Nuclear con-fusion

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Low Energy Nuclear Reactions may have much more potential than is generally realised, suggests The Scientific Alliance.

In 1989, two physicists – Martin Fleischmann and Stanley Pons – held a press conference to reveal an experiment that apparently demonstrated nuclear fusion at room temperature. Understandably, this caused a furore in the scientific world, but after the hype came the consensus that this was essentially a con. In fact, the situation is much more complicated than a simple case of poorly-designed experiments, misinterpretation or even scientific fraud.

One of the problems was the name given to the observed phenomenon, cold fusion. The suggestion that atomic nuclei could be made to fuse and release energy under such mild conditions, when normally this could be achieved only at extraordinarily high temperatures, immediately made other scientists sceptical. This was compounded by making the results public via a press conference rather than through an academic publication, as would normally be the case. This seems to be because of pressure from the University of Utah, where the work was done, to beat a rival research group. Fleischmann and Pons published their first paper on the topic the following year.

The experiment involved the electrolysis of heavy water (deuterium oxide) containing lithium hydroxide, and the surprising result was that more energy (in the form of heat) was generated in the cell than was provided via the electrolytic current. In addition, neutrons were detected, which is one of the reasons the unfortunate term 'cold fusion' was coined.

Despite their lack of a published paper at the time of the press conference, the two scientists were confident their results were reproducible. Other researchers, however, did not agree, with a number of unsuccessful attempts being made to repeat the observations. In combination with the intense and over-hyped media attention, this apparent lack of repeatability led to a general agreement that cold fusion was not a real phenomenon, even before the paper giving full details of the experiment was published in 1990.

By then, it seemed too late for Fleischmann and Pons' reputation to be rescued. But, despite this, what was once known as cold fusion has not lost its advocates. The reason for this is clear: there have been a number of similar experiments that have shown, reproducibly, that certain types of electrolytic cell do indeed produce many times more energy than is put into them. The more general term for the phenomenon is now Low Energy Nuclear Reactions, for the reaction certainly seems to be going on at a nuclear level, but fusion it is not.

One of the reasons that the initial observations did not seem to be repeatable was that full details of the experimental setup were not available, and it turns out that there are several important factors that influence the outcome. In the Fleischmann and Pons setup, a palladium cathode was used in an electrolytic cell with a salt (in their case lithium hydroxide) dissolved in heavy water. Continuous operation resulted in an eventual sudden increase in temperature of the cell that had previously been at a steady 30°C.

It became clear that, with high loadings of deuterium atoms, the crystal structure of the palladium is opened up, with the cathode physically growing in size. The initial surface area of the cathode also seems to be an important determining factor.

The mechanism by which the unexpected heat is released is not agreed, but one strong contender is via the formation of neutrons from the free electrons at the cathode and protons from water nuclei. The neutrons are absorbed by lithium nuclei to form an unstable isotope, itself decaying to beryllium, then helium (and possibly tritium). This decay process emits radiation, absorbed by electrons at the cathode and finally reemitted as heat.

The theoretical limit on anomalous heat production is about 30 times the input energy. In practice, a still very respectable ten-fold factor is about the best observed so far. For those who want to find out more about the whole field, a good first source is *New Energy Times*. Unlike some single-issue sites, this is not a forum for cranks to promote untenable hypotheses; indeed, the site currently carries a review of an example of fraud in the area.

What it also has is a series of links to work on LENR by a number of large companies and governments. Work has been underway in Japan in particular, with China, India, the USA, Russia and Israel also having research programmes. Clearly, there is enough potential here for serious work to have been commissioned. Much of the government-funded work is undoubtedly done with an eye to military use, but where the military leads, civil uses very often follow, as with nuclear fission.

LENR may turn out to be another interesting observation which cannot be usefully scaled up, but it is the only potentially truly disruptive energy technology around at the moment. We will have to find a replacement for coal, oil and gas at some stage, whether the drivers are emissions reduction or simply economic, but only nuclear fission currently has the potential to do so.

Despite the enormous sums continuing to be invested in wind and solar farms, any objective assessment of the current state of renewable energy technologies must conclude that they cannot by themselves provide the major part of our energy needs. Nuclear fission can, but we are nowhere near being able to build enough new reactors to change the balance over the next few decades. Nuclear fusion via tokamaks or laser compression remains decades away from reality, if indeed it ever becomes commercial (see, for example, nuclear fusion project leader laments ‘uncontrollable’ political forces for an update on ITER).

There is a huge amount of work to be done if LENR are ever to provide energy on a large scale, but the practicalities of running a reactor at low temperature and pressure make it a very attractive option compared with the mind-boggling challenges of containing ultra-high temperature plasma and getting useful energy from it. Unfortunately, the EU seems not yet to have realised the potential, but there’s still time to get in on the act.

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