Platinum Metals in the Motor Industry

A SELECTIVE REVIEW OF THE SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL CONGRESS AND EXPOSITION

A total of over 650 papers covering the whole range of automotive activities was presented at this year's SAE Congress, which was held in Detroit, Michigan during February. In the automobile industry, the platinum metals are used primarily for emission control purposes on both gasoline and diesel fuelled vehicles; however, their use in fuel cells for electric vehicles was also featured in some of the twenty papers that highlighted the application of the platinum metals.

Diesel Particulate Control

The introduction of diesel particulate control legislation in the United States in 1982 and the proposed introduction of more stringent standards in 1987 has provoked significant research activity on diesel particulate control. This was reflected by the number of papers presented on this particular topic, in three well attended sessions.

Three types of particulate control device were discussed, these are uncoated wall flow ceramic filters, catalytically coated ceramic filters and catalytically coated wire mesh filters. Many papers centred upon the identification of conditions necessary to regenerate these filters when particulate begins to accumulate under low speed low load driving conditions, resulting in increased exhaust back pressure. The efficacy of catalysts in promoting regeneration was stressed by a number of speakers including E. Koberstein, H.-D. Pletka and H. Völker of Degussa who compared the performance of uncatalysed and catalysed ceramic filters and concluded that soot ignition temperatures could be reduced by up to 100°C by the use of catalysts. Particulate reductions up to 80 per cent were achieved by the use of platinum-palladium catalysts, together with high conversions of gaseous hydrocarbon and carbon monoxide emissions.

Wire mesh supported platinum metal based catalytic filters were described by B. E. Enga and M. F. Buchman of Johnson Matthey with respect to regeneration under actual driving conditions. The authors described an air intake throttling system which was developed to ensure a sufficient concentration of hydrocarbons, carbon monoxide and oxygen in the engine exhaust stream to promote catalyst regeneration at lower temperatures than those required for catalytic combustion of diesel particulate. The system was activated as exhaust back pressure increased. Three operating regions for catalytic filters were identified in which exhaust back pressure was low (temperature high), constant (mid-range temperature) or rising (temperature low). P. Öser and U. Thoms of Volkswagen described the region of constant back pressure as the "balance point", that is the region where particulate collection and combustion is equal. The authors compared catalysed ceramic and wire mesh filters, and concluded that the platinum metal catalysed wire system provided the lowest ignition and balance point temperatures.

An overview of diesel particulate control methods was given by C. M. Urban of Southwest Research Institute and L. C. Landman and R. D. Wagner of the U.S. Environmental Protection Agency. It was concluded that, of the particulate control strategies investigated, only particulate filters produced large decreases in diesel exhaust particulates. Uncatalysed and catalysed ceramic filters and catalysed wire mesh filters were evaluated and most of the systems evaluated gave significant reductions in particulates and organic extractables.

In his contribution M. P. Walsh, a consultant, reviewed the benefits and the costs of diesel particulate control on light duty vehicles in the

U.S.A. and the author concluded that, under all scenarios covered by his cost-benefit model, the net benefits of diesel particulate control are well in excess of the costs.

Lead Tolerant Catalysts

The progressive introduction of much more stringent emission regulations into Europe, together with the possibility that lead will be retained in European gasoline, has promoted research into lead tolerant exhaust emission control catalysts. B. Harrison, J. R. Taylor, A. F. Diwell and A. Salathiel of Johnson Matthey described the use of a thermodynamic model to predict the nature of the lead species in vehicle exhaust in relation to lead-scavenger packages, fuel sulphur content, exhaust oxygen content and exhaust temperature. It was concluded that the identification of appropriate vehicle operating conditions was essential to the effective operation of lead tolerant catalysts. Results for monolith supported platinum based lead tolerant catalysts run on fuel containing 0.4 g/l leaded fuel were presented.

The operation of pelleted lead tolerant catalysts was described in a paper by M. Prigent, J. P. Brunelle, G. Blanchard and R. Dozière of Société Procatalyse. The nature of lead poisoning was discussed in terms of noble metal/lead interactions, adsorption of halogens from scavengers and pore mouth plugging. The authors recommended high operating temperatures for their catalysts and presented vehicle results obtained on 0.15 g/l leaded fuel. In a paper by R. H. Hammerle and Y. B. Graves of the Ford Motor Company, two different mechanisms of lead poisoning were proposed; one, which predominates at 700 to 800°C involves the poisoning of platinum sites by lead oxide, and the other, which occurs below 550°C involves the build up of an impermeable lead sulphate barrier. Methods of reversal of both of these types of poisoning were proposed and the authors suggested that a narrow range of operating temperatures would be necessary for the successful operation of lead tolerant catalysts. M. G. Henk, J. J. White, J. F. Skowron and I. Onal of Universal Oil Products also concluded that operating temperature was important, as well as the engine test cycle used for ageing catalysts.

A comparison of the fuel economy and performance of vehicles designed for European and American operation was discussed in a paper by A. C. Gullon and N. Ostrouchov of Environment Canada. The results indicated equal or better performance for the American technology and therefore have interesting implications for the possible introduction of lead free fuel into Europe, which would also allow conventional catalytic emission control technology to be used.

Fuel Cells

The papers presented in this session centred around the Los Alamos National Laboratory Fuel Cells for Transportation Applications Programme which has as its long term aim the development of fuel cells as power plants for cars, buses and commercial vehicles. The paper by H. S. Murray, R. E. Bobbett, D. K. Lynn, J. R. Huff, C. R. Derouin and J. B. McCormick of the Los Alamos National Laboratory gave an outline of the programme at Los Alamos for testing fuel cell systems for automotive applications including vehicle characterisation, fuel cell static tests and load tests and system tests. Other papers in this session related to contractors to the Los Alamos study, who had been asked to assess the feasibility of their own fuel cell technology for automotive applications. L. J. Nuttall and J. F. McElroy of General Electric described their work on solid polymer electrolyte fuel cells incorporating platinum catalysts and concluded that, given adequate engineering development, a passenger car using this technology is practical. J. K. Stedman of United Technologies Corporation gave a similar paper but based upon phosphoric acid fuel cells, again involving platinum catalysts. The technology was thought to be practical for motor vehicle applications and it was believed that power output, weight and volume targets set by Los Alamos could be met.

The overall conclusion from the Los Alamos studies was that fuel cells may be practical for vehicle applications but major factors such as cost and unit volume must be reduced in order to compete effectively with the internal combustion engine. It was thought that the most practical application may be in trucks and buses rather than passenger cars.

The papers presented at this meeting which described the use of platinum metals in automotive applications were relatively few in number, but nevertheless represented some of the major potential outlets for these metals over the next two decades. B.H.

Studies of Some Platinum Mineral Deposits

A special issue of the journal *Economic Geology* devoted to the platinum-group elements has recently been published; it contains twenty-one of the thirty-nine papers presented at the Third International Platinum Symposium held in Pretoria, South Africa during July 1981 sponsored jointly by the Society of Economic Geologists and the Geological Society of South Africa. Two additional papers not read at the symposium are also incorporated in the issue (*Econ. Geol.*, 1982, 77, (6)).

The most important platinum deposits occur in the Bushveld Igneous Complex of Southern Africa and are located in the Merensky Reef, the UG-2 chromitite layer and the Platreef. Many of the papers in the first half of this journal deal specifically with these deposits, the majority of them being based upon information obtained from drill cores or underground samples released by the mining companies for detailed investigation which have generated significant amounts of quantitative mineralogical and analytical data.

Recent work on compositional variations within and between five Sudbury ore deposits is presented but regrettably there is no contribution on the third great platinum producing area of the world, namely the Noril'sk-Talnakh combine in Siberia, U.S.S.R. However, a number of the smaller scientifically interesting areas of the world are featured including the important Stillwater Complex and the Thetford Ophiolites of North America, the Italian Ivrea-Verbano Basic Complex, the New Caledonian chromitites, and the platinum-group elements in the Polish Zechstein copper deposits.

This journal is not the sole source of the information on the mineralogy of the platinum-group elements and their behaviour during geological time that has accumulated since a previous issue was devoted to the subject, following an earlier symposium at Denver, Colorado in October 1975 (see *Econ. Geol.*, 1976, 71, (7)). The reader is specifically referred to *The Canadian Mineralogist*, 1979, 17, (2) for information on the magmatic nickel, copper and platinum-group sulphide deposits, and to the book "Platinum-Group Elements: Mineralogy, Geology, Recovery" reviewed here last year (*Platinum Metals Rev.*, 1982, **26**, (2), 57). However all the papers are amply supported by references making this issue of *Economic Geology* a most important publication for all students of the platinum deposits.

Copies of the journal can be obtained from The Economic Geology Publishing Company, University of Texas-El Paso, 202 Quinn Hall, El Paso, Texas 79968, U.S.A. Price including postage is $16.00 (U.S.) or $17.00 (outside North America.) I.E.C.

Alloying Effects of Palladium

A vast and ever increasing amount of scientific and technical information is becoming available throughout the industrialised world; fortunately advances in data generation have not proceeded in isolation. New techniques of information storage and retrieval, particularly on-line searching of national and international computer data bases, constitute an efficient means of searching the literature. Extending these techniques, publication of bibliographies developed from searches of on-line data bases can provide readers with information that enables them to determine rapidly and economically which reports in a data bank are of special interest to them.

A recent bibliography published by the U.S. National Technical Information Service contains 283 fully indexed citations from the Metals Abstracts Data Base concerning the alloying effects of palladium. The topics covered include alloying elements, magnetic and physical properties, effects of temperature and pressure, corrosion resistance and mechanical properties. Metallic glasses and superconductivity are also discussed.

Alloying Effects of Palladium. 1966–July, 1982 (Citations from the Metals Abstracts Data Base), publ. PB82–871823, can be obtained from NTIS, Springfield, VA 22161, U.S.A.