methods hitherto employed that its cost is well justified. Obviously account must be taken of the manufacturing costs of the catchment gauzes, the interest that must be paid on their intrinsic values and the costs of their subsequent refining, but overall experience so far points to the promise of universal adoption of the process in nitric acid plants in the years to come.

The benefits of the process are simply assessed. A catchment gauze pack can be installed in a burner and after a short period of service removed for analysis and refining. The analysis provides an immediate indication of the recovery rate and this can be related to the additional costs involved.

The process described above is internationally patented. (British Patent No. 1082105 applies in the U.K.) Johnson Matthey & Company Limited and their overseas subsidiaries are appointed licence agents for the process in the United Kingdom and all other countries in the world except those of North America, the European Common Market and Spain.

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Economics of Platinum Catalysts in Fuel Cells

The advantages of employing platinum metal electrocatalysts in fuel cells continue to be debated, but a paper by K. R. Williams, of "Shell" Research, presented at the Sixth International Power Source Symposium at Brighton, gives a useful guide to the economics of their use in certain types of systems.

Starting from the basis of using methanol or hydrocarbons in a low temperature system in the range 1 to 5 kW, the author compared the costs and performance of cells fuelled by pure hydrogen, impure hydrogen and methanol. Pure hydrogen may be obtained by steam-reforming methanol in a fluidised bed reactor and extracting the hydrogen by means of a silver-palladium diffusion cell. This system produces a very pure hydrogen fuel. Methanol can also be reformed to yield impure hydrogen; the cost of a diffusion cell and associated equipment would be saved, but the system weight would scarcely be reduced since more reforming catalyst is required to achieve an adequately low carbon monoxide concentration. Obtaining hydrogen by hydrocarbon reforming necessitates the use of a two-stage system – a reforming stage in the temperature range 500 to 700°C, followed by a shift reaction at lower temperatures to increase the hydrogen content of the gas.

Ruthenium-platinum electrocatalysts applied to electrodes comprising microporous plastics coated with a conductive metallic layer have been demonstrated to show a number of advantages in this type of system. In 6N KOH systems at platinum loadings of 1 mg/cm^2 power outputs of 100 mW/cm^2 can be achieved with hydrogen fuel, compared with only 40 mW/cm^2 with less expensive nickel catalysts. The ruthenium-platinum catalysts, moreover, can deal effectively with impure hydrogen, as well as with methanol directly, at a small cost of slightly increased electrode polarisation. When total system costs are compared for fuel cells operating with ruthenium-platinum and nickel catalysts, a 1 kW battery would cost around £60 in the former case (with two-thirds of this sum being attributed to the platinum) and about £50 in the latter instance. There is thus only a slight saving when non-platinum catalysts are used, due to the increased construction costs that almost completely offset the savings in electrocatalyst. The weight of such a system, moreover, is increased significantly.

In acid electrolytes the catalyst loading has a very marked effect on cell performance. Ruthenium-platinum electrocatalysts operate best around 70°C when impure hydrogen is used as fuel, but—in general—construction costs are much higher when acid electrolytes are employed due to corrosion problems.

From an analysis of costs and performances of the systems reviewed, the author concludes that although the least expensive system at the 5 kW level is that using a methanol reforming system giving pure hydrogen and non-platinum catalysts in an alkaline electrolyte, the additional cost of using platinum catalysts is minimal and bestows significant advantages in increased performance/weight parameters. The system using impure hydrogen is about $2\frac{1}{2}$ times as expensive; most expensive is that using methanol directly in an acid medium.

H. C.