The Platinum Metals in Fuel Cells

SECOND INTERNATIONAL CONFERENCE IN BRUSSELS

The merits of the platinum metals as electrocatalysts in a large number of fuel cell systems featured in a high proportion of the papers presented at the Second International Conference on the Study of Fuel Cells, organised by the Société d'Etudes de Recherches et d'Applications pour l'Industrie (SERAI) and the Société Commerciale d'Applications Scientifiques (COMASCI) and held recently at the University of Brussels.

More than fifty papers were presented at this meeting on all aspects of fuel cell technology, ranging from considerations of theoretical models of the processes taking place at working electrodes to outlines of the basic economics of the manufacture and use of fuel cells. Several instances of working cells producing power in the 1 to 2 kW region were described.

The superiority of platinum as an electrocatalyst has been clearly demonstrated by numerous researches, particularly in those fuel cells designed to work at ambient temperatures or in corrosive electrolytes, but the view has frequently been expressed that its high cost is a disadvantage for use in large scale commercial applications. C. G. Clow of Energy Conversion, presenting the results of an analysis of the basic economics of various types of low temperature fuel cells using alkaline electrolytes, pointed out that the cost of electricity generation comprises capital costs, maintenance and fuel, and that the use of the cheapest fuel and high efficiency did not necessarily mean the most economic generation of power. The cost of materials and fabrication of the fuel cell unit depend on the fuels and conditions used, and in certain systems the cost of electrodes with platinum loadings of less than 3 $mg.cm^{-2}$ did not constitute the major item of expense.

A new type of gas diffusion electrode was described by R. G. Haldeman and his co-workers of the American Cyanamid Company. This is made by impregnating a conductive graphitic carbon, bonded with fibrous polytetrafluoroethylene, with chlorplatinic acid in ethanol and reducing at 225°C. The novelty of this electrode is that a high degree of structural cohesion and flexibility is obtained even with very high proportions of the conductive graphite. Excellent results were obtained for reactions of hydrogen and oxygen in both acid and alkaline media at low platinum concentrations.

Fuel cells having particular applications in view were described by M. I. Gillibrand and J. Gray of Electrical Power Storage, and by C. G. Telschow and co-workers at Brown Boveri. In the former case capacities of over 10,000 ampere-hours without attention were claimed from cells operating at low current densities with compressed hydrogen and oxygen; such cells are ideal for use as power sources in navigational buoys and unattended beacons. In a buoy a life of three years between servicing would be possible, and a shore-based beacon could operate for six months without attention. Similarly the Brown Boveri equipment had an expected six months unattended life, and could therefore be used in certain areas of the world in telephone and television relay stations. This cell utilises a platinum metal catalyst for the direct oxidation of methanol in an alkaline electrolyte and is capable of producing power at temperatures down to —10°C.

Both acid and alkaline electrolytes can be used in direct methanol oxidation systems, as was pointed out by H. H. von Döhren and his colleagues at Varta. Both electrolytes have their advantages and Varta currently use

potassium hydroxide solutions in their experiments. Measurements made by this group indicated that below 80°C non-precious metals did not work very well, while of the platinum group metals platinum, palladium, palladium-platinum alloys and platinum-rhodium alloys were the most active at ambient temperatures.

The study of alloys of the platinum group metals for fuel cell applications continues to attract interest. Thus J. H. Fishman of Leesona Moos Laboratories had investigated the use of palladium-gold alloys for oxygen reduction in alkaline media. When a foil was used, a maximum in the activity versus composition plot was obtained with alloys containing 35 to 40 atomic per cent gold, and a sharp decrease in activity was observed in alloys containing greater than 80 atomic per cent gold. Similar behaviour was found when finely divided alloy powders were used, the activity maximum now occuring at 50 atomic per cent gold, sharply declining at 60 atomic per cent gold, irrespective of the method of preparation of the alloy.

J. Bersier of Siemens has investigated the diffusion of hydrogen through silver-palladium alloys, since the use of such alloys in the construction of non-porous diffusion electrodes avoids the difficulties arising from the brittleness and cracking experienced with pure palladium. Measurements of the diffusion coefficient of hydrogen as a function of hydrogen concentration and temperature in the range 30 to 300°C show that it is largely governed by the concentration of occluded hydrogen, and that for the 23 per cent silver-palladium alloy a definite minimum occurs in the concentration range 0.1 to 0.2 H/Me not explicable by the existence of a two-phase zone in the alloy.

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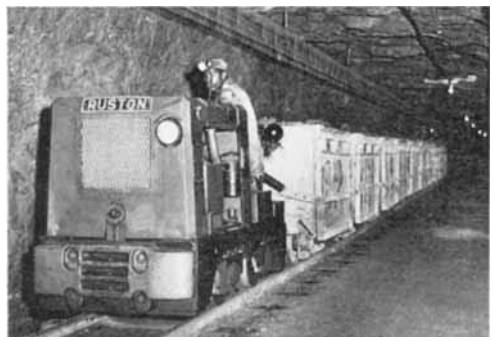
Further Expansion in Platinum Production

A NEW REFINERY IN SOUTH AFRICA



Although a further increase in the output of platinum to 750,000 ounces a year was announced by Rustenburg Platinum Mines as recently as October of last year, yet another step in the expansion programme has been decided upon. Plans to increase mining capacity to an annual equivalent of about 850,000 ounces of platinum – with corresponding amounts of the other platinum metals – have been put in hand and are expected to begin yielding these additional amounts of metal by the end of 1969. The capital expenditure involved in the complete expansion programme over the years 1967 to 1971 will exceed £15 million.

Extensions to the smelting and refining facilities are also in hand both at Matte Smelters (jointly owned by Rustenburg and Johnson Matthey) and at the Johnson Matthey plants in the United Kingdom.

In addition, Johnson Matthey have decided, subject to the necessary Government authority being granted, to build a platinum refinery as an extension to the operations already carried out at Wadeville by Johnson Matthey & Co South Africa (Pty) Limited. This new refinery will be constructed and equipped during 1968 and will come into operation in the early part of 1969. It will take partially refined material treated by Matte Smelters at Rustenburg and produce pure platinum, palladium, rhodium, iridium, ruthenium and osmium as well as their compounds. The new Johnson Matthey refinery at Wadeville will complete the plans for handling Rustenburg's increased output and will, for the first time, make platinum metals available in marketable forms in South Africa.