NASA TECH BRIEF

Device Separates Hydrogen from Solution in Water at Ambient Temperatures

A separator has been devised to decrease the partial pressure of hydrogen gas dissolved in water under hydrostatic pressure. The separator is required to remove dissolved hydrogen from the water produced by fuel cells containing an alkaline electrolyte. It operates at room temperature (75°F) to decrease the partial pressure of the dissolved hydrogen from approximately 60 psia to less than 1 psia in the effluent fuel cell water. The unit eliminates the hazards associated with the release of hydrogen gas from water solution when the hydrostatic pressure is rapidly decreased.

The separator consists of closely spaced (1/8 in. or less) flat plates or 1/8 in.-diameter tubes made of a 75 percent palladium-25 percent silver alloy coated on both sides with palladium black, which is tightly bonded to the alloy surfaces by a special process. The process involves the direct application of palladium chloride to the surfaces of the plates or tubes followed by hydrogen reduction of the chloride to palladium black. Nominal loadings of 2 milligrams of the palladium black per square centimeter of alloy surface are achieved by this process. The surface area required to effect a specified decrease in hydrogen pressure is a function of water flow rate, temperature, and plate area or tube radius. The active area for hydrogen permeation can be minimized using closely spaced flat plates; but heavy backup plates would be required to enable the separator to withstand hydrostatic pressures up to 75 psia. Small-diameter tubes (1/8 in. o.d., 10 mil wall thickness) will withstand the hydrostatic pressures, but a greater active area than that of flat plates would be required to effect the same decrease in hydrogen pressure. Tubes of larger diameter than 1/8 in. would not be as efficient, whereas smaller-diameter tubes cannot be properly coated internally with the palladium black.

A separator that was fabricated consists of 18 tubes, each 20 inches long, arranged in parallel groups of 3, providing a series length of 10 feet, or an overall length of 30 feet. At 75°F, with a water flow of 10 mil per minute through the tubes, the unit will drop the partial pressure of dissolved hydrogen from 60 psia to less than 0.5 psia, without affecting the hydrostatic water pressure. At operating temperatures above 75°F even better efficiencies are possible. The separator will work equally well in air or vacuum, as in either case the partial pressure of hydrogen on the exterior of the tubes is essentially zero. A test unit has been operated for more than 5 months (3700 hours) without loss of efficiency.

Notes:

1. The rate of removal of hydrogen from water solution depends on the diffusion rate of hydrogen through water rather than through the tube wall; consequently practical designs can be achieved using relatively thick (10 mil) tubes.
2. The permeability of hydrogen gas through palladium or palladium-silver alloys at high pressures (400 psia) is well known and has been applied in a process for hydrogen purification. It is believed that the new separator design is the first instance of the practical use of these alloys for the separation of hydrogen from water solution at relatively low temperatures.

(continued overleaf)

3. The coated palladium-silver alloy can be used to pass hydrogen, either gaseous or dissolved, into or out of vessels containing gases or liquids. The alloy could have application in electrochemical systems such as batteries (where the alloy can be an electrode); in chemical processes for controlling the concentration of hydrogen, either as a reactant or product of reaction; and in hydrogen sensing devices.
4. Requests for further information may be directed to:

   Technology Utilization Officer
   Manned Spacecraft Center
   Houston, Texas 77058
   Reference: B69-10635

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

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