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NASA TECH BRIEF

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Using Permeable Membranes to Produce Hydrogen and Oxygen From Water

A new concept may make it profitable to obtain a usable fuel, hydrogen, from one of the Earth's most abundant resources, water. In a process now under study, superheated steam is fed into a long tunnel made of a selectively permeable membrane. This input superheated steam consists of a natural balance, or equilibrium, between water vapor and a small percentage of free hydrogen and oxygen.

As the steam moves along the tunnel, the initial free hydrogen escapes through the membrane, and the water vapor and the oxygen remain inside the tunnel. This upsets the natural water/oxygen/hydrogen equilibrium in the steam, and results in the decomposition of some of the water molecules into more hydrogen and oxygen. Some of this hydrogen is removed thereby causing further decomposition of water molecules to provide more hydrogen for subsequent removal. Thus, as the gaseous mixture passes through the long tunnel, hydrogen will be continuously formed and removed.

In the past, attempts had been made to remove free hydrogen from water vapor using selectively permeable membranes. The productivity of these methods was limited to the recovery of the small amounts of free hydrogen naturally present in the water vapor. The features that make this new process superior are:

a. The flowing vapor is contained within the membrane, under conditions favoring decomposition, for a long period of time.
b. This extended period of time allows the water/oxygen/hydrogen system to produce hydrogen through the decomposition of water.
c. The process continues, and new hydrogen is produced as long as the gaseous mixture is in the tunnel.

Figure 1 shows one possible configuration for the separation tunnel. It consists of two thin sheets of a hydrogen-permeable material, such as palladium, bonded together to form a long continuous maze.

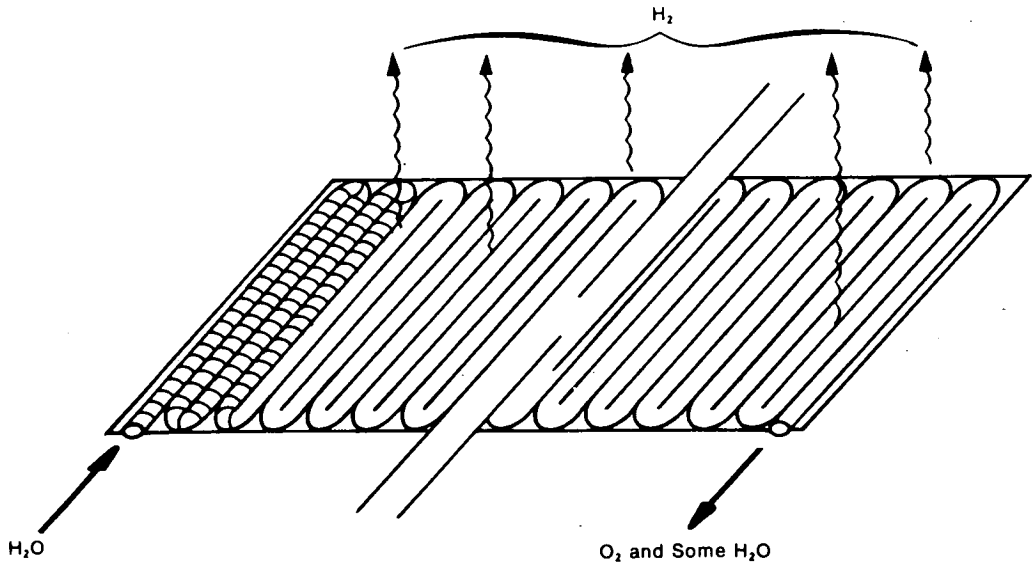

Figure 1. Separation Tunnel Conceptual Sketch (Not To Scale)

(continued overleaf)

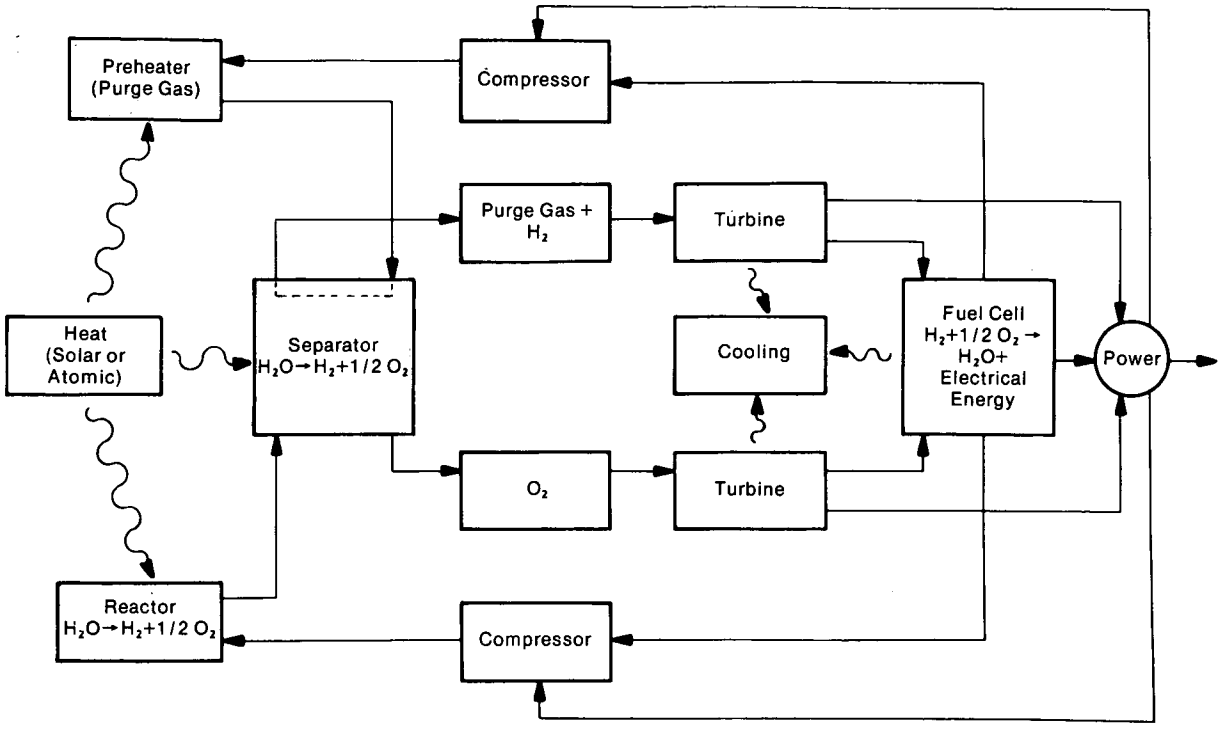

Figure 2. Proposed System for Generating Electricity

Steam would flow through the tunnel at a temperature of 600° C (1112° F) or higher, and at approximately 10 atmospheres pressure. As hydrogen passes through the membrane, it would be flushed away by an inert gas. The removal of the hydrogen outside the tunnel keeps the system out of equilibrium and enhances the production of new hydrogen inside the tunnel. Laboratory tests have demonstrated that the method enables the decomposition of water several orders of magnitude beyond the equilibrium state (where only small amounts of free hydrogen are present).

A system that might be used to produce electricity by recombination of the separated hydrogen and oxygen is shown in Figure 2. Preheated steam is decomposed into hydrogen and oxygen in the separator. Hydrogen is flushed from outside the membrane tunnel, and oxygen and water vapor are taken from inside the tunnel. The hot gases must be cooled; and since the gases are hot enough, turbines are used in the cooling process to add to the overall system output. The cooled gases are then recombined in a hydrogen/oxygen fuel cell to produce the major electrical output of the system.

Note:

Requests for further information may be directed to:

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Patent status:

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