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A New Source of Energy using Low-Energy Fusion of Hydrogen

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Abstract

This paper describes the claim for energy production based on the so-called cold fusion effect. Reasons are given to explore this energy source based on the need for such clean energy and the observed behavior.

Chemical energy alone has powered civilization until relatively recently when nuclear fission power based on uranium became available. Efforts are now underway to go the next step on this path using nuclear sources by harnessing the fusion of hydrogen. The first attempt using the so-called hot fusion method has not been successful in producing practical power. Furthermore, the required generator is expected to be impractical as results of its complexity and size even after the many engineering problems are solved. Perhaps a different approach is needed. Fortunately, a new method to cause fusion using a simpler method was recently discovered; only to be widely rejected because it conflicts with what is known about nuclear interaction. This paper addresses this issue by summarizing some of the evidence supporting such a novel fusion reaction.

Keywords: Cold fusion; Ideal energy; Clean energy; Fusion energy

Background and Introduction

Growing civilizations need and have always sought an increasingly intense source of energy in greater quantity. Chemical energy from wood, coal, oil, and natural gas was the source for many centuries until power from a nuclear fission reaction became possible. Fission power, using uranium, was expected to satisfy the growing demand well into the future. However, this source of energy was eventually proven too dangerous for widespread use. Even the fossil fuels are now recognized as being a threat to the future because CO_2, a greenhouse gas, is formed as energy is released.

For many years, fusion power was expected to provide industrial-level energy for the future. Indeed, if this source were successful, it could become the hoped-for ideal energy because hydrogen is available everywhere without limit and without hazardous byproducts. Unfortunately, the isotopes of hydrogen are very difficult to fuse, requiring large machines able to heat plasma to very high temperatures. Although this method, called hot fusion, has been studied now for close to 75 years [1,2], a method to create useful power has so far eluded discovery [3-5]. As result, mankind is in an increasingly untenable situation. Chemical energy produces CO_2, a cause of climate change; energy from wind and solar is unreliable and insufficient in many places; and fission energy creates dangerous radioactive waste, thereby making these sources less suitable for large-scale use. Unless, fusion power can be mastered, the future can be expected to be unpleasant and limited.

Just when fusion energy looked increasingly unlikely as a practical energy source, a new way to generate fusion power was discovered. In 1989, Fleischmann and Pons [6-9] claimed to be able to fuse deuterium in palladium metal without the need for high temperature or a complex machine. Twenty-eight years of research in over twelve countries provided evidence supporting their claim for an unusual fusion process. Apparently, a unique condition within a material structure, such as palladium metal, can overcome the barrier for fusion by using what appears to be localized electric charge rather than high energy. As result, energy is made without energetic radiation and without significant radioactive waste. This process was called cold fusion initially and now is described as low-energy-nuclear-reaction (LENR). The method can also be called slow fusion because the fusion event appears to release energy more slowly compared to normal nuclear reactions. Use of nickel [10-12] rather than palladium has generated further interest, but this paper will focus only on palladium.

Discussion

The special condition required to cause the LENR reaction is difficult to create. This difficulty has encouraged general rejection by conventional science [13-15] and has slowed understanding. Without this acceptance, the essential funding and talent are not available to achieve understanding. In fact, a rational person has to wonder why the claim for LENR is not being explored with intensity in spite of this problem. After all, the serious environmental problems created by conventional sources of energy would be expected to encourage exploration of even the most unlikely of possible solutions. Nevertheless, interest is increasing as described in the report provided by the Anthropocene Institute [16]. This report identifies over 100 entities engaged in the study of LENR, with more than 50 commercial organizations being supported by a total of about $ 250M. The research is being done in at least nine countries within university as well as private laboratories. Consequently, interest in LENR is growing, although slowly – perhaps too slowly to save mankind from the consequences of using conventional energy.

In order for the claim to be more widely accepted, proof is required. Where can such evidence be found? A person could start by reading over 1000 papers published in four languages that describe the phenomenon, many in peer reviewed scientific journals – but who has the time? Or, a person could read the two books [17,18]. I wrote that summarize what is currently known. Other summaries are also available [19-26]. However, to save the reader the trouble, the high points of the supporting evidence are described in this paper.

A path to acceptance of LENR requires an answer to the question, “What can be measured to prove that a novel nuclear process actually occurs?” The most obvious and convenient measurement involves production of energy having no clear relationship to any conventional source, both in magnitude and compared to known possible reactions. Although this energy has been measured hundreds of times when using a variety of calorimeter designs, real and imagined error have distracted from the importance of these studies. Nevertheless, this commonly observed extra energy is consistent only with a novel nuclear process because the amount of energy frequently far exceeds any known chemical source as well as the expected error in its measurement.

If nuclear energy were produced, a nuclear product must be present. Unlike hot fusion, which makes easily detected tritium and energetic neutrons (2.54 MeV) in equal amounts, the LENR process makes essentially no neutrons and very little tritium. In fact, the measured tritium/neutron ratio frequently falls near 10^6, as shown by the summary in FIG. 1. While the presence of these two nuclear products is proof for unusual nuclear processes taking place in a material, they are never produced at sufficient rates to account for observed power. The only nuclear product consistent with power production is helium-4 (^4He).

Besides helium and tritium being produced, a complex collection of transmutation products is also occasionally reported. These nuclear products result from the nuclei of a hydrogen isotope entering the nucleus of a heavy element, such as palladium, and producing either a fragment of the target or a still heavier element [27-31]. Such nuclear products are very hard to justify when conventional understanding is applied. Nevertheless, many well-done studies report similar transmutation products.

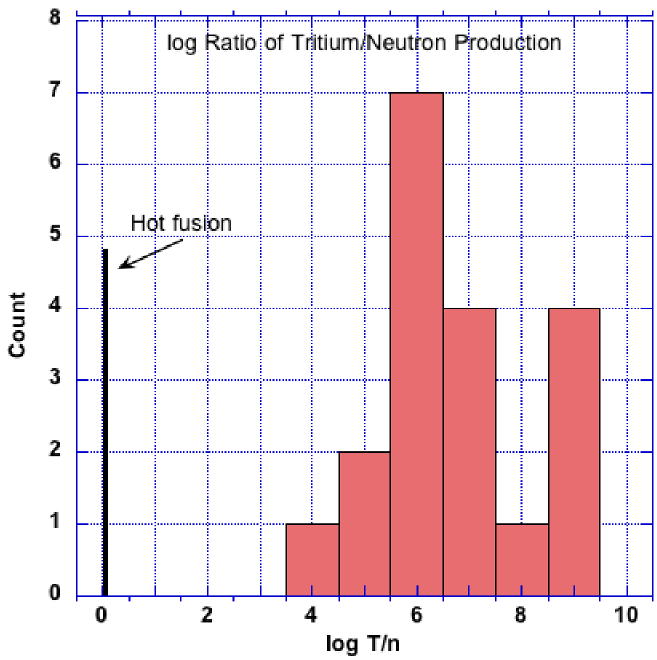

FIG. 1. **Histogram of independent studies that measured both tritium and neutron emission [32], with COUNT giving the number of times the noted log T/n value was reported. The clustering of values suggests a relationship exists between tritium and neutron production, but not the same one known to result from hot fusion.**

The claim for helium production is easy to ignore because a significant amount is present in the normal atmosphere, which makes the sought-for helium easy to mistake for helium from this source. When this error is combined with the normal error in a calorimeter measurement, reasons to ignore the claim based on heat or helium alone can become overwhelming. On the other hand, the energy/helium ratio does not have this problem. The independent errors in the He and power measurements are unlikely to combine and create a consistent value for this ratio unless the helium and energy both resulted from the same nuclear reaction. Even if several other nuclear reactions happened at the same time, thereby shifting the ratio away from the expected value, as some people have speculated, consistent behavior would strongly support the processes being interrelated.

No matter how production of heat energy and helium are explained, the process is clearly the result of an unconventional mechanism to which creative thinking needs to be applied.

This ratio has been measured 17 times by four independent laboratories, the result of which is plotted in FIG. 2. This collection shows a range of values with an expected amount of random scatter. Of considerable importance, the average value is equal to about 50% of the value expected to result from d-d fusion. This difference is thought to result because some helium would be retained by the palladium in which the LENR reaction occurred. When efforts were made to remove all the trapped helium from the palladium, the expected value for d-d fusion was obtained [33].

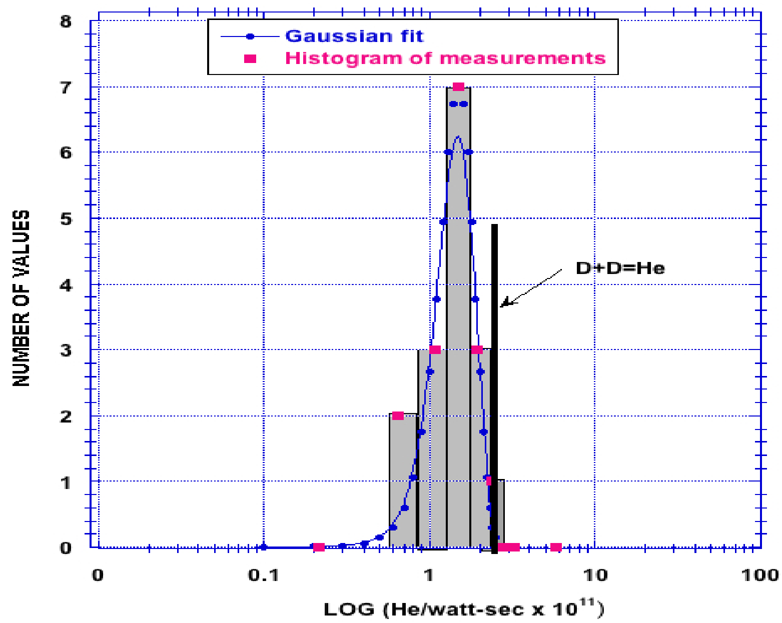

FIG. 2. **Summary of 17 measurements of both helium and energy production during the same study [32]. Superimposed on the distribution of values is a fit to the Gaussian error function. The fit is typical of an expected amount of random error being present in the measurements. The value for this ratio resulting from deuterium-deuterium (d-d) fusion is known to be 23.8 MeV for each nucleus of helium made.**

In addition, the behavior is consistent with the LENR process taking place in the surface region because only helium formed within a few tens of microns from the surface can be expected to leave the palladium and to be detected in the gas. If helium were formed on the surface itself, none would be retained by the palladium. Consequently, these studies help to identify a narrow region near the surface of a palladium sample where the LENR process takes place. Even within this region, the LENR process is scattered and not uniform, neither in time nor position. Apparently, this strange mechanism requires a rare condition in which to operate.

Evidence for other complex nuclear reactions has been summarized in several reviews [20,34-38]. Although these complex reactions occur at smaller rates than helium production, their occurrence provides additional evidence for the process being real while adding complexity to any explanation of the process. In spite of this difficulty, many explanations have been published and are being tested.

Evidence for an unusual kind of nuclear interaction keeps growing. Independent replication, as required by modern science, also has been accomplished. The only problem remaining is to discover how to achieve a greater and more reliable rate than is presently possible.

In this regard, one of many observed patterns of behavior is important. When a sample from a batch of palladium is found to produce LENR, most samples taken from that same batch are found to also host the process. Once a sample makes extra energy, energy production from that sample continues and is reproducible for long periods-of-time. The challenge is to create the active batch in the first place. Thus, rather than being a job for physics, as is hot fusion, cold fusion involves materials science as the essential first step. Unfortunately, this unique marriage between physics and chemistry has not been a happy one.

In summary, the LENR process is thought to take place in nano-sized regions near the surface of a hydrogen-containing material where many local sources of energy form. Power from these many sites combines to produce the measured power. The rate of the nuclear reaction is very sensitive to temperature but not sensitive to the D/Pd ratio once the process starts. In other words, something about the treatment creates a rare and unusual condition in the material that can become nuclear active. The kind of nuclear product produced by the process is determined by the elements present at the nuclear-active site.

The consequence of this phenomenon must be explored for two important reasons. First, this process promises to provide the ideal, inexhaustible, and clean energy mankind has been seeking for use on earth and for space travel. Second, an entirely new way for nuclei to interact has been discovered, with unpredictable consequences for both science and technology. We can only hope creative scientists will find this new discovery more interesting to explore than to reject.

Conclusion

The LENR phenomenon has been proven real based on the accepted rules used by science. The only unknown is how to cause it to occur at reliable and useful levels. This problem can only be solved by intense research. Such attention will become available only after the phenomenon is more broadly accepted than is presently the case. We are now waiting for this acceptance. Meanwhile, low-scale research is underway in at least six countries.

Once understood, this source of energy can be expected to replace most other sources and to allow repair of the environment. We can also expect this energy to be essential for further exploration of the solar system and during future occupation of the Moon and Mars.

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