Progress in Hydrogen Energy Systems

PAPERS AT THE SECOND INTERNATIONAL CONFERENCE

At a four-day conference held at Zürich in August 1978 one hundred and fifty-nine papers were presented covering many facets of a potential hydrogen economy. The platinum group metals are already utilised in several aspects of hydrogen production and use. From this brief review of some of the relevant papers presented it seems probable that they will continue to play an important role.

At present hydrogen is produced most cheaply from hydrocarbon fossil fuels. However, in view of their increasing cost and scarcity, the conference paid most attention to methods of affecting the endothermic dissociation of water, namely: thermolysis, electrolysis, thermochemical lysis and photolysis. The use of nuclear and renewable power sources to generate the necessary electrical and thermal power was advocated.

It was indicated that surface inhomogeneities on group VIII metal electrodes traditionally used for electrolysis resulted in preferred sites of electrolytic discharge. Improvements which it was thought might lead to current densities of 1.0 A/cm^2 and cell voltages of 1.8 volts included new electrode materials, higher cell pressures and temperatures, new cell membranes to operate therein, and solid polymer electrolytes. Photo-assisted electrolysis using solar energy with low efficiency was reported for oxides with relatively large band gaps but the improvement was only marginal.

Unfortunately core temperatures of nuclear reactors, commonly 1250 K, are too low for significant thermolysis but are useful for thermochemical cycles. Most work concerned variations on the following sulphur cycle:

$$2H_2O + SO_2 + xX_2 \xrightarrow{350\ K} H_2SO_4 + 2HX_x \quad (i)$$

$$2HX_x \xrightarrow{500\ K} xX_2 + H_2 \quad (ii)$$

$$H_2SO_4 \xrightarrow{1150\ K} H_2O + SO_2 + \tfrac{1}{2}O_2 \quad (iii)$$

H_2SO_4 and HX_x (where X is bromine or iodine) are liberated at platinum anodes and cathodes, respectively, in electrolytic step (i). In 1925 Hinshelwood showed that step (ii) could be catalysed by platinum or gold but J. Yeheskel, D. Leger and P. Courvoisier reported that palladium membranes were also active and allow the separation of hydrogen. The maximum gross thermal efficiency of electrolytic and thermochemical processes is approximately 40 per cent.

Transmission and storage networks for gaseous industrial hydrogen at pressures of 0.5 to 6.0 MPa have existed for many years in West Germany, the United Kingdom and the United States of America. However, higher storage densities are obtained after liquefaction, formation of readily decomposed compounds such as ammonia, or absorption in the interstices of metals and alloys. The latter has the advantage of use at moderate temperature and several relatively inexpensive alloys of group VIII metals, including $LaNi_5$, $CoTi_2$ and FeTi, absorb useful quantities of hydrogen.

The potential uses of hydrogen discussed included fuel cells, combustion (alone or mixed with methane), reduction of metal oxides, and as a fuel for automobiles, aircraft and trains. Experimental hydrogen-powered vehicles and houses are being tested by several industrial concerns and some were exhibited.

The proceedings of the conference are to be published later in the year, "Hydrogen Energy System", T. N. Veziroglu ed., Pergamon Press, Oxford. P. A. S.