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Oxygen for Space Vehicles

ELECTROLYSIS OF WATER WITH PLATINUM AND PALLADIUM ALLOY ELECTRODES

The electrolysis of water provides one of the most convenient means of generating oxygen for consumption by astronauts in space vehicles. Hydrogen is a valuable by-product of this process, and may be used in several catalytic reactions that are carried out in space capsules. Members of the Battelle Institute, Columbus, Ohio, have reported the results of research carried out during recent years and aimed at providing a water electrolysis system that can operate with high efficiency under the conditions of weightlessness that are encountered in space (1)

Conventional electrolysis cells in which both the oxygen and hydrogen are liberated in a free electrolyte would rapidly decline in operational efficiency under conditions of weightlessness due to progressive blocking of the electrode surfaces by the bubbles of gas liberated there. Systems employing conventional nickel anodes, steel cathodes and asbestos diaphragms and providing an artificial gravity by rotating the cell have, therefore, been investigated; they were found to be too large, heavy and cumbersome to operate.

It was found that the need for an artificial gravity could be avoided by employing a matrix to immobilise the electrolyte which is retained by capillary forces that are effective in the absence of gravity. Initial experiments were carried out using a Teflon matrix containing hydrated phosphorus pentoxide as electrolyte. This separated the two screen electrodes, and water for the continuous electrolysis process was provided by absorption from the air that was circulated through the anode compartment. The oxygen liberated during electrolysis at the anode was passed straight into the circulating air stream.

When an electrolyte matrix separated a platinum screen anode and a 25 per cent silver-palladium alloy foil cathode, almost all the hydrogen liberated during electrolysis diffused through the cathode into a collection space behind it. The best matrix was found to consist of Teflon fibres holding insoluble calcium hydroxide impregnated with 66 per cent NaOH solution. A carbon-dioxide free water vapour feed was fed to the anode compartment which surrounded the ¼ inch diameter 0.005 inch wall palladium alloy tubular cathodes. Such cells, operating at 145°C and 2 volts, with current densities of 75 amp/ft^2, gave hydrogen transmissions of 97 to 100 per cent during twenty four-hour runs. The water vapour fed to the matrix during this period of operation from a generator at 100°C amounted to more than six times the weight of water originally contained in the matrix, and indicated that steady-state conditions had been achieved.

Based on these preliminary results, a design has been suggested for an electrolysis cell to produce 6 lb per day of oxygen – enough for three men. Such a cell would require 5.1 ft^2 of silver-palladium alloy surface, in the form of 70 tubes ¼ inch diameter, 0.005 inch wall thickness. It would be cylindrical in shape, with a length of 17 inches and an outside diameter of 5 inches; the palladium alloy tubes would each be surrounded by an annular matrix and a platinum screen anode, and the whole tube bundle arranged between manifolds similar to the design on which many tubular heat exchanges are based.

H. C.

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