Growth of Platinum Reforming in Western Europe

MEETING THE DEMAND FOR HIGH-OCTANE FUELS AND AROMATIC HYDROCARBONS

By B. M. Glover, B.Sc.

Industrial Division, Johnson Matthey & Co Limited

In terms of demand for petroleum products Europe differs from America in one vital respect. Consumption of fuel oil is very high, whereas American industry has available large supplies of natural gas; the refiner in the U.S.A. can therefore produce high quality fuels partly by catalytic cracking of heavy distillates, but his European counterpart has no such opportunity and must rely to a much greater extent on catalytic reforming processes to produce high quality fuels from straight-run naphthas.

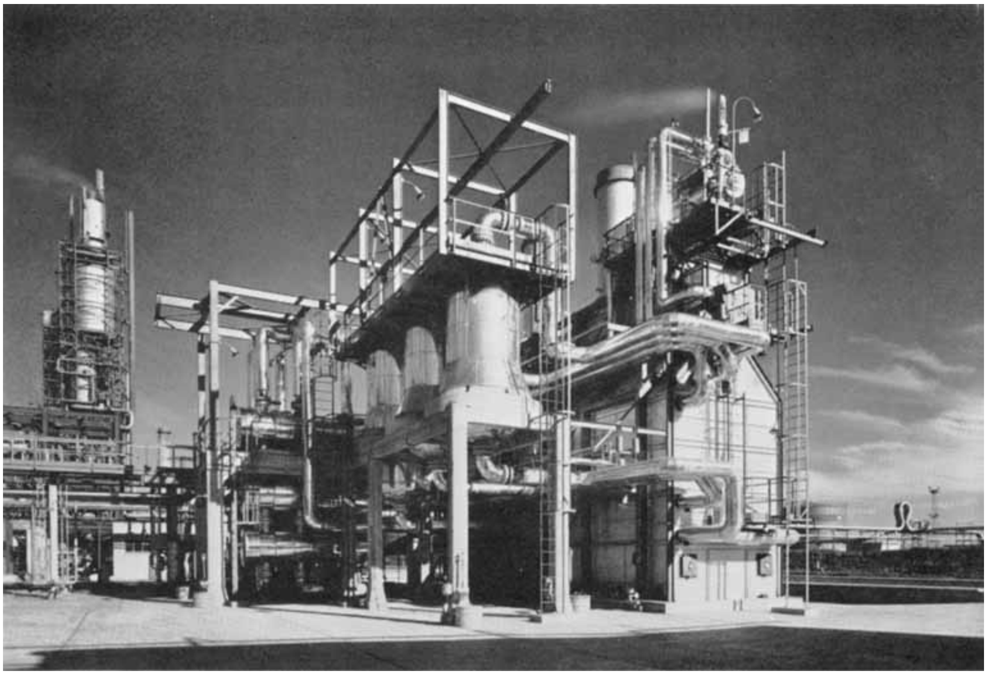
Again, while demand for high-octane gasolines has increased significantly, the growth in demand for aromatic hydrocarbons in Western Europe has been phenomenal. Until fairly recently the coal industry in Europe was able to meet this demand, but this situation has changed materially and it has become an obvious move on the part of oil refiners to install capacity for the separation of benzene and other aromatics from platinum reformates by fractional or extractive distillation.

Today something between 30 and 40 per cent of the organic chemicals produced in Western Europe are derived from petroleum and the proportion is increasing rapidly.

By the beginning of the present year the number of platinum reforming plants in Western Europe had grown to sixty-three, with a capacity of 27.4 million metric tons per year. In fact nearly two-thirds of existing Western European oil refineries have a catalytic reforming unit in operation. These reforming plants are located in every country of Europe with the exception of Luxembourg, Portugal and Yugoslavia, and in the latter two countries active planning is under way for their construction. There are twenty-two in Italy, sixteen in Western Germany, nine in France and eight in the United Kingdom. In the next three years some existing plants are to be extended and at least ten new refineries with platinum reforming units will go on stream; total reforming capacity will then have increased to at least 36 million metric tons per year.

This situation of reliance upon platinum reforming processes has come about in the space of only thirteen years since the introduction by Universal Oil Products Co in 1949 of the Platforming process—a catalytic process employing a platinum catalyst. Prior to this date catalytic reforming had certainly been used to a small extent to provide improved automobile and aviation fuels for wartime purposes, but the shortcomings of the catalysts employed and the complexity of their regeneration had ruled out the process in terms of peacetime economics.

The Platforming process, then, marked the beginning of a distinct phase, and although the first installation was not followed by others until more than a year later, the feasibility of this new route to both high-octane fuels and aromatic chemicals had been clearly established and it was not long before other oil companies and research organisations began to develop broadly similar processes.



Construction of new petroleum refineries in Western Europe is proceeding at a vigorous pace. In most cases the new plants include a platinum reforming unit producing high-octane fuels and high purity aromatic hydrocarbons. The illustration shows the Universal Oil Products Platforming unit at the refinery of Condor Societa per l'Industria Petrolifina e Chemica at Rho, Italy.

There followed rapidly, principally in the United States, a major growth in the utilisation of platinum reforming, with a very considerable usage of platinum in the form of a catalyst dispersed on an alumina support generally in the form of small pellets.

This growth reached a peak in terms of new plant construction around the year 1957, after which the building of new reforming facilities tended to slow down and to run parallel with the growth of general refining capacity.

Platinum reforming processes spread to Europe in the early fifties, but initially progress was much slower than in the United States. Today, however, and for the reasons already outlined, a very different situation exists, and the European scene presents a most active picture of platinum reforming as a means of meeting the rapidly growing demand for both high-octane fuels and petrochemical intermediates.

Catalytic reforming processes are basically continuous high temperature, high pressure processes carried out in an atmosphere of hydrogen. Generally a series of reactors is employed—usually three in number—although with some regenerative types of process an additional or "swing" reactor is installed, to be brought into play during regeneration of the catalyst in any one reactor.

The importance of catalysts to petroleum reforming lies in their highly specific ability to convert the various components present in low-octane petroleum naphthas to branched-chain and aromatic compounds of high-octane numbers. Catalysts for these processes consist of platinum on an alumina support, the latter also playing an important role in the various chemical processes taking place and aromatising long-chain saturated paraffins. The percentage of platinum is usually of the order of 0.2 to 0.75, while a small but critical amount of a halogen is also incorporated in the base to maintain the correct balance between the conversion of paraffins by dehydrocyclisation, hydro-cracking and isomerisation. From

One of the three Platforming units at the Gelsenberg Benzin AG refinery at Gelsenkirchen, West Germany. In addition to high-octane motor fuel, high purity benzene is produced by separation from the reformate in a UOP Udex unit.

time to time improved platinum catalysts have been introduced to provide greater selectivity and longer life, particularly in view of the greater severity of operation imposed on refiners by increasing demands for higher octane ratings.

Platforming, now widely employed in most refineries—it accounts for 50 per cent of installed capacity of all reforming processes throughout the world—is a fixed-bed process operating at temperatures around 550°C and pressures up to 700 lb per square inch. It yields, as do other platinum reforming processes, large quantities of hydrogen which are employed either in other refining operations or for ammonia synthesis, and is able to produce a range of aromatics which may be separated from each other and from unchanged feed stock by fractional or extractive distillation.

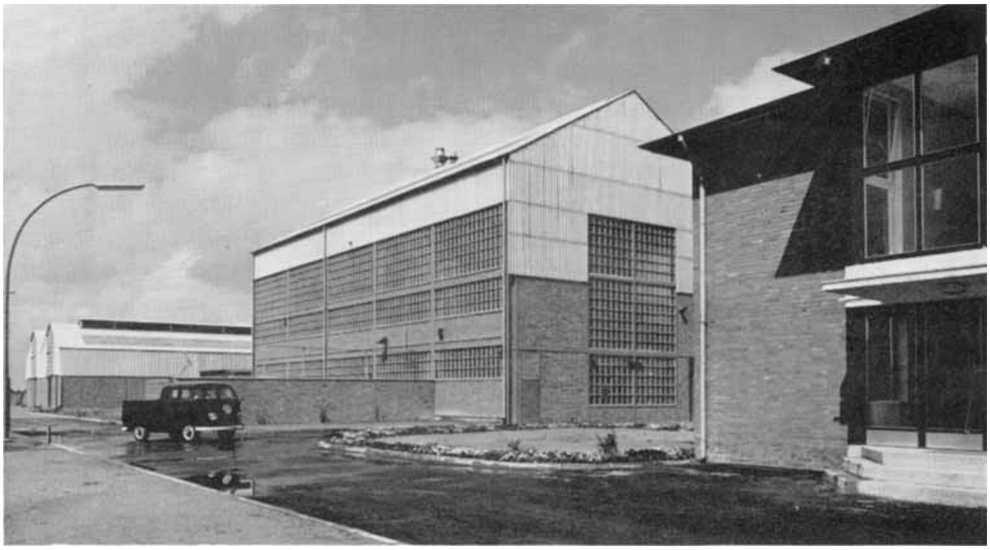
Other platinum reforming processes employing an alumina-base catalyst impregnated with platinum and one or more halogens include Ultraforming, a process developed by the Standard Oil Company of Indiana, which is a regenerative process (that is, the catalyst is frequently regenerated *in situ*), and Powerforming, developed by Esso Research and Engineering, also a regenerative process using a catalyst developed by the Davison Chemical Company. Houdriforming (Houdry Process Corporation), Sinclair-Baker Reforming (Sinclair Oil Company) and Catalytic Reforming (Humble Oil and Refining Company) are again processes yielding high-octane reformates and capable of being operated to produce aromatic chemicals as well as motor and aviation fuels.

Penex-Platforming (U.O.P.), Pentafining (Atlantic Refining) and the Butamer Process (U.O.P.) all employ platinum catalysts either to produce aromatic compounds from paraffins or to isomerise straight-chain paraffins to their branched-chain isomers.

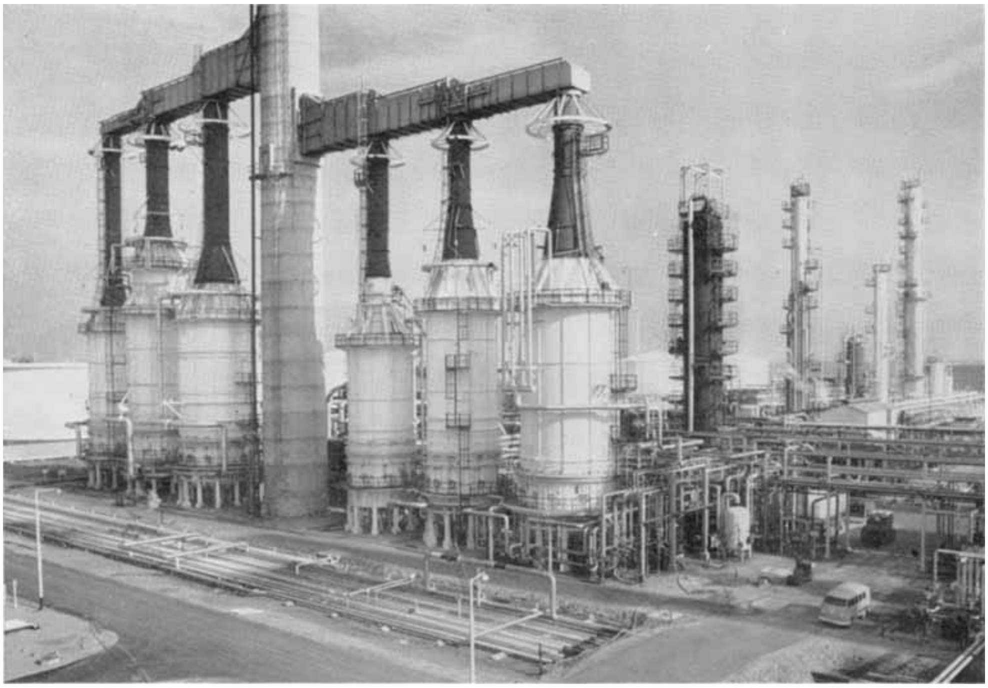
The original distinction between regenerative and non-regenerative operations with platinum catalysts requires some explanatory comment. In the Platforming process the catalyst operates over long periods without regeneration, so that for the original relatively mild operations up to about 92–93 clear octane number of product *in situ* regeneration was not needed or justified. For more severe operations, especially with the Middle East naphthas of low naphthene content, occasional regeneration *in situ*, two to four times per year depending on operating conditions and severity, is employed as being more economical than higher hydrogen circulation and a larger lock-up of platinum catalyst. Other platinum-reforming processes vary in frequency of *in situ* regeneration, depending on the composition of the catalyst and the operating conditions employed. Since most European operations today demand very high severity—98 to 100 clear octane number product—and use Middle East naphtha, intermittent *in situ* regeneration is now generally installed, although in some cases swing reactors are employed.

Apart from their use in upgrading gasoline, the major aromatic hydrocarbons produced in the platinum reforming processes—benzene, toluene and the xylenes—are widely used as solvents and as intermediates in the organic chemical industry. High purity benzene can readily be converted to cyclohexane, or to ethylbenzene for the further production of styrene. Toluene may possibly continue to be produced in excess of demand, but can be converted to benzene by hydrodealkylation; the future of the xylenes, however, could be very large, mainly for the production of terephthalic acid, isophthalic acid and phthalic anhydrine from para-, meta- and ortho-xylene respectively. The production of naphthalene from reformates by hydrodealkylation of heavy fractions—already in commercial operation in the United States—also presents considerable possibilities. In the light of steadily increasing European demand for plastics, synthetic fibres, synthetic rubbers, detergents, insecticides and lubricant additives the prospects of an enormous growth in the production of aromatic intermediates from petroleum sources are obvious.

In 1953 catalyst manufacturing facilities were set up in the United Kingdom by Universal-Matthey Products, an associated company of Universal Oil Products and Johnson Matthey, to meet the demand from European licensees of the Platforming pro-



Production of platinum-on-alumina catalyst for European licensees of the Platforming process was begun in England in 1953 by Universal-Matthey Products Ltd. Local demand has been met by the construction of this new plant in Cologne, operated by Universal-Matthey Products (Deutschland) GmbH.



The Powerforming process, a catalytic reforming operation using a platinum-on-alumina catalyst developed by the Davison Chemical Co, is employed in this section of the Esso Nederland refinery near Rotterdam. A large new plant is planned on the same site to produce benzene, toluene and xylenes from the reformates.

cess. The growth of this process led in 1959 to the construction of additional manufacturing plant in Cologne by a new subsidiary company, Universal-Matthey Products (Deutschland), to provide a source of supply nearer to continental refineries. Platinum reforming catalysts for other processes have also been made available from Kali-Chemie in West Germany and from the Ketjen organisation in Holland.

One major feature of European development in the use of platinum-reforming processes has been the entry, either alone or jointly with existing chemical producers, of oil companies into the production of organic chemicals as a distinct but allied activity to petroleum refining. For example, British Petroleum and California Chemical have announced plans to build an aromatics plant at the B.P. refinery in Kent, while another aromatics plant is planned by B.P. Benzin und Petroleum at Dinslaken in West Germany to operate on feed stock from the adjoining B.P. refinery. Esso Nederland is building a major plant on the site of its refinery at Botlek near Rotterdam for the same purpose, and the new Shell refinery at Godorf is linked by pipe-line to a petrochemical plant jointly owned by Shell and Badische Anilin. New aromatics plants are also to be built near the Mobil Chemica Italiana refinery at Naples and at the Esso refinery at Fawley, near Southampton.

The construction of a number of trans-continental pipelines for the transportation of crude oil has also given impetus to the petrochemical industry in general. Refineries can be, and in fact are being, sited inland in relation to their consuming industries while the prospect of the eventual removal of tariffs in the European Common Market has also led to an increasing number of refinery projects, for instance, along the Franco-German border. In fact more than half of all new refining capacity at present being planned or built in Europe is located at inland centres. In addition to the refineries in the Ruhr area, served already by two pipelines from Rotterdam and Wilhelmshaven respectively, five new plants will be constructed near Karlsruhe and Strasbourg close to the main terminals of the new pipeline from Lavera, near Marseilles, to be opened in January of next year, while a Swiss refinery at Aigle will receive crude oil by pipeline from Genoa.

Typical of some recent installations are the first major petroleum refinery to be built in Austria—the Oesterreichische Mineralvelverwaltungs A.G. plant at Schwechat near Vienna —with a 250,000 tons per year Platformer; the new B.P. refinery at Dinslaken in the Ruhr with a high severity Platformer of 500,000 tons annual capacity, from which a proportion of the aromatics are passed to Erdoelchemie at Dormagen to be steam-cracked and used as petrochemical raw materials; the Esso-Rotterdam refinery which includes a Powerformer, and the Shell refinery at Godorf near Cologne with a Platformer. At the Gelsenberg Benzin refinery at Gelsenkirchen-Horst a third Platforming unit has been put on stream, together with a U.O.P. Udex unit for the separation of high purity benzene from the reformate.

The general trend to be discerned in this vigorously growing European industry is towards flexibility of refinery operation—the possibility to produce high-purity aromatics according to market needs while still satisfying the increasing demand for automobile fuels of higher octane ratings. Platinum reforming processes constitute one of the most versatile tools available to the refiner, and by their more severe operation, by the development of improved platinum catalysts and by continual modification and improvement of the processes by the licensors will obviously go on playing a key role in the overall economics of European petroleum refining.

Complex Platinum Compounds and Virus Activity

A POSSIBLE MEANS OF ATTACK ON CANCER TUMOURS

Among the many researches being undertaken into the likely causes and possible treatments of cancer, evidence has been accumulating to indicate that viruses may be involved in many types of the disease. Viruses contain proteins, nucleic acids and polypeptide linkages and therefore present obvious possibilities as co-ordinating agents for certain metal ions, with the further possibility that complex inorganic compounds might be used successfully in destroying or reducing their disease-producing activity.

At the meeting of the American Chemical Society held in Washington, D.C., in March a valuable step forward in this direction was reported by Dawn Francis, Dr Stanley Kirchner and Dr J. C. Bergman of the Department of Chemistry, Wayne State University, Detroit, working in collaboration with Dr Yung-Kang Wei of the National Research Council, Ottawa. Because it would be impossible to introduce a metal ion into a living system with the expectation that it would by-pass normal proteins and await complexing by co-ordination sites in the virus, these workers proposed to introduce metal ions as co-ordination complexes of intermediate stability; in this way it was hoped that they would be stable enough to escape reaction with normal proteins but not so stable as to resist attack by virus proteins.

Some complex inorganic compounds are known to be carcinostatic, among them 6-mercaptopurine, and the preparations made and tested in this research included this biologically active compound and its complexes with platinum and palladium. In tests with cancer tumours in mice, these latter two compounds proved to be extremely active, showing in fact a much greater activity than that of 6-mercaptopurine itself. These results certainly lend support to the hypothesis put forward, but further closely controlled tests with 6-mercaptopurine on both complexed and uncomplexed forms are now being conducted.