Platinum Group Catalysts for Europe

CAR EMISSIONS CONTROL AND FUTURE METAL DEMAND

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In recent years, the Western World has grown increasingly concerned about the consequences of environmental pollution. In the case of gaseous pollution of the atmosphere, knowledge of these effects is still very limited although the secondary problems resulting from atmospheric interaction between pollutant gases have received much attention. At present the most important problems that have been identified are photochemical smog, oxidant formation and acid deposition.

Motor vehicles are responsible for a significant proportion of the hydrocarbons, carbon monoxide and nitrogen oxides emitted to the atmosphere but the application of advanced platinum group metals technology enables all three to be controlled in a cost effective manner. As a consequence, a major market for platinum group metals has arisen in the United States of America and Japan to ensure that cars used in those countries comply with their stringent emission control standards. Similar regulations will be introduced in Australia in 1985, and recent initiatives indicate that European countries are also likely to legislate for a further reduction in the level of emissions from motor vehicle exhausts. Thus, it is anticipated that a growing requirement for emission control systems will lead to increased demand for platinum, palladium and rhodium, the metals currently found to be most suitable for this application. This paper considers the predicted development and probable magnitude of this new European market, for which ample metal resources are available.

In Europe both national and international organisations with many diverse interests are seeking to contribute to the evolution of emission control standards. As a result progress has been slow; too slow in the view of some nations who are proposing to adopt U.S. standards unilaterally.

To comply with new legislation in the U.S.A. in 1974 the majority of American automobile manufacturers found it necessary to incorporate catalyst control technology in their new vehicles, a change which depended upon the availability of lead-free gasoline. The introduction of these catalysts resulted in a significant change in the pattern of platinum usage, and some three years later approximately 45 per cent of all platinum consumed in the U.S.A. was used by the automobile industry.

Environmental Concern in Germany

A widely held belief that atmospheric pollution leading to rainfall contaminated with sulphur dioxide, heavy metals, nitrogen oxides and photo-oxidants is causing the death of vast areas of pine forests in the Federal Republic of Germany has focused attention on many aspects of environmental pollution, including that caused by noxious vehicle emissions. As a result the government is seeking a reduction in car exhaust emissions to about 10 per cent of

the present levels. In practical terms the new standards will necessitate the use of three-way catalysts for the simultaneous control of hydrocarbons, carbon monoxide and nitrogen oxide emissions. As the durability and effectiveness of these catalysts depends upon their use in conjunction with unleaded gasoline, this will be introduced concurrently.

While the Federal Republic of Germany seems likely to lead the way, other Western European nations, particularly Sweden, Switzerland and Austria, are equally determined to find a solution to environmental pollution problems.

European Autocatalysts

Catalyst-based emissions control technology is incorporated in European manufactured cars exported to the U.S.A. and to Japan, but these tend to be only the larger and top specification models. The majority of European cars use small high power output engines designed for European driving conditions and different engineering and catalytic solutions will be necessary to satisfy the stringent standards expected. The catalysts will be required to operate efficiently both at the very low average speeds typical of city driving and also at speeds in excess of 70 miles an hour, when exhaust gas temperatures are very high. In addition, at least initially, the so-called unleaded gasoline is likely to be contaminated with more residual lead than is the case in the U.S.A. Thus a degree of lead-tolerance by the catalyst will be essential.

Current platinum metal catalyst technology is quite capable of meeting the anticipated requirements of the legislators.

Anticipated Demand for Platinum Metals

It is entirely conceivable that all cars used in Western Europe at the end of the decade will be fitted with exhaust emission control catalysts. As approximately 90 per cent of the 10 million new cars registered annually in Western Europe are gasoline-engined a very substantial demand for platinum group metals is foreseen. This will, perhaps, commence in 1986 and increase to a maximum demand in the early 1990s. The most widely accepted estimate of this demand is that given by the Committee of Common Market Automobile Constructors – the trade association of the European motor industry – which amounts to 15,000 kilograms of platinum group metals annually.

World Platinum Sources

In the richest deposits known the total concentration of the six platinum group metals rarely exceeds 10 parts per million, nevertheless substantial reserves are at present being mined. In addition it has been suggested that other resources, including materials whose presence is only assumed but which it may be potentially feasible to recover when it is required, are even larger. Currently Southern Africa, the Soviet Union and Canada produce 99 per cent of the world's newly mined platinum group metals, the first two each contributing about 46 per cent of the total. Table I gives estimates of world reserves and resources of the platinum group metals. In Southern Africa the gigantic geological structure known as the Bushveld Igneous Complex is believed to contain 80 per cent of the world's reserves and 70 per cent of its resources of platinum group metals, excluding deposits in the People's Republic of China. No figures for the latter are available although it is believed that limited production from substantial reserves may already be taking place there. In addition to Southern Africa, the Soviet Union, Canada, China and minor sources, substantial resources are present in the Stillwater Complex in Montana, U.S.A. and may come into production by the end of the decade.

It is important to note that the deposits of Southern Africa are mined principally for the platinum group metals, and therefore output can be geared to the needs of the platinum users. In other areas the platinum group metals are recovered as by-products during the mining of base metals so here output is determined by the demand for these base metals.

For the three-way control of automobile exhaust emissions, platinum is the most

Table I

World Platinum Group Metal Resources, in tonnes

Source	Reserves		Other resources of the six platinum group metals	Grand total of platinum group metal resources
	Platinum only	The six platinum group metals		
United States	Not available	31	9,283	9,300
Canada	124	280	217	500
Colombia	<30	<30	124	155
USSR	1,860	6,200	6,200	12,420
Southern Africa	10,860	18,000	46,570	65,195
World total (rounded up)	12,900	24,600	62,400	87,600

Table II

The Platinum Availability and Production Capacity of Rustenburg Platinum Mines

Platinum reserves (Other platinum group metals are additional)	10,000 tonnes
Annual platinum group metal production	45 – 50 tonnes
Proportion of Southern African platinum group metal output	>50 per cent
Installed platinum group metal production capacity	55 – 70 tonnes
Maximum leadtime to increase capacity	18 – 20 months
Forecast of annual platinum group metal demand for European car emission control catalysts	13 – 15 tonnes
Estimated total world platinum group metal resources	87,500 tonnes

important metal although small quantities of rhodium and, occasionally palladium, are also incorporated. Now, the proportion of individual platinum group metals in the different locations varies greatly; in the Soviet deposits palladium is the major element while the output from the mines in Southern Africa is richest in platinum. In 1982 approximately 72 metric tonnes of newly-mined platinum were supplied to the Western World and three-quarters of this was mined in Southern Africa, more than half of the latter being supplied by the Rustenburg Platinum Mines. Some relevant data of platinum availability and production capacity at these mines is given in Table II.

At the present rate of production – and allowing for possible major new applications, including the use of emission control catalysts in Europe – world reserves and resources of platinum are more than sufficient to outlast the use of current technology in the internal combustion engines used for motive power. Even if only the reserves and resources of Southern Africa are considered, the anticipated additional demand created by the introduction of emission control catalysts on all new European cars could be met readily. The lead time required to bring new capacity to production, – if this should prove to be necessary, and if the position of Rustenburg Platinum Mines is typical of the industry – is less than the time likely to be demanded by the motor manufacturing industry for the implementation of catalytic emission control standards.

Finally it should be noted that European demand for platinum group metals for this particular new application could be reduced once cars equipped with platinum-containing catalysts reach the end of their useful life, and the platinum group metals are recycled.