M. Sandquist.

8. "Electrochemically induced Deuterium-Tritium Fusion Power Reactor -- Preliminary Design of a Reactor System," by Y. Oka, S. Koshizuka, and S. Kondo.

9. "Reactor Prospects of Muon-Catalyzed Fusion of Deuterium and Tritium Concentrated in Transition Metals," by Weston M. Stacey, Jr.

The editor of Fusion Technology plans to have a Special section for technical notes on cold fusion in subsequent issues of this journal.

WORKSHOP ON COLD FUSION PHENOMENA

Los Alamos National Laboratory has published (and distributed to attendees) "Highlights of Papers Presented at the Workshop on Cold Fusion Phenomena," Santa Fe, New Mexico, May 23-25, 1989. Copies of this 26-page document are available from the National

Technical Information Service, U. S. Department of Commerce, 5285 Port Royal Rd., Springfield, VA 22161.

Note on Tritium Production.

Dr. K. L. Wolf was kind enough to send us a draft of "Neutron Emission and the Tritium Content Associated with Deuterium Loaded Palladium and Titanium Metals," by K.L. Wolf, N.J.C. Packham, D.R. Lawson, J. Shoemaker, F. Cheng, and J. C. Wass. The paper will appear in the Proceedings of the Workshop on Cold Fusion Phenomena, May 23-25, 1989, Santa Fe, NM.

An additional paper has been prepared to report further experimental findings: "Production of Tritium from D_2O Electrolysis at a Palladium Cathode," by N.J.C. Packham, K.L. Wolf, J.C. Wass, R.C. Kainthla, and J.O'M.Bockris, Department of Chemistry and the Cyclotron Institute, Texas A & M University, College Station, Texas 77843. Dr. Bockris presented parts of this paper at the 13th Annual Utah Conference on Energy, Mining and New Technology, University of Utah, Friday, September 8, 1989. Dr. Bockris made the statement that tritium can be expected to be produced at about two percent of the current costs of producing tritium. This paper reports on experiments with cold fusion cells where all sources of tritium contamination are evaluated. The results are that tritium is produced at levels as high as 50,000,000 times background activity. (The publication date and place for this paper was not known at the time of publication of this issue. Ed.)

ANNOTATED BIBLIOGRAPHY ON COLD FUSION

Dr. Samuel P. Faile has been and is collecting bibliographic information on cold fusion. Fusion Facts is negotiating with Dr. Faile to offer this bibliography to our readers on computer media together with "INFOFIND," a search and retrieval program for desk-top computers. We will have more information about the availability of this extensive bibliography in the October issue of Fusion Facts.

THE FASER

A paper just received from David H. Mitchell (PRO Systems, Inc. of San Juan Capistrano, CA) is titled "Fusion Amplification by Stimulated Emission of Radiation." The conclusions state: "Fusion Amplification by Stimulated Emission of Radiation may be a unifying 22concept to help in the development of detailed theories of various aspects of fusion and possibly super-conductivity. Many observed phenomenon can be accounted for by analysis of entire systems not as groups of particles but as standing sets of waves. Optimization of fusion systems should be achieved by resonant analysis of the entire system: fusion cavity, fusion material, and pumping method."

FUSION CONCEPTS TAUGHT BY COMPUTER COURSEWARE

Technical staff of the Fusion Information Center has announced the August 1, 1989 release of a SOLID-STATE FUSION tutorial diskette that will run on desk-top computers compatible with International Business Machines desk-top computers.

About forty concepts from physics and chemistry are presented so that the user can review (or

learn) the ideas important to solid-state fusion. The courseware is student-interactive, concept-based, and is supplied on either 3 1/2 in. or 5 1/4 in. diskettes.

Exposure to high school or college basic physics and chemistry courses are recommended as pre-requisites for this courseware. INFOFIND, a search and retrieval program, together with an index of all non-trivial words and the complete text of the tutorials, is also provided. The introductory price is $99 (two diskettes). The first 200 subscribers to the FUSION FACTS will receive these diskettes at no additional cost.

FURTHER INFORMATION ABOUT FUSION

The following publications have been helpful in furnishing latest fusion information:

FUSION ASIA
C-9 Nizamuddin East
New Delhi 110013, India
$40 for 4 issues.

21st CENTURY SCIENCE AND TECHNOLOGY
P.O. Box 65473, Wash. D.C.
$20 for 6 issues.

FUSION TECHNOLOGY
Recently added new section on Cold Fusion
555 N. Kensington Ave.
LaGrange Park, Illinois 60525
$310 for 2 volumes + 1 supplement.

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