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CATALYTIC FUSION OF DEUTERIUM INTO HELIUM-4

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Long empirical study has defined one specific set of experimental conditions under which D_2 reproducibly undergoes nuclear fusion under mild laboratory conditions.

Gaseous D_2 is contacted with a supported metallic catalyst at superatmospheric pressure, and about 130-300° C. The catalyst is a platinum-group metal, at about 1/2% to 1% by weight, on activated carbon. Pd, Pt, Ir and Rh all work, and Ru has not been carefully studied yet. (Pd is preferred). This type of PGM on activated carbon is one of the standard heterogeneous catalysts employed in the chemical industry, but the useful range of PGM content is much narrower than is known to be generally useful. Also, many other types of supports are sometimes useful in general catalytic applications, but none of the others—such as silica, alumina, ceramics, kieselguhr, etc.-appear to be useful for D_2 fusion.

This fusion process does not produce neutrons, helium-3, tritium (or, presumably, hydrogen), but instead produces only helium-4. The fuel gas from long-term runs has been analyzed by a large, magnetic-sector, mass spectrograph to contain very roughly 100 ppm of helium-4, which was not present in the research-grade D_2 fuel.

The reaction is: $2D \rightarrow$ He-4 + 24 meV. The energy thus produced is enormous, and because deuterium is very cheap in the form of heavy water (less than $l/gm.), the fuel cost for this process is very low indeed (much less than 1 cent per KWH).

This process has promise for low cost production of heat and power on a large commercial scale, and the oceans contain enough deuterium, as heavy water, to satisfy the earth's energy needs for many millions of years. An international patent application, Serial No. WO 97/43768, was published November 20, 1997.

Once scale-up is successful, the bottleneck obviously will be the enormous amount of PGM needed for a working, commercial-scale power plant, and the ensuing impact on the PGM markets. (Very roughly, one commercial power plant will require 1% of the world's annual production of Pd).

The mechanism of this fusion reaction is not known. Obviously, it is very specific, and quite different from those of the usual heterogeneous catalysis. Important facts, which must be explained by any successful mechanism are:

a) Only the reaction $D + D \rightarrow$ He-4 occurs

b) The only generally successful catalysts are about 1/2% to 1% PGM on activated carbon

i) Other substrates do not appear useful

ii) Pd, Pt, Rh, and Ir all work

c) The reaction occurs only in the range of about 130 - 300° C., with activity peaking at about 250° C.

d) The effect of pressure on reaction rate is small.

Some of the previously positive results of other investigators in the field of deuterium fusion may have depended on this particular mechanism, or may not. Clearly, any other study which produced neutrons, tritium, or He-3, reveals some other mechanism. And there seem to be instances of such in the literature. It seems too early to speculate on just how many different such fusion mechanisms have been reliably determined, and indeed how many are in fact catalytic in nature, and if not catalytic, then what?

The actual equipment employed is shown in the exhibited photograph. The reaction vessel is a 1.6 liter WW II 304 83 oxygen bottle, modified by welding to include:

a) a half-collar loading-unloading port

b) a pressure gauge with inlet— outlet valve

c) a thermowell reaching near the bottom of the reactor

d) a heating mantle

e) a steam tube in the form of an internal "V".

In operation, about 50 to 100 g. of the candidate catalyst is loaded into the vessel, and the loading port sealed with pipe dope. The reactor is then evacuated, and loaded with hydrogen to about 30 to 50 psig. Then the reactor is heated (with constant voltage on the heating mantle) to about 200 to 225° C. for a period of several hours. The reactor is then vented and evacuated, and the process repeated, until a constant temperature is reached in the thermowell. Then, the vessel is vented and evacuated, and the process is repeated with deuterium gas in place of the hydrogen, and then repeated once more with deuterium. If the temperature reached with deuterium is at least about 5° C. more than with hydrogen, thp catalyst is deemed specifically active for D_2 fusion. In fact, temperature differentials between D_2 and H_2 of greater than 20° C. have been sometimes reached.

Fusion Power Inc. offers two products to assist others in the laboratory fusion of deuterium:

1) A Pd on activated carbon catalyst optimized for greatest activity.

2) Electrodes developed for large effects in the electrolytic fusion of heavy water (Pons - Fleischmann process).

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