

*Transcript of a ZOOM talk by Edmund Storms
for the COEF-12 conference, August 14 and 15,
2020.*

**Hi, I'm Edmund Storms, speaking from my home
in beautiful Santa Fe, NM. I'm going to tell you
about Cold Fusion.**

**Cold Fusion: From rejection as
a fiasco to being a salvation of
civilization**

Edmund Storms

Santa Fe, NM

Twelfth International Conference on Future Energy-COFE12
Albuquerque, NM, August 14-16, 2020

**The title of the talk is Cold Fusion: From rejection
as a fiasco to being a salvation of civilization.**

**The rejection is continuing but the salvation has
yet to start. To understand the fiasco, a little
history is required.**

Cold Fusion was born on March 23,
1989

Fathers:

Martin Fleischmann, Prof. Univ. Southampton, Fellow of
Royal Soc. (born 1927, died 2012)

Stanley Pons, Prof. Univ. Utah, Chairman of Chemistry Dept.
(born 1943, living in France)

Mother: Curiosity and luck

BIG DEAL!!

COFE-12 Conference, Albuquerque,
NM (8/14-16/2020)

2

Cold Fusion was discovered by Professors Martin Fleischmann and Stanley Pons working at the University of Utah and announced in 1989. This was a BIG DEAL. Their discovery was announced around the world. Everyone realized the importance. People predicted that the pollution being caused by oil extraction and transport could be eliminated. Nuclear accidents would no longer be a worry. We now know that if this clean energy had been developed 31 years ago, future global warming would have been reduced. As result, the rejection has had serious consequences to the future of civilization.

Fleischmann, M.; Pons, S.; Hawkins, M. Electrochemically induced nuclear fusion of deuterium. *J. Electroanal. Chem.* 1989, 261, 301.

I was working at LANL (Los Alamos National Laboratory) at the time. The laboratory was

attempting to develop fission power for use in space, which is a very difficult problem. In fact, having sufficient power for extended space travel is still a problem. The power produced by cold fusion could be the ideal solution. As result, people at Los Alamos became very exited. Dozens of people stopped their normal work and attempted to replicate what Fleischmann and Pons claimed. I was able to make tritium and then excess energy using their method. Both studies were published in a peer reviewed scientific journal.

Storms, E. K.; Talcott, C. L. Electrolytic tritium production. *Fusion Technol.* 1990, 17, 680.

Storms, E. K. Measurements of excess heat from a Pons-Fleischmann-type electrolytic cell using palladium sheet. *Fusion Technol.* 1993, 23, 230.

Response of Scientific Community

- LANL/DOE Workshop on Cold Fusion Phenomena, Santa Fe, NM, May 23-25, 1989

Attendees are from National Labs, universities, and various countries.

- NSF/EPRI Workshop on Anomalous Effects in Deuterated Metals, Washington DC, October 16-18, 1989

COFE-12 Conference, Albuquerque,
NM (8/12-16/2020)

3

A workshop was held in Santa Fe in May for interested people from all over the US and from several other countries to plan how best to study cold fusion.

Another larger workshop was held in Washington in October. There some of the results were discussed. As you can see, the scientific community was mobilizing to investigate this unusual nuclear process.

As expected, many efforts failed and many people were skeptical of the claim – for good reason. Nevertheless, work was underway with an open mind to determine what was real and what was not.

Response of the US Government

First review was in November 1989, called the Energy Research Advisory Board, Cold Fusion Panel.

The co-chairman, Norman Ramsey, threatened to resign if the other co-chairman, John Huizenga, did not provide a more balanced conclusion.

This review set the tone for the rejection that continues to this day.

COFE-12 Conference, Albuquerque,
NM (8/12-16/2020)

4

But then people involved in the extraction and use of oil took notice. They realized they would be put out of business if cold fusion were made useful. In addition, people who were trying to harness fusion using a different and more complex method, called hot fusion, realized they might suffer the same fate. So, H. W. Bush, an oil-man and president at the time, asked the DOE (Department of Energy) to look into the reality of the claim.

ERAB "Report of the cold fusion panel to the Energy Research Advisory Board,"
Department of Energy, DOE/S-0073, 1989.

A committee was assembled of about 22 people, most who had no understanding of the subject and no interest, but had important positions. The co-

chairman, John Huizenga, ran the show and wrote the report. When the other co-chairman, Norman Ramsey, read the report, he was appalled by the obvious bias and threatened to resign if changes were not made. The changes were made but had no effect on how the report was understood by everyone.

As a result, all work sponsored by the US government stopped as did some work in other countries. As a Japanese scientist told me, if the US DOE says the effect is nonsense, it must be nonsense. That confidence in the opinion of the DOE no longer exists. Work in Japan and in other countries is now underway. Eventual success by these efforts could result in a national security threat to the US. Once again, the rejection by the DOE could have serious future consequences.

Iwamura, Y.; Itoh, T.; Kasagi, J.; Kitamura, A.; Takahashi, A.; Takahashi, K.; Seto, R.; Hatano, T.; Hioki, T.; Motohiro, T. et al. Anomalous Heat Effects Induced by Metal Nano-composites and Hydrogen Gas. *J. Cond. Matter. Nucl. Sci.* 2019, 29, 119.

Kitamura, A.; Takahashi, A.; Takahashi, K.; Seto, R.; Hatano, T.; Iwamura, Y.; Itoh, T.; Kasagi, J.; Nakamura, M.; Uchimura, M. et al. Excess heat evolution from nanocomposite samples under exposure to hydrogen isotope gases. *International J. Hydrogen Energy* 2018, 43, 16187.

Iwamura, Y.; Itoh, T.; Kasagi, J.; Kitamura, A.; Takahashi, A.; Takahashi, K. Replication Experiments at Tohoku University on Anomalous Heat Generation Using Nickel-based Binary Nanocomposites and Hydrogen Isotope Gas. *JCMNS* 2017, 24, 191.

The rejection was so strong and nasty that Pons and family immigrated to France and became French citizens. He and Fleischmann continue their studies there with support from a Japanese company.

Fleischmann, M. Reflections on the sociology of science and social responsibility in science, in relationship to cold fusion. *Accountability Res.* 2000, 8, 19.

Opinion of John Huizenga

Prof. Chemistry and Physics
University of Rochester

Cold Fusion: The Scientific Fiasco of the Century,
Oxford University Press, 1992, 1993, 318 pages.

COFE-12 Conference, Albuquerque,
NM (8/12-16/2020)

5

In order to remove any doubt about his opinions, Prof. Huizenga wrote a book entitled “Cold Fusion: The Scientific Fiasco of the Century”. Little did he know at the time the book its self would be the fiasco.

Huizenga, J. R. *Cold fusion: The scientific fiasco of the century*; second ed.; Oxford University Press: New York, 1993.

The orchestrated and sometimes nasty rejection slowed work but it did not stop it. Many wealthy individuals took notice, realized the importance to mankind, and the profit potential. Also, people like myself who saw the effect continued their studies. In my case, I was able to continue my studies at Los Alamos for another year because the laboratory administration realized the reality and the importance of the discovery even if the DOE did not. I retired after the DOE clamped down on even this small effort.

My wife and I moved to Santa Fe where we built a house with an attached wood-working workshop-cold fusion laboratory combination. I continued my studies with support from people who understood the importance of the discovery.

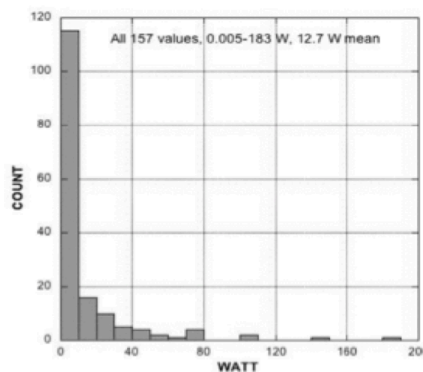
Over the years I wrote two books, 10 reviews, close to 100 published papers, and have done experiments involving all aspects of the process. I can say with certainty based on personal experience and on a complete examination of available information, the claimed discovery is real!

Storms, E. A New Source of Energy using Low-Energy Fusion of Hydrogen.
Environmental Science : An Indian Journal 2017, 13 (2), 1.

Storms, E. The Present Status of Cold Fusion and its Expected Influence on Science and Technology *Innovative Energy Policies* 2015, 4 (1).
Storms, E. K. A Students Guide to Cold Fusion, www.LENR.org, 2012.
Storms, E. K. The status of cold fusion (2010). *Naturwissenschaften* 2010, 97, 861.

Now that 31 years have passed during which thousands of studies have been done in laboratories in at least 12 countries, let's see what the evidence shows.

Histogram of power produced by
157 studies using Pd+D (1989-2006)
Batch sensitive



COFE-12 Conference, Albuquerque,
NM (8/12-16/2020)

6

Let's look first at energy production. The energy is measured as power, i.e. watts, using a calorimeter. Many possible errors have been identified and are now avoided. The so-called excess power cannot result from a prosaic process such as a chemical reaction because the required chemicals are not present or because the

magnitude far exceeds any possible chemical reaction.

This figure shows a histogram in which the number of independent measurements is compared to the power being measured. The excess power is produced by small samples of palladium (about several grams) electrolyzed in D₂O. This pattern has continued up to the present time.

Storms, E. Anomalous Energy Produced by PdD. *J. Cond. Matter. Nucl. Sci.* 2016, 20, 81.

Azizi, O.; El-Boher, A.; He, J.-H.; Hubler, G. K.; Pease, D.; Isaacson, W.; Violante, V.; Gangopadhyay, S. Progress towards understanding anomalous heat effect in metal deuterides. *Current Science* 2015, 108 (4), 565.

As you can see, most studies report less than a few watts, but a significant number are able to produce much more power. The amount depends on the nature of the Pd, not on its physical form or the treatment. If a piece of Pd is found to produce the effect, most samples taken from that batch will be active. Unfortunately, most batches of Pd are not active. The reason for this difference is only now being understood. As result, the effect can now be produced with much greater confidence.

Source of energy?

Reaction	MeV	Hot-fusion Fraction	Cold-fusion Fraction
$D+D = {}^4\text{He} + \text{energy}$	23.8	<1%(gamma-ray)	>99.9%(no gamma-ray)
$D+D = \text{Tritium} + \text{proton}$	4.03	50%	rare
$D+D = \text{neutron} + {}^3\text{He}$	3.27	50%	extremely rare

COFE-12 Conference, Albuquerque,
NM (8/12-16/2020)

7

What kind of nuclear reaction might be the source of the energy?? The only kind of fusion known before cold fusion was the so-called hot fusion. It is called hot because the deuteron must be raised to a very high temperature for fusion to take place, in this case, in plasma. The He^4 that results is unstable and fragments two ways, one produces tritium plus a proton and the other produces a neutron plus He^3 . Because the neutron is easy to detect, it was one of the first nuclear products sought as a test of the cold fusion claim. No neutrons were detected no matter how hard people looked. The skeptics then used the mantra, “no neutrons, no fusion”. Nevertheless, tritium was produced and clearly detected. How could

tritium be made without neutrons? This question was never answered which allowed the skeptics to ignore this contradiction.

What nuclear process might produce the observed energy?

$D + D = He^4 + 0.0256 \text{ amu}$
mass loss or 23.85 MeV

IMPOSSIBLE!!

Momentum is not conserved.
Helium can result from air leak.
Required radiation not detected.

COFE-12 Conference, Albuquerque,
NM (8/12-16/2020)

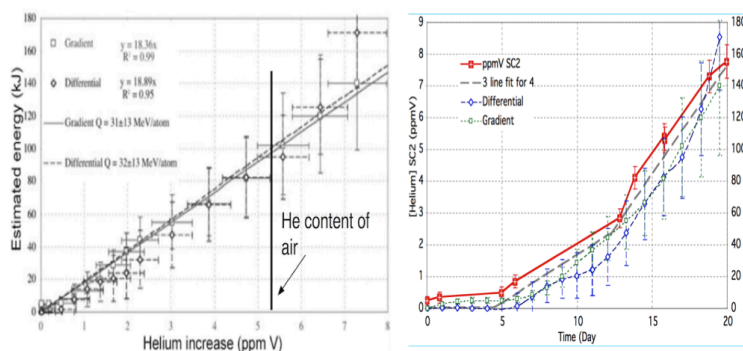
8

Production of He^4 without fragmentation was suggested. This reaction would produce 23.85 MeV of energy. This idea was shot down because the required energetic and deadly gamma emission was clearly not produced. There were no dead graduate students and Fleischmann and Pons were healthy. Besides, momentum could not be conserved without this deadly radiation being emitted, which meant that the helium could not result from fusion. The detected He^4 could even be

conveniently explained as an air leak because air contains 5.25 ppm of helium.

Morrey, J. R.; Caffee, M. W.; Farrar IV, H.; Hoffman, N. J.; Hudson, G. B.; Jones, R. H.; Kurz, M. D.; Lupton, J.; Oliver, B. M.; Ruiz, B. V. et al. Measurements of helium in electrolyzed palladium. *Fusion Technol.* **1990**, 18, 659.

Measurement of energy and helium production from Pd on charcoal in D₂ gas at 250° C. (McKubre et al., 2003)
Replication of behavior reported first by Les Case (1991, 1997).



COFE-12 Conference, Albuquerque,
NM (8/12-16/2020)

9

Nevertheless, people were seeing evidence for He⁴. The first person to accurately measure the relationship between helium and energy production was Dr. Melvin Miles working at the Naval research center in China Lake. I will show his results later but first let's look a more recent study with an interesting back-story.

Bush, B. F.; Lagowski, J. J.; Miles, M. H.; Ostrom, G. S. Helium production during the electrolysis of D₂O in cold fusion experiments. *J. Electroanal. Chem.* **1991**, 304, 271.

- Miles, M.; Bush, B. F.; Ostrom, G. S.; Lagowski, J. J. Second Annual Conference on Cold Fusion, "The Science of Cold Fusion", Como, Italy, 1991; p 363.
- Miles, M. H.; Hollins, R. A.; Bush, B. F.; Lagowski, J. J.; Miles, R. E. Correlation of excess power and helium production during D₂O and H₂O electrolysis using palladium cathodes. *J. Electroanal. Chem.* **1993**, 346, 99.
- Miles, M.; Bush, B. F.; Lagowski, J. J. Anomalous effects involving excess power, radiation, and helium production during D₂O electrolysis using palladium cathodes. *Fusion Technol.* **1994**, 25, 478.

Les Case was a catalyst chemist who had the idea that a chemical catalyst might initiate the cold fusion process. So, he had friends at United Catalyst prepare a typical catalyst with palladium on charcoal. Gradually they discovered how to make excess energy and helium. Les was looking forward to making money by using the free energy to purify sea-water that he would use to irrigate barren land in Australia. He would then make his money selling the land, thus avoiding all the problems associated with the reputation of cold fusion.

He ordered a large batch of the catalyst. Much to his dismay, the material was dead. The reason was soon discovered. During a clean up, the company had thrown away the barrel of charcoal being used to make his material. This was special charcoal made from coconuts grown on an island in the Pacific. Apparently, the many extra elements in this material were important.

Case, L. The 9th International Conference on Cold Fusion, Condensed Matter Nuclear Science, Tsinghua Univ., Beijing, China, 2002; p 22.
Case, L. C. The Seventh International Conference on Cold Fusion, Vancouver, Canada, 1998; p 48.
Case, L. C. The reality of 'cold fusion'. *Fusion Technol.* **1991**, *20*, 478.
Case, L. COPRODUCTION OF ENERGY AND HELIUM FROM D₂, WO 97/43768, USA, 1997.

Meanwhile, Les had sent some of the active material to Michael McKubre at SRI for him to test. Mike had a very high-resolution mass spectrometer that allowed him to measure He⁴ in the presence of D₂ gas. Mike designed a calorimeter that allowed him to measure excess power and helium at the same time while the material was heated at 250° C in D₂ gas, according to Les's instructions. The graph on the right shows how the excess energy and helium increased over a 20 day period. Note the reaction was slow to start and then became more rapid. The graph on the left shows the relationship between helium and excess energy. As you can see, the values all fall on the same straight line even after the helium content in the gas exceeded the concentration in air. Consequently, the helium did not come from air. Also, the straight line has a slope consistent with the energy/He⁴ ratio produced by the D+D fusion reaction.

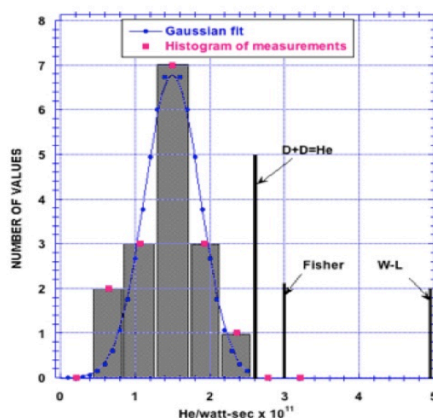
McKubre, M. C. H. Tenth International Conference on Cold Fusion, Cambridge, MA, 2003.

McKubre, M. C. 14th International Conference on Condensed Matter Nuclear Science, Washington DC, 2008; p 673.

McKubre, M. C.; Tanzella, F. Cold fusion, LENR, CMNS, FPE: One perspective on the state of the science based on measurements made at SRI. *J. Cond. Matter Nucl. Sci.* **2011**, *4*, 32.

Histogram of values of He/energy from four independent studies

(see details in [E.K.Storms](#), The status of cold fusion (2010). *Naturwissenschaften* **2010**, *97*, 861.)



Data from 4 independent measurements of both He and energy produced at the same time using the electrolytic method.

COFE-12 Conference, Albuquerque,
NM (8/12-16/2020)

10

If the values obtain by Miles are combined with three other independent studies that also used the electrolytic method to react Pd with D₂O, this relationship is produced. The distribution of values shows the average He/energy ratio is nearly equal to 1/2 of the value expected if the reaction were D+D=He⁴. This difference is expected because only the helium in the evolving gas was measured. Some helium would have remained in

the Pd metal, which was not measured. Nevertheless, the agreement between the measurement and the required value is close enough to make this behavior the smoking gun.

Gozzi, D.; Caputo, R.; Cignini, P. L.; Tomellini, M.; Gigli, G.; Balducci, G.; Cisbani, E.; Frullani, S.; Garibaldi, F.; Jodice, M. et al. Fourth International Conference on Cold Fusion, Lahaina, Maui, 1993; p 6.

Bush, B. F.; Lagowski, J. J. The Seventh International Conference on Cold Fusion, Held at: Vancouver, Canada, 1998; p 38.

DeNinno, A.; Frattolillo, A.; Rizzo, A.; Del Giudice, E. Tenth International Conference on Cold Fusion, Cambridge, MA, 2003; p 133.

DeNinno, A.; Frattolillo, A.; Rizzo, A.; Del Giudice, E. In *ASTI-5*; www.iscmns.org/: Asti, Italy, 2004.

Miles, M. Tenth International Conference on Cold Fusion, Cambridge, MA, 2003; p 123.

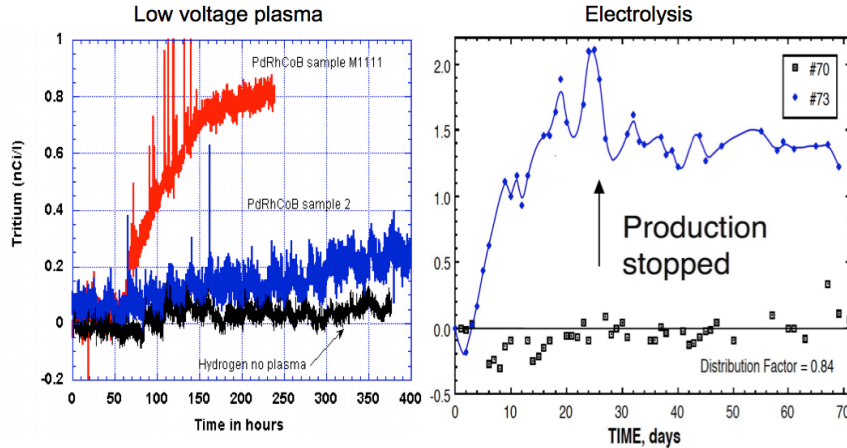
Besides, the shape of the distribution is consistent with a normal Gaussian error function. In other words, the measurements are consistent with the occurrence of the same nuclear reaction having an expected amount of random error. Such consistency could not result from only experimental error.

Example of tritium production

(Nearly 300 papers published describing tritium production using electrolysis, gas discharge or D₂ gas diffusion through Pd.)

Claytor et al.(1992-2020) D₂ gas

Storms + Talcott (1991) D₂O



COFE-12 Conference, Albuquerque,
NM (8/12-16/2020)

11

Tritium is another nuclear product that should not be produced according to the skeptics. Here are two examples of tritium being made by two different methods used at LANL. Dozens of other examples have been reported by other laboratories.

Storms, E. K. *The science of low energy nuclear reaction*; World Scientific: Singapore, 2007.

Tom Claytor subjected a small cathode of various alloys to low-voltage gas discharge while measuring the tritium in real time in the circulating D₂ gas. The voltage is too small to produce the hot fusion reaction as he determined by the absence of measured neutrons. You can see an example of what happens when no plasma

is present and when a dead alloy is used. The active alloy clearly produced tritium. He tested dozens of alloys and found some made much more tritium than others. Again the reaction was batch dependent. Tom continued his work at LANL until the DOE forced him to stop. He then set up a private laboratory near his home where he continued to study this and other methods to cause the cold fusion reaction.

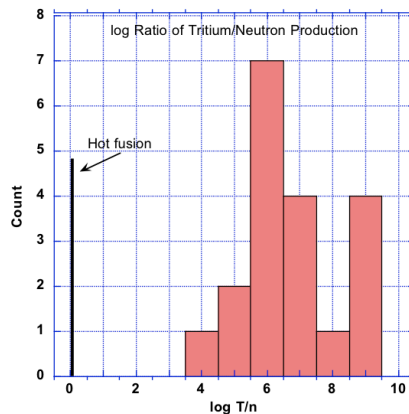
- Claytor, T. N.; Fowler, M. M. In *12th International Workshop on Anomalies in Hydrogen Loaded Metals* Italy, 2017.
- Claytor, T. N.; Fowler, M. M.; Storms, E. K.; Cantwell, R. In *Space Technology & Applications International Forum* Albuquerque NM, 2016
- Claytor, T. N.; Schwab, M. J.; Thoma, D. J.; Teter, D. F.; Tuggle, D. G. The Seventh International Conference on Cold Fusion, Vancouver, Canada, 1998; p 88.
- Claytor, T. N.; Jackson, D. D.; Tuggle, D. G. Tritium production from a low voltage deuterium discharge of palladium and other metals. *J. New Energy* **1996**, 1 (1), 111.
- Claytor, T. N.; Jackson, D. D.; Tuggle, D. G. Tritium production from low voltage deuterium discharge on palladium and other metals. *Infinite Energy* **1996**, 2 (7), 39.
- Claytor, T. N.; Tuggle, D. G.; Taylor, S. F. Third International Conference on Cold Fusion, "Frontiers of Cold Fusion", Nagoya Japan, 1992; p 217.

The other graph compares two cells that Carol Talcott, later to become Carol Storms, studied at LANL using the electrolytic method. Two identical cells were run at the same time in the same location, with one making tritium and the other not. The study was able to show the tritium was not initially in the Pd and did not come from the environment. Production of tritium was

delayed for 3 days, continued for about 20 days then stopped. This behavior is typical of all of the many published reports of tritium production.

- Storms, E. K.; Talcott, C. L. Electrolytic tritium production. *Fusion Technol.* **1990**, 17, 680.
- Packham, N. J. C.; Wolf, K. L.; Wass, J. C.; Kainthla, R. C.; Bockris, J. O. M. Production of tritium from D₂O electrolysis at a palladium cathode. *J. Electroanal. Chem.* **1989**, 270, 451.
- Hodko, D.; Bockris, J. Possible excess tritium production on Pd codeposited with deuterium. *J. Electroanal. Chem.* **1993**, 353, 33.
- Iyengar, P. K.; Srinivasan, M.; Sikka, S. K.; Shyam, A.; Chitra, V.; Kulkarni, L. V.; Rout, R. K.; Krishnan, M. S.; Malhotra, S. K.; Gaonkar, D. G. et al. Bhabha Atomic Research Centre studies on cold fusion. *Fusion Technol.* **1990**, 18, 32.

Histogram of log tritium/neutron ratio



COFE-12 Conference, Albuquerque,
NM (8/12-16/2020)

12

When tritium (T) and neutrons (n) are measured at the same time, a rough correlation is found that centers on a T/n ratio of about 10^6 . This is shown using a histogram of the number of independent

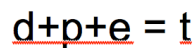
measurements plotted against the log of the T/n ratio. The value produced by the hot fusion process can be seen on the left.

Srinivasan, M. Observation of neutrons and tritium in the early BARC cold fusion experiments. *Current Science* **2015**, *108* (4), 619.

In other words, although the ratio does not match the value produced by hot fusion, neutrons seem to result from a process influenced by the tritium content. This behavior adds one more clue about the nature of the fusion process.

Nature of tritium formation

- Formation of tritium requires a mixture of H and D to fuse. ([Romadanov et al. 1998](#), [Claytor, 2019](#))



Irony: We at LANL worked hard to keep D₂O free of H₂O. Tritium was rarely produced.

John [Bockris](#) at Texas A&M made no effort to avoid H₂O. He made tritium easily.

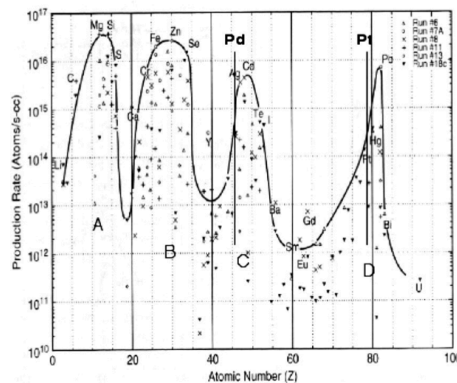
Several studies show that tritium production requires a mixture of D and H. However, if these two isotopes were to fuse, He³ would be the

expected product. Tritium would result only if an electron were added during the process. So, we apparently have another clue about the nature of the fusion process.

Romodanov, V. A.; Savin, V. I.; Skuratnik, Y. B.; Majorov, V. N. Sixth International Conference on Cold Fusion, Progress in New Hydrogen Energy, Lake Toya, Hokkaido, Japan, 1996; p 340.

Claytor, T. N.; Fowler, M. M. In *12th International Workshop on Anomalies in Hydrogen Loaded Metals* Italy, 2017.

Transmutation products found by Miley et al. when Pd+D present (1996)



COFE-12 Conference, Albuquerque,
NM (8/12-16/2020)

14

And now the plot thickens and tests whether you actually have an open mind.

The process has been found by many people to produce what is called transmutation. This is a reaction during which one or more hydrogen

nuclei are added to other elements, thereby causing production of a new element. Such reactions are even more difficult to justify and explain than fusion because of the huge Coulomb barrier. Apparently, fusion must occur in order to provide the energy and fusion product that is then added to a nearby nucleus. We will see more evidence for this conclusion shortly.

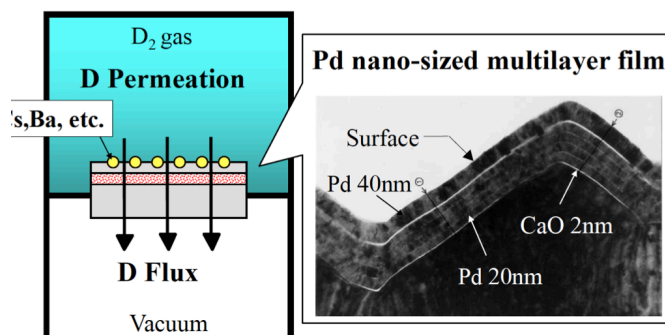
This figure shows one kind of transmutation reaction that results in addition of several D to Pd or Pt followed by fission of the product to produce two smaller nuclei. These two smaller nuclei result in the two populations you can see on the left.

This behavior implies that the fusion process can involve atoms that happen to be near where fusion is taking place. In addition, the resulting nuclear reaction can be novel and unexpected.

Srinivasan, M.; Miley, G.; Storms, E. K. In *Nuclear Energy Encyclopedia: Science, Technology, and Applications*; Krivit, S.; Lehr, J. H.; Kingery, T. B., Eds.; John Wiley & Sons: Hoboken, NJ, 2011.

Miley, G.; Shrestha, P. In *ACS Symposium Series 998, Low-Energy Nuclear Reactions Sourcebook*; Marwan, J.; Krivit, S. B., Eds.; American Chemical Society: Washington, DC, 2008.

Method used by Iwamura et al. at
Mitsubishi Heavy Industries
(1998-2020)



COFE-12 Conference, Albuquerque,
NM (8/12-16/2020)

15

But the plot thickens even more. Workers at Mitsubishi Heavy Industries in Japan explored transmutation using a sandwich of CaO (calcium oxide) and Pd (palladium). You can see a magnified cross-section on the right. When they caused D₂ gas to diffuse through this layer, excess energy was produced. Even more amazing, when they deposited various elements on the exposed Pd surface, these were transmuted in unexpected ways.

- Iwamura, Y.; Itoh, T.; Yamazaki, N.; Yonemura, H.; Fukutani, K.; Sekiba, D. Recent advances in deuterium permeation transmutation experiments. *J. Cond. Matter Nucl. Sci.* **2013**, *10*, 63.
- Iwamura, Y.; Itoh, T.; Terada, Y.; Ishikawa, T. Transmutation reactions induced by deuterium permeation through nano-structured Pd multilayer thin film. *Trans. Amer. Nucl. Soc.* **2012**, *107*, 422.
- Iwamura, Y.; Itoh, T.; Yamazaki, N.; Kasagi, J.; Terada, Y.; Ishikawa, T.; Sekiba, D.; Yonemura, H.; Fukutani, K. Observation of low energy nuclear transmutation reactions induced by deuterium permeation through multilayer Pd and CaO thin film. *J. Cond. Matter Nucl. Sci.* **2011**, *4*, 132.

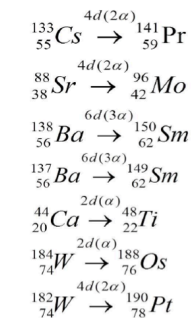
Iwamura, Y.; Sakano, M.; Itoh, T. Elemental analysis of Pd complexes: effects of D₂ gas permeation. *Jpn. J. Appl. Phys. A* **2002**, 41 (7), 4642.

Iwamura, Y.; Itoh, T.; Gotoh, N.; Toyoda, I. Detection of anomalous elements, X-ray, and excess heat in a D₂-Pd system and its interpretation by the electron-induced nuclear reaction model. *Fusion Technol.* **1998**, 33, 476.

Transmutation reactions reported by Iwamura et al. (1998-2020)

Products analyzed by ICP-MS, SIMS, and XPS

(Cs decreased at the same rate Pr increased. 2.8 MeV produced.)



COFE-12 Conference, Albuquerque,
NM (8/12-16/2020)

16

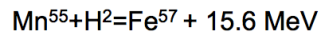
Their initial study involved applying cesium to the Pd surface by vapor deposition. They found that praseodymium was produced. Using in-situ XPS (X-ray Photoelectron Spectroscopy), they were able to show that the cesium concentration decreased as the amount of praseodymium increased. No other nuclear products were detected.

Apparently, two He⁴ or four D enter the nucleus of cesium all at the same time. Attempts to replicate the claim at NRL (Naval Research

Laboratory) failed but were successful at another independent laboratory in Japan. This work has continued and the claims have become even better supported by the evidence.

Then they deposited other elements with the results shown in the table. Apparently, as many as three He^4 nuclei can be added simultaneously to another nearby nucleus, with the number depending on the nature of target element. Once again, we are given clues about the very strange mechanism causing cold fusion. Once again we are forced to consider the impossible.

Effect of bacteria on the reaction



by Vysotskii et al. (1996-2020)

(Fe increased at the same rate Mn decreased.)

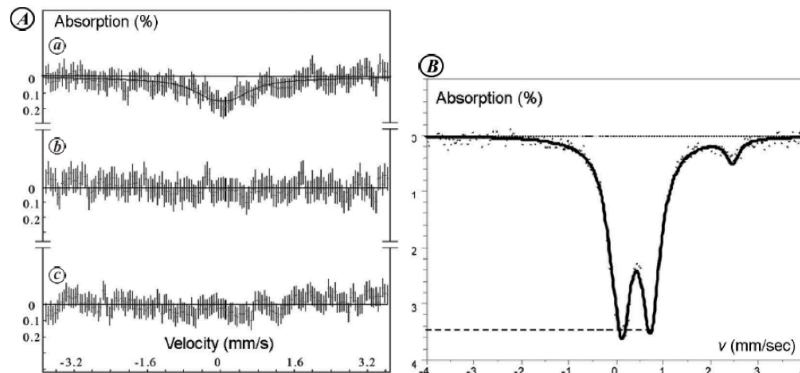


Figure 1. A, Mossbauer spectra of Fe^{57} isotope of *Saccharomyces cerevisiae* culture grown in nutrient medium in the presence of (a) D_2O and Mn^{55} ; (b) H_2O and Mn^{55} and (c) D_2O without Mn^{55} . B, Mossbauer spectrum of MCT grown in nutrient medium in the presence of D_2O and Mn^{55} isotope.

But Nature is not finished with producing amazing behavior. For many years, various studies have suggested that living cells can also produce transmutation. Naturally, this claim was soundly rejected.

Kervran, C. L. Transmutations biologiques, metabolismes aberrants de l'asote, le potassium et le magnesium. *Librairie Maloine S. A, Paris* **1963**.

Komaki, H. production de proteines par 29 souches de microorganismes et augmentation du potassium en milieu de culture sodique sans potassium. *Revue de Pathologie Comparee* **1967**, 67, 213.

Kervran, C. L. *Biological transmutations*; Swan House Publishing Co., 1972.

Biberian, J.-P. Biological transmutations. *Current Science* **2015**, 108 (4), 633.

Nevertheless, workers in Ukraine decided to explore this idea. They used a well-known kind of yeast as the living cell, to which they added D₂O and manganese 55. The intent was to determine if iron 57 would be produced. They used the Mossbauer effect to detect the iron 57 isotope.

In case you are not familiar with this method, when Fe⁵⁷ results from k-capture (an electron from the k electron shell enters the nucleus) of Co⁵⁷, which is a conventional nuclear reaction, the resulting gamma can be absorbed by another Fe⁵⁷ nucleus if the energy state of the target atom exactly matches the energy of the gamma. The energy of the gamma is matched to the absorbing

Fe⁵⁷ energy-state by changing the relative velocity between the emitter and the target atom.

The figures show the amount of adsorption as the relative velocity is changed. The graph on the left shows no reduction in gamma intensity when H₂O is used and when manganese is absent. When manganese and D₂O are both present, the gamma is absorbed, which shows that Fe⁵⁷ was produced. Eventually, they were able to make the process very robust, with the result shown on the right. Clearly, a deuteron can be added to a manganese nucleus to produce iron 57. Nothing else would result in absorption of the radiation.

You might ask why the yeast would want to make iron out of manganese. I will leave this question as a homework assignment.

Vysotskii, V.; Kornilova, A. A. Low-energy nuclear reactions and transmutation of stable and radioactive isotopes in growing biological systems. *J. Cond. Matter Nucl. Sci.* **2011**, *4*, 146.

Vysotskii, V.; Tashyrev, A. B.; Kornilova, A. A. In *ACS Symposium Series 998, Low-Energy Nuclear Reactions Sourcebook*; Marwan, J.; Krivit, S. B., Eds.; American Chemical Society: Washington, DC, 2008.

Vysotskii, V.; Kornilova, A. A.; Samoylenko, I. I. Experimental discovery and investigation of the phenomenon of nuclear transmutation of isotopes in growing biological cultures. *Infinite Energy* **1996**, *2* (10), 63.

Vysotskii, V.; Odintsov, A.; Pavlovich, V. N.; Tashyrev, A.; Kornilova, A. A. 11th International Conference on Cold Fusion, Marseilles, France, 2004; p 530.

Change of radioactive decay rate of Cs^{137} in presence of a yeast by Vysotskii et al (2015)

Decay rate increased by a factor of 35.

Saccharomyces cerevisiae

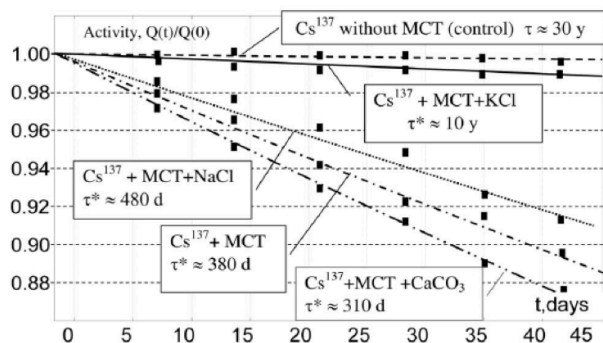


Figure 4. Accelerated deactivation (accelerated rates of decay) of Cs^{137} isotope in 'biological cells' in the presence of different chemical elements.

COFE-12 Conference, Albuquerque,
NM (8/12-16/2020)

18

Now they asked, what would happen if the target isotope were radioactive? Would the transmutation reaction change the decay rate? They tested this idea by placing cesium 137, a common radioactive product of the fission reaction, in their yeast culture. They found that the effective decay rate was increased up to 35 times. The figure shows the measured reduction in activity as a function of time when other elements were added to the mixture. The designation MCT means a culture that was found to be especially active. As you can see, the presence of certain elements made the loss of Cs^{137} more rapid because some Cs was transmuted to a

stable element, thereby making less Cs available to decay. An obvious use would be to accelerate the natural decontamination at Chernobyl.

Vysotskii, V. I.; Kornilova, A. A. Microbial transmutation of Cs-137 and LENR in growing biological systems. *Current Science* **2015**, *108* (4), 636.

Vysotskii, V.; Kornilova, A. A. *Nuclear fusion and transmutation of isotopes in biological systems*; MIR Publishing House, Russia 302, 2003.

Radiation

- Occasional radioactive products in addition to tritium
- Weak neutron emission correlated with tritium production and with fractofusion
- Energetic particle emission as result of ion bombardment and during electrolysis
- Collimated X-ray emission produced by ion bombardment.
- Occasional low-energy X-ray emission
- Occasional RF emission
- Occasional strange radiation

Too complex to understand and discuss.

COFE-12 Conference, Albuquerque,
NM (8/12-16/2020)

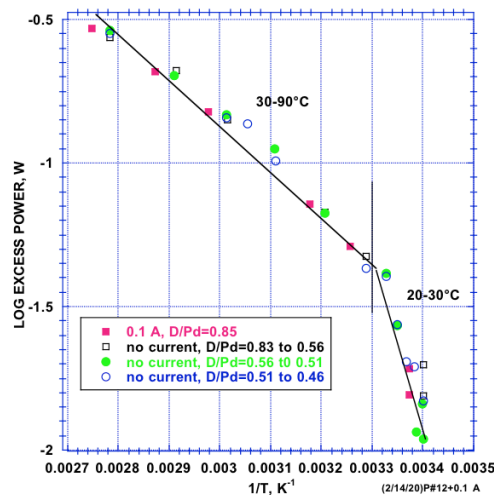
19

Up to now, I have avoided discussing the radiation that must result from the nuclear process in order for the energy to be dissipated and turned into heat in the calorimeter. The radiation is also required to conserve momentum. Once again, the cold fusion process confounds explanation because very little radiation is detected outside of the apparatus. This is good news for the health of the experimenter but bad news for the effort to understand the process. What is worse, the

radiation that is detected is highly variable and sometimes very unusual. Consequently, this question is too complex to answer here. Nevertheless, radiation is emitted and detected, as is required. However, it does not have the large expected energy.

Effect of Temperature

(activation energy = 28.7 KJ/mol)



COFE-12 Conference, Albuquerque,
NM (8/12-16/2020)

20

Now I would like to show some actual data and what it implies. Here is a plot of the log excess power vs 1/T. This is a typical Arrhenius plot that allows the activation energy for a reaction to be determined.

Storms, E. K., unpublished, 2020

The excess power was produced by a 0.5 g sample of Pd that had been activated and then reacted with deuterium at 20° C using electrolysis. Excess power was produced immediately after the Pd had reacted with deuterium and the sample was heated. The long delay experienced by other studies did not occur.

The red squares were produced while 0.1 A was applied to the cathode. This held the D/Pd ratio constant at PdD_{0.85}. You can see that all the values fall nicely on a straight line.

The other values resulted when this current was turned off. This allowed D to be lost. The resulting D/Pd ratios measured before and after each temperature study are shown. As you can see, the excess power was not changed by the ratio changing from 0.85 to 0.46. Other studies showed no change even when the ratio was reduced to 0.16. Consequently, we can conclude that once the nuclear reaction starts, it is not influenced by the concentration of D in the material.

However, the temperature clearly has a large effect on the rate of energy production. The slope of the line between 30° and 90° C can be used to calculate an energy of activation for the rate

limiting process. This activation energy is 28.7 KJ/mole. Using this value, we can determine the mechanism that limits the rate of the nuclear reaction.

Simple logic requires the deuterium that is converted to helium at a particular location to be replaced. This deuterium must come from the surrounding physical structure. The rate of transport through a structure is determined by the diffusion constant. If the log diffusion constant of D through PdD_{0.85} is plotted vs 1/T, the activation energy for diffusion can be determined. The activation energy for diffusion is found to be 28.0 KJ/mol. This value is consistent with the activation energy that limits the nuclear process within experimental error.

In addition, every sample studied showed the same activation energy regardless of the total amount of power being produced. Consequently, the rate of power production above about 30° C seems to be determined by how fast deuterium can diffuse through the lattice and replace D being converted to helium.

This graph also shows a change in the effect of temperature below about 30° C. I can propose an

explanation for this behavior, but this would require too much time and require you to understand the mechanism I have proposed to explain all observed behavior. Unfortunately, we do not have time to discuss this idea.

Storms, E. How Basic Behavior of LENR can Guide A Search for an Explanation. *JCMNS* **2016**, *20*, 100.

Storms, E. How the explanation of LENR can be made consistent with observed behavior and natural laws. *Current Science* **2015**, *108* (4), 531.

Storms, E. K. *The explanation of low energy nuclear reaction*; Infinite Energy Press: Concord, NH, 2014.

Summary of major behavior

Process has eight important characteristics:

1. (*Batch sensitive*) A rare and unique condition is present throughout an active batch.
2. (*Produced by various materials in different physical forms*) Not unique to palladium or to a metallic structure.
3. (*The nuclear products are produced at isolated random sites*) The process does not take place uniformly throughout the material. (*Physical gaps and/or cracks*)
4. (*Fusion involves all isotopes of hydrogen to produce He4 and/or tritium*) A chemical assembly containing any hydrogen isotope form in special physical locations. (*Assembly has a chemical structure similar to metallic hydrogen.*)
5. (*Expected result is absent*) The hydrogen nuclei fuse as result of a novel process. (*THE BIG DISCOVERY*)
6. (*Temperature effect*) Hydrogen atoms diffuse from the surrounding structure to replace hydrogen that is lost by fusion. (*Temperature is the main controlling variable.*)
7. (*Transmutation*) On rare occasions, one or more of the fusion products enter the nucleus of a nearby atom to cause transmutation. (*Collective behavior*)
8. (*Radiation and radioactivity*) Complex radiation and occasional radioactivity. (*Complex behavior*)

Eight general behaviors describe the behavior of the nuclear process. These behaviors can be used

to prove without a doubt that nuclear reactions of several unusual kinds can take place in a chemical environment without application of enough energy to overcome the Coulomb barrier in the normal way. The behaviors can also be used to create a model to describe the process. The process is clearly very unusual and not consistent with how conventional nuclear processes are found to behave. Consequently, a new kind of nuclear interaction must be considered, instead of rejecting the evidence because it conflicts with what is known.

CONCLUSION

**THE REJECTION WAS AND IS A
HUGE MISTAKE!!**

A new kind of nuclear interaction can be initiated in different kinds of condensed matter, including living cells, to cause fusion of hydrogen isotopes and transmutation of other elements.

An ideal source of energy is available without the threats to the environment created by carbon containing compounds and fission of uranium.

Arthur C. Clarke said in 1998, "Ignoring cold fusion is one of the greatest scandals in the history of science".

THE REJECTION WAS AND IS A HUGE MISTAKE!! I can't emphasis this enough.

Two basic facts have now been demonstrated.

1. A new kind of nuclear interaction can be initiated in different kinds of condensed matter, including living cells, to cause fusion of hydrogen isotopes and transmutation of other elements.

2. An ideal source of energy is available without the threats to the environment created by carbon containing compounds and fission of uranium.

As Arthur C. Clarke said, “Ignoring cold fusion is one of the greatest scandals in the history of science”. This comment still applies.

Clarke, A. C. 2001: The coming age of hydrogen power. *Infinite Energy* **1998**, 4 (22), 15.

The only challenge remaining is to understand the process well enough to make it useful.

Results Available at

- <https://coldfusionnow.org/crew/edmund-storms/>
 - [https://en.wikipedia.org/wiki/Edmund Storms](https://en.wikipedia.org/wiki/Edmund_Storms)
 - www.LENR.org
 - “The Science of Low Energy Nuclear Reaction”, World Scientific, 2007, 313 pg.
 - “The Explanation of Low Energy Nuclear Reaction”, Infinite Energy Press, 2013, 323 pg.
 - <http://iscmns.org/CMNS/CMNS.htm>
- (J. Condensed Matter Nuclear Science, Vol. 1, April 2007 – Vol. 32, May 2020)

COFE-12 Conference, Albuquerque,
NM (8/12-16/2020)

23

More information can be obtained from these sources.

I have written two books that summarize the observations and explanations. These are out of print but can be obtained from Amazon in digital form.

A digital library containing many of the papers about cold fusion is available on the Internet. Jed Rothwell administers this site. (www.LENR.org)

And a peer-reviewed digital journal was created to make papers about cold fusion available

because such papers are commonly rejected by other journals. This journal is called J. Condensed Matter Nuclear Science and now has 32 volumes. The editor is Jean-Paul Biberian.

Copies of many papers from the twenty-two ICCF conferences can be found at LENR.org.

Thank you for showing interest. I also want to thank my computer, the Internet, and the great skill and patience of Tom Valone for making this talk possible. I would be glad to answer any questions.