New Type Platforming Catalyst Produced and Tested in Europe

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Catalytic reforming holds a key position in the overall operations of European petroleum refiners. The British Petroleum Company employs the platforming process at many of its refineries, and by skilled operation and the use of a new catalyst it has demonstrated how standard equipment operates economically at high severity. This article reviews the "100 octane plus" operations at the Kent refinery, which takes its catalyst supplies from U.K. manufacturing facilities specially set up in the interests of licencees of the process.

Catalytic reforming has increasingly become an important tool for European refiners because of a peculiarity in the markets supplied by them which is not evident in the markets served by North American refiners.

In Europe there is practically no natural gas or low pressure gas available, and there is a far greater dependence upon distillate stocks and residuals for space heating and power. Hence, by American standards, catalytic cracking plays a minor role in European refinery schemes because it is not at all desirable to catalytically-crack a proportionately large volume of distillates into motor spirits. Thus the primary source of motor fuel in Europe consists of straight run naphthas which are poor in octane ratings and which are unusually difficult to up-grade to the level of catalytically cracked petrol.

The Special Importance of Catalytic Reforming in Europe

Consequently the problem of European refiners is to convert low-octane quality straight run naphthas without reducing the fuel oil make by catalytic cracking in order to meet the quality necessary to sell petrol in highly competitive local and export markets.

By employing catalytic reforming, refiners not only obtain the necessary quality, but literally "build-in" octane numbers to market requirements.

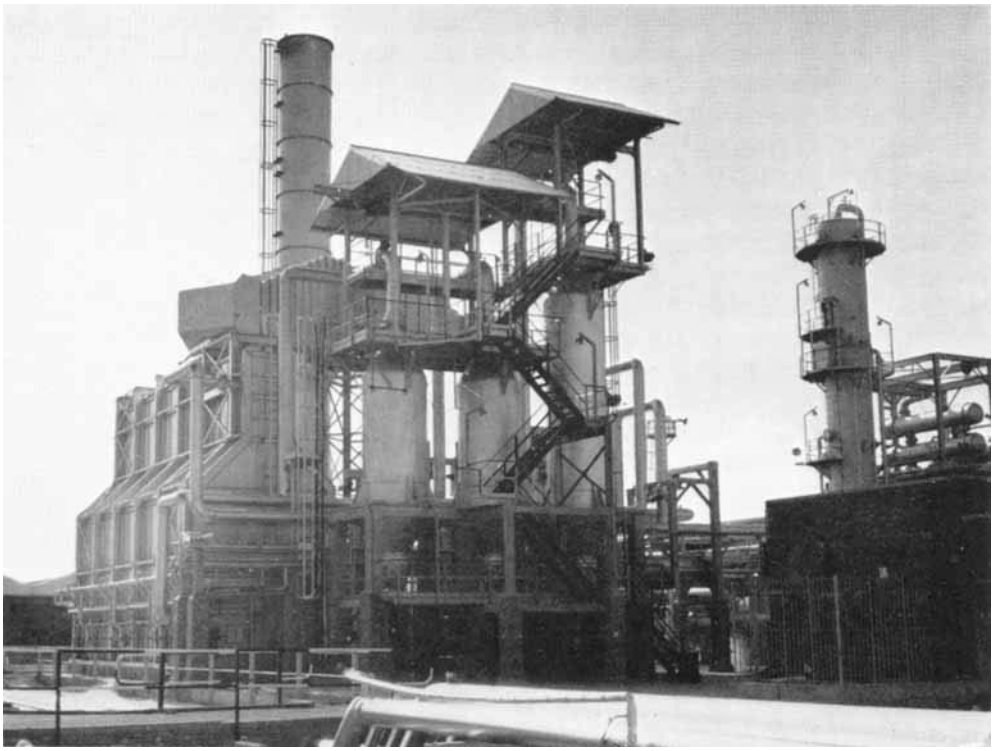
Within this situation there recently came the following announcement:

"British Petroleum Company increases the knock rating of the platformate from its Kent refinery by three research numbers and its leaded rating to 101 *under more severe conditions with a new catalyst"*

The story that follows tells something of the skilled operations of British Petroleum to assure itself it will have the equipment to produce the higher octane petrol which its markets may need in the foreseeable future—with due consideration to economy, stability and security of operation; and also of the progress made in Europe in developing a catalyst technology.

The Kent Refinery of British Petroleum

This is one of the largest refineries in the British Isles. When present additions are completed it will be the company's largest refinery in this area. The first ground was broken for it on June 13th, 1950, following selection and acquisition of a site on the River Medway side of the Isle of Grain.



The reactors of the British Petroleum Company's platformer at the Kent refinery

The story behind the location of additional "home" refining capacity for British Petroleum, then known as Anglo-Iranian Oil Company, was the increasing availability of Middle East crude, coupled with Britain's consumption of petroleum products being far in excess of its existing domestic refinery capacity. In short, more domestic capacity was needed urgently to save dollar exchange. After considerable investigation it was decided that an entirely new refinery—preferably located somewhere along the Thames estuary—was desirable to cover the area of eastern England relatively distant from British Petroleum's existing refineries at Llandarcy, South Wales, and at Grangemouth in Scotland, although the capacities of these were also being increased.

Of several locations along the Thames, the Isle of Grain was favoured because of its convenience to the potentially large consuming area of Metropolitan London and the fact that over forty feet of water, even at lowest tides, was already available within a few feet of shore without dredging.

The original refinery consisted of a 90,000 b/d crude-installation unit—the largest in Europe at the time of its construction—and facilities for the production of lubricating oils in addition to motor spirits, kerosene and fuel oils. Specialised units included two vacuum distillation units each of 17,000 b/d capacity; a 10,000 b/d fluid catalytic cracking unit, an 8,150 b/d SO_2 extraction unit, a 4,000 b/d propane-deasphalting unit, a 5,000 b/d furfural extraction unit, a 4,000 b/d MEK dewaxing unit and 3,120 b/d of clay-contacting facilities. Four copper sweeteners, each of 8,000 b/d were installed to treat motor spirits and kerosene.

Just before the refinery was ready for commissioning, the great east-coast floods of January 1953 swept over the Isle of Grain and most of the refinery was under water

for over two weeks. This naturally delayed completion, and the first units to operate in the plant were not commissioned until February 1953. The catalytic cracking unit, as well as some others, were commissioned as Stage 2 in the autumn of 1953, while the lubricating oil facilities, Stage 3 were not completed until the summer of 1954. The 6,000 b/sd UOP platforming unit—the first addition to the refinery—had been authorised for construction by this time, for completion in the spring of 1955.

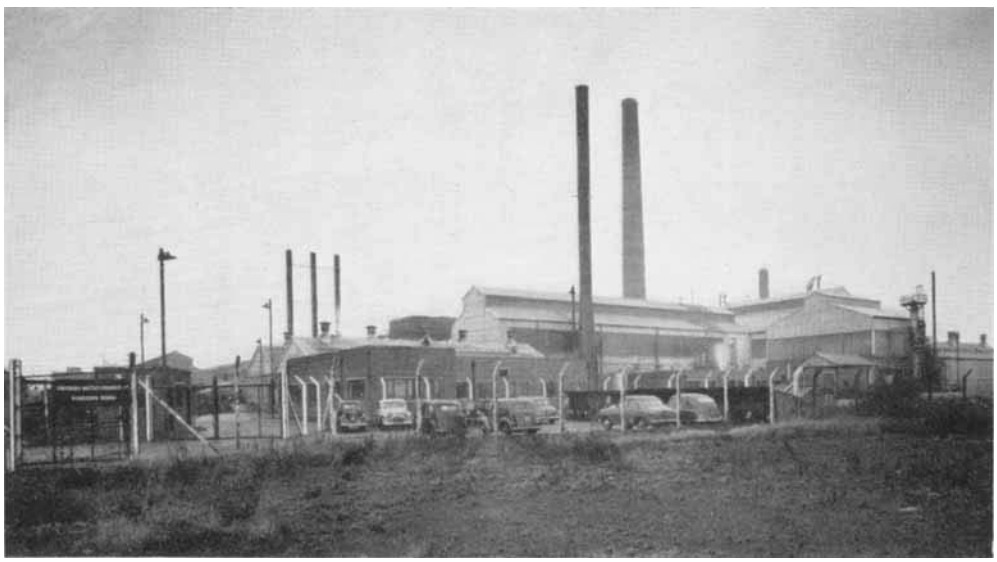
British Petroleum is now increasing the crude charging capacity at the Kent refinery to 140,000 b/d. With this 50,000 b/d expansion of basic throughput, a second platforming unit of 10,000 b/sd capacity has been designed and licensed by Universal Oil Products and is now under construction. When this unit is completed and commissioned, the Kent refinery will have the greatest concentration of platforming capacity in the United Kingdom.

At the time the first Kent platformer was designed most of the installations then being built were intended consistently to yield a product having a clear octane rating of 80 to 85 research. The upward trend in the octane quality of commercial motor spirits has, however, made it necessary for most of these platformers to make a product testing appreciably above 85 "research" clear. Hence the news of the operation of the platforming unit at the Kent refinery to produce a 95-octane clear platformate from a Kuwait naphtha becomes of world-wide interest, particularly since the only major changes made to the original unit were new screens to accommodate a smaller catalyst.

Platforming Catalyst Manufactured in England

This first platformer at the Kent refinery was shut down in December 1956 during the Suez crisis after a run of 226 days. This achievement was accomplished on the 6,000 b/sd unit of standard design through the use of Universal Oil Products Company's R8 catalyst which is designed specifically for use in the production of super-octane motor fuels. This new catalyst, which is high in activity, was manufactured in England by Universal-Matthey Products Limited.

This organisation was formed in 1953 in association with Universal Oil Products Company and Johnson Matthey & Com-



The London catalyst manufacturing plant of Universal-Matthey Products Ltd.

pany Limited, and entirely new manufacturing facilities were set up near London. The construction of this most modern catalyst plant was therefore going on simultaneously with the building of the platformer at the Kent refinery and it is interesting to note how the endeavours of those responsible for these quite diverse projects have combined in their success.

These domestic manufacturing facilities were needed and designed to make available for sterling the platforming catalyst requirements of the British Petroleum Company and all other licensees of the UOP platforming process the world over; in this way licensees of this process secured future continuous operation of their platforming units free from the worry that dollar shortages might at any time cut them off from American sources of supply. (The important Shell plant at Stanlow, Cheshire, had already had to draw its first catalyst supplies from the United States, and many other platformers were under construction at that time in the softer currency areas.)

The most essential requirements in setting up local arrangements were:

(1) To replicate precisely in England in every way the very high quality of the R5 catalyst then being supplied from the United States.

(2) To get into production in the shortest possible time to prevent a heavy drain of dollars.

(3) To secure to the new company the immediate availability of technical improvements in catalyst type and manufacturing techniques which might later be developed in the United States by Universal Oil Products so that the local products could always be competitive in every way.

It is a high compliment to those responsible for the scheme to be able to record that a continuing technical services agreement with UOP has worked so effectively that local manufacture of the newer R7 and R8 catalysts has commenced simultaneously with their announcement, and that the benefits obtained in continuing manufacturing improvements have enabled substantial reductions in price to be made through economy of manufacture in spite of the more general inflationary trends. These catalyst manufacturing facilities have been extended, and a complete catalyst service supported by spent catalyst recovery facilities in and out of the Port of London has brought the full benefits of the platforming process not only to the Kent refinery but to all other European refiners who have elected to operate it.

Details of the Kent Refinery Platforming Run

The 1957 Annual Refining Review of *World Petroleum*, from which most of this information has been abstracted, has published for the first time some of the details of the amazing platforming run of the Kent refinery which was brought to an end only by lack of charge stock during the Suez crisis. The detailed data it reveals in the form of tables and charts are the first to be published from a commercial platformer reforming Kuwait naphtha over one of the newer platforming catalysts. The fractioned Kuwait naphtha was typically predominant in paraffins and low in naphthenes and was hitherto not considered to be ideal for platforming to levels above 90 "research" clear.

The charge stock, with a boiling range of 215°F—350°F, contained:

Paraffins	64 per cent
Olefins	trace
Naphthenes.. ..	23 per cent
Aromatics	13 per cent

The platformate produced had a boiling range of 100°F—396°F and its aromatics content was nearly quadrupled at 49 per cent. Since this is greater than can be accounted for by conversion of all the original naphthenes to aromatics, there must have been aromatisation of some of the paraffins.

The operating data reflect the very high degree of skill that was evident in this close

operation to produce a stabilised platformate at 6 lb Reid vapour pressure having a clear octane number of 95.2 to 95.3; this, on occasional test with the addition of 3 ml tetraethyl-lead per gallon, indicated that a fuel with a 101 "research" octane rating was available from the whole product, not merely from a heavy fraction of it.

The product liquid volume yield was 75 per cent as an overall average over the run, which in view of the severe conditions employed is regarded as quite satisfactory economically.

At the time the run was terminated, after 226 days of operation, the catalyst activity was still very satisfactory.

This represents a catalyst life at that time of 42 barrels of charge stock per pound; so satisfactory was this considered that British Petroleum planned to resume operations again with the same catalyst as soon as naphtha was available, and to carry out nothing beyond routine maintenance in the enforced shut-down period. In the meantime the unit was to be sealed off and the catalyst left undisturbed in hydrogen within the reactors.

Further indications of most satisfactory catalyst performance were made possible by the very high quality of the controls exercised by the operating staff. The total temperature drop over the three reactors decreased only very slowly and gradually over the course of the whole run, while the inlet temperatures to individual reactors had to be raised by only 20°F over the period. Thus there was no evidence of severe carbon deposition or other fouling which would have been symptomatic of loss of catalyst activity and selectivity.

This was also confirmed by a constant daily plot of the volumes of high pressure separator gases which were almost constant throughout and thus consistent only with a very slow diminution in activity.

A plot of the volume of stabiliser gases also showed only a gradual increase, and shows as almost a mirror image of the decline of the high pressure separator gases, which indicates there was very little increase in hydrocracking reactions.

In all, the run showed that high severity can be used on a standard platformer on a tough feed stock without economic penalty in terms of catalyst life and that regeneration is unnecessary when UOP R8 catalyst is employed.

An earlier run at the Kent refinery had employed the first spherical UOP R5 catalyst which had been designed and supplied primarily for operations to about 85 "clear". This foreshadowed what might be achieved with catalysts specifically modified to suit higher severities. Although R5 had not been designed specifically for the service, British Petroleum elected to operate the Kent platformer on substantially the same tough Kuwait naphtha at 92 "clear" octane or above.

From a feed stock in the boiling range 211°F to 347°F containing 0.04 per cent sulphur, 67 per cent paraffins, 22 per cent naphthenes and 11 per cent aromatics they consistently obtained a platformate having a boiling range of 100°F to 390°F consisting of 45 to 46 per cent aromatics. The liquid volume yield on that occasion was 76 per cent and the temperatures of the individual reactors had to be increased by only 10°F during the run.

At the end of 146 days, when the R5 catalyst life was already 36 barrels per pound, the unit was shut down for a scheduled maintenance and inspection programme. At this time a very close examination of the catalyst itself showed it was by no means fully spent despite the severity of operational conditions that had been employed. For reasons already stated, namely their desire to produce a motor spirit of even higher octane rating than the 92 "clear" obtained for this run, British Petroleum elected to replace the still unspent R5 catalyst with R8. The only major modification was the change in reactor screens to support a smaller catalyst. Inspections of the remainder of the facilities fully confirmed that the higher severity runs had caused only normal wear and tear.