

product range than is obtained at present with iron catalysts on a commercial scale. Reaction conditions may be selected such that hydrocarbons above C₁₈ can be minimised to negligible quantities and hydrocarbons in the range C₁ to C₄ can be kept to manageable proportions. Cobalt-based catalysts were the first to be used commercially and these have been followed by iron-based systems. It now seems likely that ruthenium will find significant use in third generation systems. Ruthenium is intrinsically more expensive than cobalt and iron, however

it may be recovered from spent catalysts and recycled in the form of fresh catalyst, thus reducing the overall catalyst inventory. Ruthenium was not considered as a potential industrial Fischer-Tropsch catalyst in the early 1930s because of its cost; but with the currently available improved catalyst technology involving highly dispersed supported ruthenium the intrinsic high activity of this metal can be effectively utilised and its overall economic performance compared with iron now looks more favourable.

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Cogeneration of Nitric Acid and Electricity

PLATINUM ELECTRODES EMPLOYED IN HIGH-TEMPERATURE FUEL CELL

One of the most important industrial processes to utilise a platinum group metal catalyst is the production of nitric acid. In the process a mixture of ammonia and air is passed over a rhodium-platinum catalyst gauze at a temperature of 750 to 950°C, first producing nitric oxide and then nitrogen dioxide which is subsequently absorbed in water. The reaction is highly exothermic and in many modern high pressure plants the heat energy from the tail-gas is recovered as it passes through a turbine, thus contributing to the power required to compress the process gas.

For a long time the desirability of obtaining this energy as electricity, rather than as heat, has been appreciated. Now workers at the Massachusetts Institute of Technology have reported on an ammonia high temperature solid electrolyte fuel cell which appears to offer an

opportunity for producing nitric acid while recovering the exothermic energy as electricity, (R. D. Farr and C. G. Vayenas, *J. Electrochem. Soc.*, 1980, **127**, (7), 1478-83).

Their fuel cell consists of an yttria-stabilised zirconia tube with electrodes of porous platinum, having an estimated thickness of 3 microns, deposited on both surfaces. The electrodes performed well over long periods of time, and scanning electron microscopy showed that extensive sintering and faceting had occurred on the anode, similar to that which is observed during the normal catalytic oxidation of ammonia over platinum. The fuel, ammonia diluted with helium, flows through the tube while the cathode is exposed to air. Nitric oxide is the primary electro-oxidation product, and under optimum operating conditions yields in excess of 60 per cent can be obtained.