

An Informed Skeptic's View of Cold Fusion

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Sources of technical information

- www.LENR.org
- “The Science of Low Energy Nuclear Reaction”, Edmund Storms, World Scientific (2007), www.amazon.com

Difference between hot and cold fusion

Hot Fusion

- Uses high translational energy to blast through Coulomb barrier.
- Characteristic reaction products are equal amounts of tritium and neutrons.
- Initiated in a plasma, by ion bombardment, or by intense laser light.

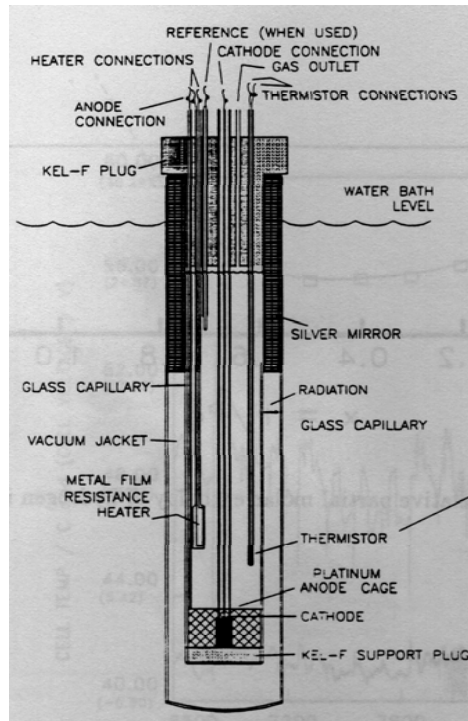
Cold Fusion

- Uses a process in condensed matter at modest temperature to lower the effective Coulomb charge.
- Characteristic reaction products are helium, occasional tritium, rare neutrons, transmutation products and low energy radiation.
- Initiated by electrolysis, gas discharge, ambient gas, or sonic implantation.

Criteria used to evaluate observations

- Quantity, i.e. how often has the basic phenomenon been observed? *How many are enough?*
- Quality, i.e. how far above the expected error or uncertainty is the signal? *How good is good enough?*
- Consistent patterns of behavior, i.e. do various measurements show the same relationship to two or more important variables?
- Can the phenomenon be initiated using more than one method?

Drawing of Fleischmann-Pons calorimeter

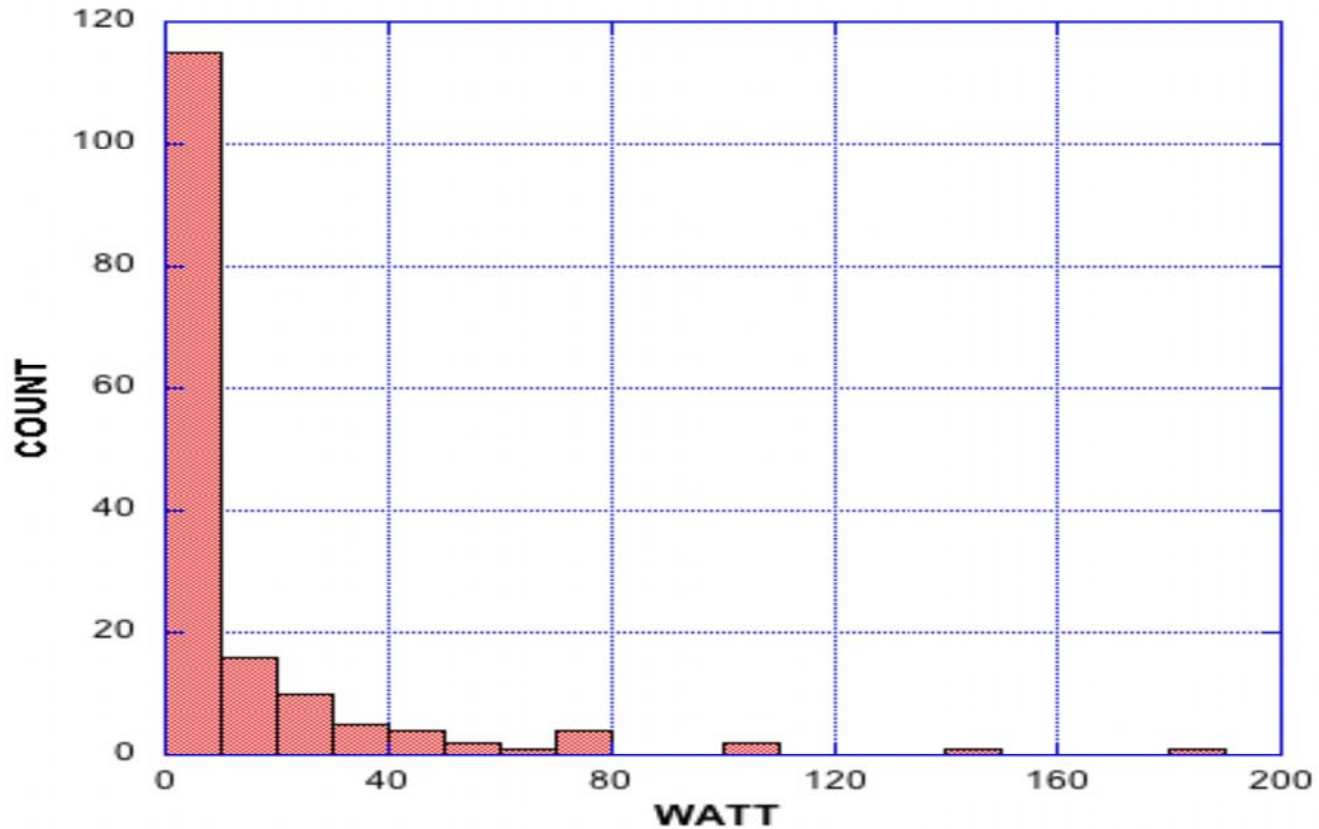


- Cell is filled with $D_2O + LiOD$
- Current is applied to form D_2 at palladium cathode and O_2 at platinum anode.
- Applied Power = $V * A$.
- Temperature difference between inside and outside is measured. Produced Power = $A + B * \Delta T$ or $A + B * (T_i^4 - T_o^4)$.
- Excess Power = Produced Power - Applied Power
- A and B are determined by applying electric power to a resistor in the cell.

The skeptic's argument

- Agreed, calorimetry is well understood and potentially accurate.
- Therefore, the claimed excess power must be caused by failure to use the method properly.
- This failure must be caused by incompetence that results in errors being ignored that only a skeptic can identify.
- Repeated replication by many people is required to make the skeptical explanations less plausible.
- However, the skeptical explanations can never be made completely implausible because neutrons are not produced in the expected amount.

Histogram of 157 reports of excess power



Abbreviated list for sources of heat measurements

- **FRANCE**
- Conservatoire National des Arts et Metiers (CNAM)
- University of Marseilles-Luminy
- **INDIA**
- Bhabha Atomic Research Center
- **ISRAEL**
- Energetics Technologies Ltd.
- **ITALY**
- Ente per le Nuove Tecnologie, l'Energia e l'Ambiente (ENEA), Frascati
- University of Bologna
- La Sapienza University
- **RUSSIAN FEDERATION**
- LUCH (Federal State Unitary Enterprise),
- Institute of Physical Chemistry
- **JAPAN**
- Hokkaido University
- Kagoshima University
- Kobe University
- Mitsubishi Heavy Industries
- Tohoku University
- Tokyo Institute of Technology
- Yokohama National University
- Technova, Inc.
- **UNITED STATES**
- First Gate Energies
- Los Alamos National Laboratory
- JET Thermal Products
- SRI International
- Portland State University
- SPAWAR Systems Center (Navy)
- University of Illinois

Plausible errors

- Failure to measure correct temperatures.
- Failure to consider energy sources other than nuclear.
- Failure to measure correct input power.

Is an error in input power important?

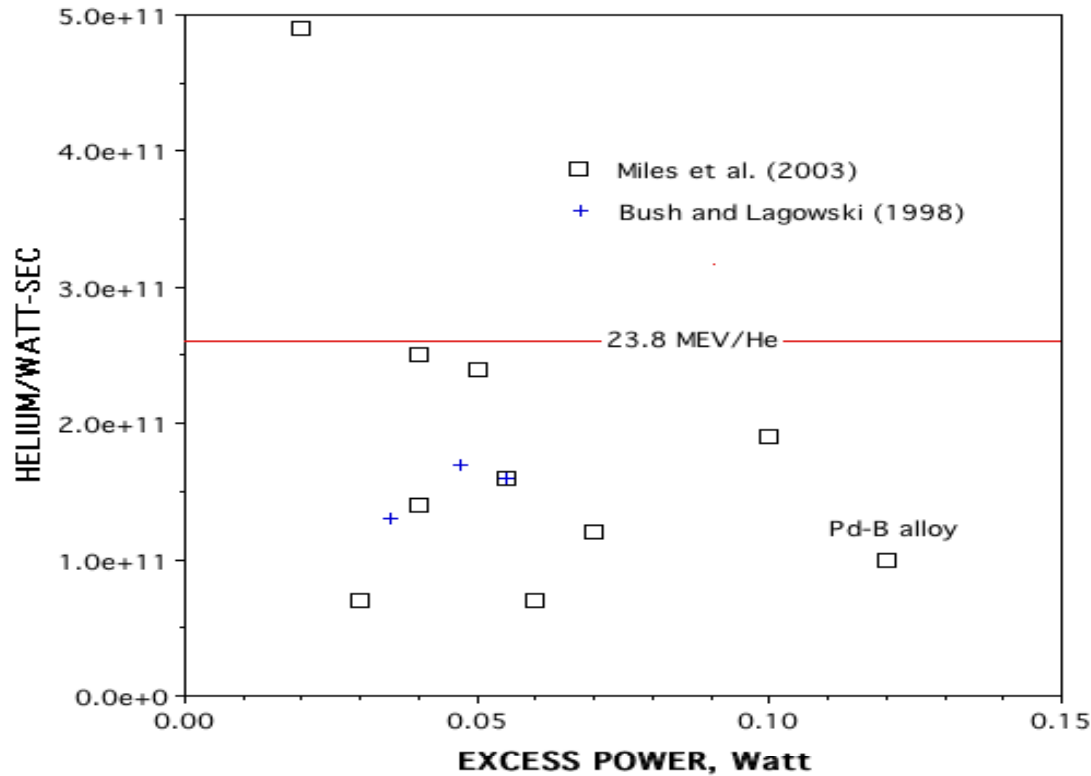
- The various methods used to initiate the effect differ in the use of input power.
- Gas loading requires no input power.
- “Life-after-death” requires no input power.
- The electrolytic method was analyzed by Dieter Britz (J. Electroanal. Chem., 1995) who found that this was not a source of error.
- Some electrolytic experiments deny this explanation.

Example of results that deny an error in input power

Electrolysis using D₂O, Energetics Technologies (2005)

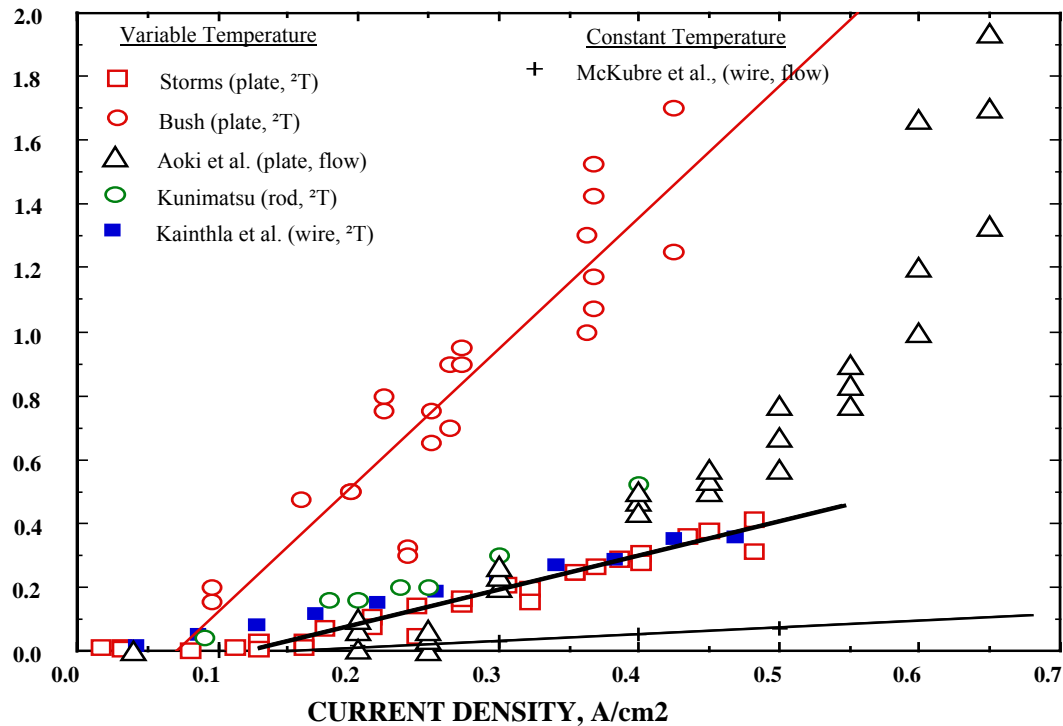


Helium and energy production compared using deuterium

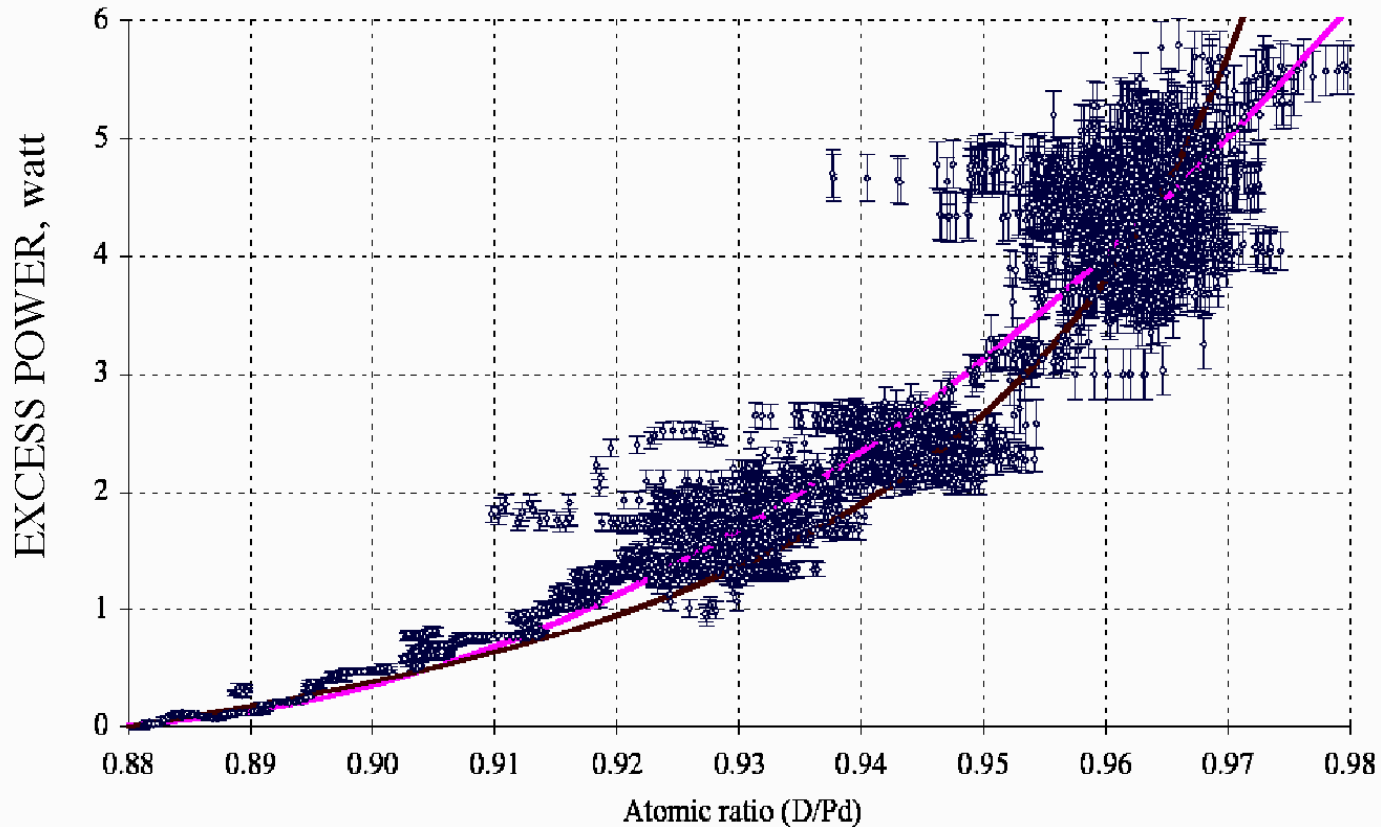


Effect of current density on excess power

EFFECT OF CURRENT DENSITY ON EXCESS POWER
Produced by Palladium



Relationship between excess power and average concentration of D in a Pd cathode



Summary of what is believed by many people

- Both p and d can be involved in nuclear reactions, apparently as clusters.
- The reactions include d-d fusion, transmutation, and fission.
- The reactions can produce energy, helium, energetic particles, tritium, neutrons, transmutation products, and photon emission on different occasions. Radioactive products are seldom produced.
- The reactions require a special arrangement of atoms in a solid lattice or in a living organism called the Nuclear Active Environment.
- Nanosized material is important.
- The reactions can be initiated using electrolysis, gas discharge, gas loading, or by sonic methods.

What belief is required to remain a rational skeptic?

- Believe that each of the hundreds of studies contain errors that were overlooked.
- Believe that a majority of the hundreds of people studying the various aspects of the phenomenon are incompetent only when they study CF.
- Believe that it is impossible for a new mechanism to exist that can lower the Coulomb barrier under any condition.

Frequently used mantra

- Extraordinary claims require extraordinary evidence.

New Corollary

- Extraordinary evidence should not be rejected just because it supports extraordinary claims.

Requirements of a theory

1. The process allows helium production at rates in excess of 10^{12} events/second and occasional tritium with a few neutrons.
2. The process allows hydrogen isotopes to enter the nucleus of heavier nuclei resulting in transmutation products.
3. The process leading up to the nuclear reaction is exothermic.
4. The process does not result in emission of gamma radiation, energetic particles in excess of about 1 MeV or radioactive decay.
5. The process making helium is very sensitive to the concentration of deuterium in the NAE.
6. The process is accelerated by higher temperature, laser light, and RF radiation.
7. The process apparently involves clusters of hydrogen isotopes.

Characteristics of the NAE

1. The NAE consists of an arrangement of atoms that is not common but can form by chance during extended electrolysis and other processes.
2. The NAE resides near the surface.
3. The NAE is enhanced by the presence of certain atoms and is inhibited by other atoms.
4. The NAE is capable of acquiring a high concentration of hydrogen isotopes.
5. The NAE can form in a living organism.