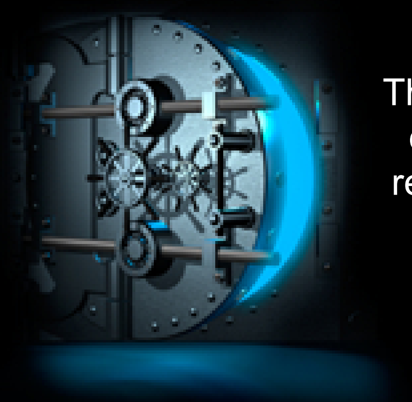

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TITLE: NUCLEAR WEAPON IMPLICATIONS OF "COLD" FUSION

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Nuclear Weapon Implications of "Cold" Fusion

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The great public excitement of "cold" fusion has died away but research continues. Evidence for power generation in electrochemical cells has been strengthened with the addition of reactors for the electrolyzed products. The generation of tritium in these cells as well as in the Frascati-type experiments have been clearly documented, indicating that nuclear reactions are occurring. In some cases, the tritium generation may explain most, if not all, of the excess power generated. While neutrons have been measured in statistically significant numbers, the ratio of neutron to triton production is only 3×10^{-9}, which presents some challenges to nuclear reaction theory. The major implications to the weapon program are twofold: (1) safety of metal hydride storage of deuterium and tritium, and (2) the possibility of economic tritium production. Indeed, economic production may have already been demonstrated. Other possible applications are suggested.

I. BACKGROUND

On 23 March 1989 Martin Fleischmann and Stanley Pons announced via press conference that nuclear fusion had been achieved in an electrochemical cell with a palladium cathode with D_2O (0.1 M LiOD) electrolyte.[1] That same day Steve Jones and collaborators submitted their paper[2] to Nature documenting a similar but lower-level effect with a titanium cathode in an acid electrolyte of D_2O. The following two months were without recent parallel in public excitement concerning things scientific. On 18 April, the Frascati Laboratory in Rome announced the detection of neutrons from titanium charged with deuterium by gas overpressure during pressure and temperature cycles.[3] Other metals[4] can also be made to work similarly.

Public interest has waned and many scientists have dismissed the claims as honest (or dishonest) mistakes. Those who had seen the surprising results [Utah, BYU, Texas A&M, Stanford, Florida universities; Los Alamos National Laboratory; and researchers in Italy, India, and the USSR, among others] have continued experiments. Irreproducibility has been frustrating and indicates an imperfect understanding; however, some conclusions can be drawn. The following is the author's effort to briefly survey them.

II. "COLD" FUSION STATUS--OCTOBER 1989

The electrolytic cells continue to develop excess power at rates of 15[5] to 20[6] watts/cm^3 in the Pd cathode. Alternatively, an excess of 12% of the input power has been documented.[7] These numbers persist even after the recombination of the electrolyzed D_2 and O_2 by a reactor within the calorimeter.

Accompanying the excess power in most, but notably not all, calorimetric measurements has been orders of magnitude increases on tritium concentrations in both the electrolyte and the cathode gas. Triton production rates have reached[8] $>10^{11}$ atoms (T)/sec in cells that produce 0.3 watts excess power (10 watts/cm^3). A reasonable conclusion is that nuclear reactions of some sort are occurring. Indeed, 5×10^{11} tritons/sec from the reaction

$$d + d \rightarrow p + t + 4.0\,\text{MeV} \qquad (1)$$

would create the measured excess power. The source of excess power in cells with no tritium remains to be explained. Tritium is also produced in Frascati type experiments.[9]

Neutrons are emitted in bursts averaging 10^6/minute in electrochemical cells and 5×10^4/min in gas experiments.[9] They seem to come in strongly non-equilibrium conditions. The best value of the ratio of neutron to triton production comes from an unusual solid state sandwich of Pd and silicon,[10] which gives a value of 3×10^{-9}. Confirmatory values were derived from electrochemical cells.[9] This presents a mystery to nuclear reaction models since reaction (1) should be greater than

$$d + d \rightarrow n + {}^3He + 3.27\,\text{MeV}\,,$$

by only a factor of 1.04.[11]

No reliable gamma or x-ray measurements on cells producing excess power/tritium have been reported. Experiments are under way and should help resolve the nuclear reactions that must be occurring.

Despite strong urging,[12] no tritium experiments have yet been performed. Such experiments are needed to help determine reaction mechanisms (hot or cold) as well as to determine possible health risks of metal hydride storage of DT mixtures.

III. WEAPON IMPLICATIONS

- The possibility exists for neutron emission and/or increased tritium concentrations whenever deuterium and/or tritium are stored in metal hydride beds. Either could constitute an unexpected health hazard.
- If tritium were generated at 5×10^{11} atoms/sec from a cell operating at 0.628^{A} $(0.5^{A}/cm^{2})$ with a voltage of 8^{V}, it would provide 18×10^{-6}g(T)/KWH. At 3¢/KWH tritium could be produced for $17K/gram. In addition, 9.4 g(D_2)/KWH would be produced, which is of considerable value together with some 12% excess power. Better efficiency could come with lower voltage (higher molarity). Tritium has been produced[9] in commercially available Milton-Roy cells with 5M NaOD electrolyte; if tritium efficiency was maintained, then this report does make tritium production economic.
- It should be possible to maintain tritium concentrations using metal hydride bed selective absorption and external power during long-term nuclear weapon storage.
- Heavy elements have analogous electronic structure to Pd, Ti, etc. These metals and alloys could be superior in cold fusion applications. Even with similar performance, they suggest interesting device possibilities.
- Neutron bursts seem to occur during maximum non-equilibrium conditions. New initiator concepts?
- A low concentrationP of tritium can be maintained in deuterium gas or deuterated liquid by a variety of methods including electrical current. This could make feasible some interesting design options.

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