Platinum for Fuel Cells

AVAILABILITY AND COST-EFFECTIVENESS

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The unique combination of excellent corrosion resistance with high catalytic activity has assured the application of the platinum metals, at least in some fuel cell systems. In discussing the use of the platinum metals in fuel cells, however, two questions constantly recur. Is there enough platinum available to meet the potential demands of the fuel cell systems under development? How can the platinum electrocatalyst be used at maximum cost-effectiveness? Neither question can be answered simply, since in both cases there are several interrelated complicating features.

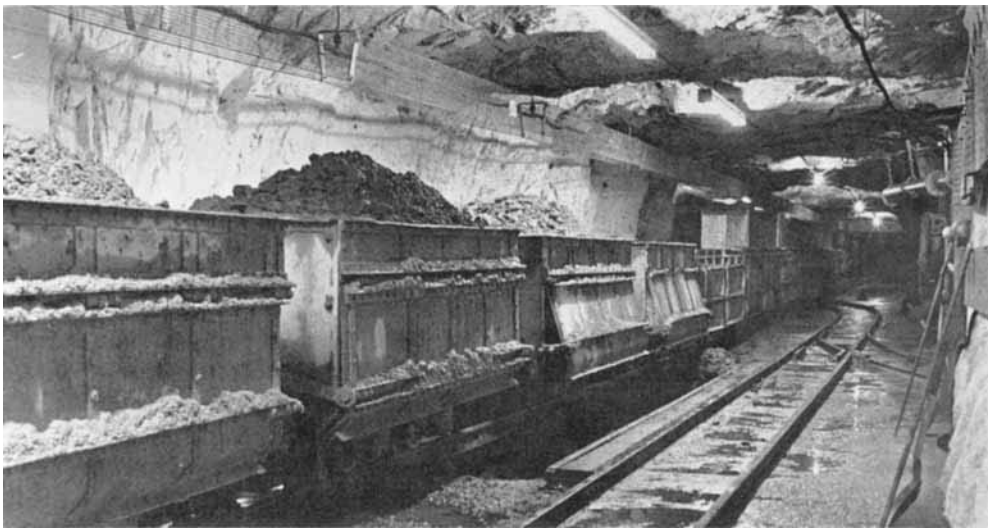
There has been a good deal of talk about a shortage of platinum for industrial uses during the last few years. In fact, there has been no absolute shortage. Although the demand has increased very substantially, practically all real needs have been met by the main primary sources – South Africa, Canada and Russia – supplemented in 1966 by a release of some 300,000 ounces from the U.S. Strategic Stockpile.

The amounts available from Canada, Russia and the minor producers have remained relatively static. The big increase in availability has come from Rustenburg Platinum Mines, for whom Johnson Matthey are the refiners and distributors. As was announced last year, substantial increases in mining and refining operations are in hand to provide an output of 850,000 ounces of platinum a year (1). This is more than a four-fold increase in the output of platinum since 1964, with of course corresponding increases in the supply of rhodium, ruthenium, palladium and iridium. Underground reserves of metal are estimated to be sufficient to last well into the next century at the planned rate of output.

An impression of shortage has stemmed from the fact that there is a wide disparity in the selling prices for South African and Canadian metal, on the one hand, and that for the metal coming from Russia and the minor producers. Since, of course, no one wants to use the more costly sources unless compelled to do so, there is a shortage of relatively low-cost platinum.

And platinum for fuel cells? Demands for platinum metals for any of the numerous specialised fuel cell systems now under development are likely to grow slowly; initial demands can, no doubt, be easily met from current outputs. At a certain stage in the market development of each fuel cell, moreover, some platinum will become available by the recovery from spent electrodes. (The design of platinum metal-containing electrode structures to permit economic metal recovery after use could incidentally be the subject of fruitful collaboration between fuel cell researcher and platinum refiner.) Large-scale, continuing supplies of platinum, however, can only be assured by early direct consultation with the producers. Whereas it may not be possible to equip each of ten million motor-cars per annum with a fuel cell power source containing 100 grams of platinum, it appears certain that the more realistic demands for metal that may be made by fuel cells now under development for specialised applications can be met.

Apart from the question of availability, the high intrinsic value of the platinum metals makes it imperative that the most effective use be made of them in electrode structures. Several approaches to this have recently been suggested (2). Primarily, these concentrate on making catalytically available and active



Operations at Rustenburg Platinum Mines have been extended many times over the last thirty years and now provide the largest source of the platinum metals in the world. Further expansion plans will increase output to approximately 850,000 ounces of platinum a year

the highest possible proportion of metal atoms that are incorporated in an electrode structure. For platinum metal blacks, for example, their preparation with very high surface areas per unit weight is a necessary step in this direction. Such blacks, however, must also exhibit particular properties of dispersion in the binders used to secure them to their electrodes. High surface area, moreover, is not a unique index of catalytic activity, since this depends to some extent on the individual features of each fuel cell system.

In order to reduce cost to a minimum there is now a strong and growing trend to use supported platinum metal catalysts in the development of fuel cells for commercial applications. Such catalysts, containing a relatively low metal concentration (for example, 5 per cent) on an electronically conductive support (for example, charcoal) enable specific metal areas to be achieved that are far higher than those of blacks. Even with the best catalysts that are at present available, however, less than 25 per cent – more usually only 5 to 10 per cent – of the metal atoms are catalytically accessible and active. With all of them, the grade of support selected and the technique employed in their preparation critically determine their suitability in a particular fuel system. Their specific activities (for example R/A, where R=activity in appropriate units, and A= metal area per unit weight of catalyst) may differ widely when variations in catalyst preparations are introduced. Fuel cell research aimed at finding the economically optimum electrocatalyst for a particular system will therefore have to consider not only the most appropriate of the platinum metals, or a synergistic binary mixture of these, but also the best method of preparation.

The Johnson Matthey Research Laboratories are heavily engaged in the investigation of catalyst preparation procedures to obtain the greatest cost-effectiveness from the platinum metals. Collaboration with catalyst users and research workers operating in specific areas, including fuel cells, is increasingly leading to the point where the factors that govern metal utilisation may be controlled.

References

1 *Platinum Metals Review*, 1967, **11**, 131
2 *Platinum Metals Review*, 1968, **12**, 21