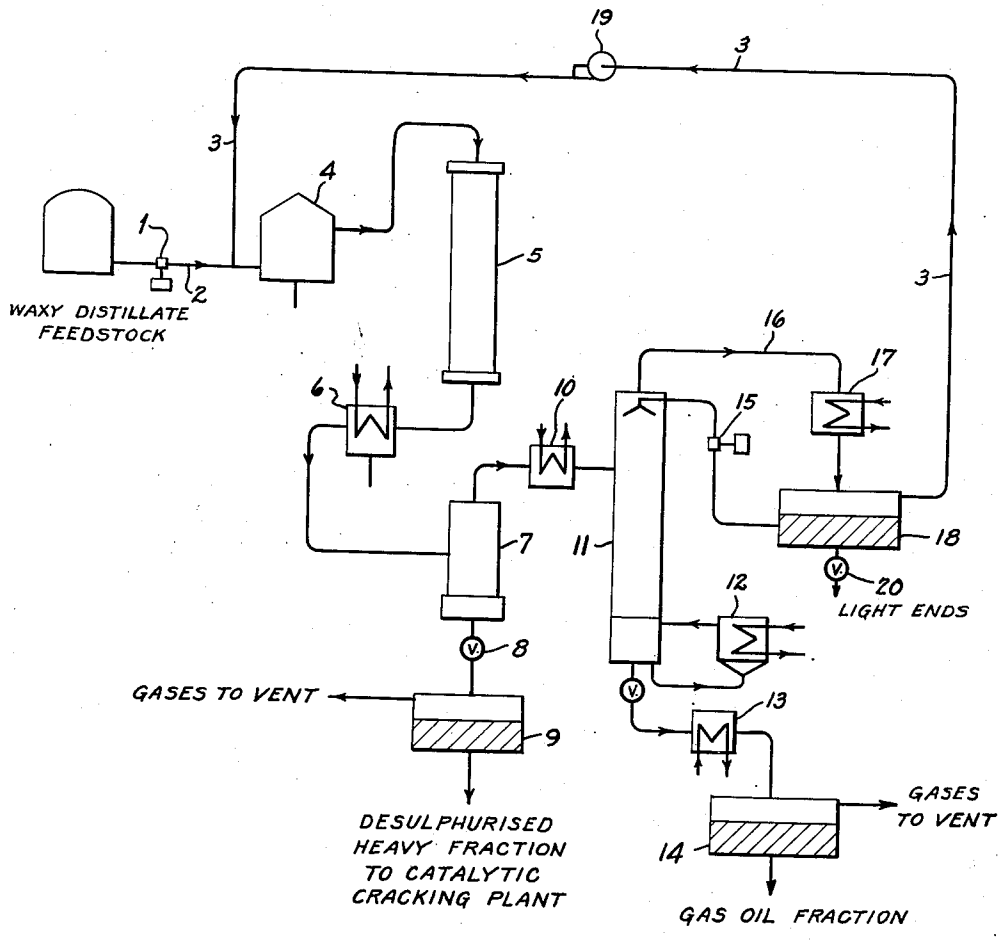
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CATALYTIC CRACKING OF PETROLEUM HYDROCARBONS

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CATALYTIC CRACKING OF PETROLEUM HYDROCARBONS

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This invention relates to the catalytic cracking of petroleum hydrocarbons.

It is known that petroleum fractions boiling in the wax distillate range or higher may be catalytically cracked for the production of considerable quantities of gasoline and gas oil. The gas oil produced in this way is, however, of very poor quality and is useful only as boiler fuel, while if the feedstock contains sulphur, as it usually does, the cracked gasoline is also sulphur-containing and requires to be treated for the removal of sulphur.

A process has now been developed of treating a sulphur-containing petroleum feedstock boiling in the wax distillate range or higher for the production of a gas oil fraction of considerably better quality than the cracked gas oil, without any appreciable reduction in the quantity of cracked gasoline based on the weight of the feedstock. The process has the further advantage that the cracked gasoline is substantially free from sulphur and has a higher octane number than normal cracked gasoline.

The process of the invention consists in passing a sulphur-containing petroleum feedstock boiling in the wax distillate range or higher, to a hydrofining stage where it is contacted with a sulphur-resistant hydrogenation catalyst in the presence of hydrogen, and under conditions of temperature and pressure to effect conversion of sulphur present in the feedstock into hydrogen sulphide, removing the hydrogen sulphide from the hydrofined feedstock, separating a gas oil fraction from the hydrofined feedstock, and passing the residue boiling above the gas oil range to a catalytic cracking stage.

It has been found that the residue boiling above the gas oil range is more susceptible to catalytic cracking than the original feedstock with the result that the yield of gasoline based on the original feedstock is only slightly lower and has a higher octane number. Furthermore, the gasoline produced by catalytically cracking the residue is substantially free from sulphur. There is the further advantage that the hydrofining of the feedstock considerably reduces the corrosion difficulties experienced in the cracking plant.

The amount of gas oil that may be recovered from the hydrofined feedstock depends on the sulphur content of the original feedstock. As an example, an Iranian wax distillate has a sulphur content of 1.6 wt. percent, and assuming all the sulphur to be present in the form of sulphides, the sulphur compounds would constitute 20% of the molecules in the feedstock and some or all

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of the molecules produced from the sulphur compounds by hydrofining would boil outside the range of the original feedstock.

The accompanying drawing which forms part of the instant specification and is to be read in conjunction therewith, diagrammatically illustrates one system of apparatus for carrying out the process of the invention.

Referring to the drawing, wax distillate or other petroleum feedstock is fed via pump 1 and line 2 to the preheater 4 where the reactants are heated to the operating temperature. Recycle gas joins the cold feed via line 3 before entering the preheater. The heated reactants enter the top of the catalytic reactor 5 and flow downward through the catalyst bed under the predetermined hydrofining conditions of temperature and pressure. The desulphurized reactants are then passed through a waste heat boiler or cooler 6 where the temperature is dropped sufficiently to ensure that all material boiling above a selected temperature is condensed in the knock out drum or fractionator 7. The condensed material which comprises the heavy desulphurized fraction is let down to atmospheric pressure via valve 8 and is then fed to the catalytic cracking unit (not shown). The vapors leaving knock out drum 7 are further cooled in a waste heat boiler or water cooler 10 and passed into the knock out tower or fractionator 11 where a bottoms product consisting of the gas oil fraction is removed via cooler 13 and separator 14 to storage. The knock out tower or fractionator is fitted with a reboiler 12 and provided with reflux line 15. The overheads of the fractionator 11 are cooled by a water cooler 17, the gaseous fraction consisting mainly of hydrogen being separated in vessel 18 and recycled via line 3 and booster 19 to feed line 2. The liquid from vessel 18, which consists of light ends is removed via let down valve 20 to storage.

The invention will now be described with reference to the following example.

An Iranian wax distillate having the following characteristics:

S. G. at 140° F.	0.8775
Sulphur, wt. percent	1.52
Distillation:	
Wt. percent 200° C.–400° C.	13.1
Wt percent>400° C.	86.9

was passed over a catalyst consisting of cobalt molybdate supported on alumina at a temperature of about 780° F., at a pressure of 1000 lb./sq. in. and at a space velocity of 1.0 v./v./hr., together with hydrogen amounting to 4000 cu. ft. per barrel

of feedstock. The hydrofined product, after removal of the hydrogen sulphide, represented 97.2 wt. percent of the original feedstock and had the following characteristics:

S. G. at 140° F.	0.8445
Sulphur, wt. percent	0.04
Distillation:	
Wt. percent to 200° C.	3.5
Wt. percent 200° C.–400° C.	37.5
Wt percent>400° C.	59.0

The sulphur removed therefore amounted to 97.4% by wt. and it will be noted that there is considerably more material boiling within the range 200° C.–400° C.

The hydrofined product was then distilled for the recovery of a gas oil fraction representing 19% by weight on the original feedstock, the fraction having the characteristics set out in the following Table I:

Table I

S. G.		.892
I. B. P.	° C.	213
10%	° C.	247
50%	° C.	307.5
F. B. P.	° C.	Cut at 350
90%	° C.	339.5
Sulphur content		.048
Pour point	° F.	<−30
Aniline point	° C.	47
Diesel index		33

The residue remaining after the separation of the gas oil fraction was then catalytically cracked in a fixed bed and the results of the cracking operation are set out in the following Table II with the results (for comparison) obtained by catalytically cracking the original feedstock.

Table II

	Residue from Hydrofined Wax Dist.	Original feedstock
Cat. cracking temperature, ° F.	950	950
Feedrate g./hr.	159.0	155.7
Products, wt. percent on Feed:		
Gas	11.6	11.2
Liquid	73.1	79.0
Carbon+Loss	15.3	9.8
Gasoline, wt. percent on feed	41.1	32.5
Gas Oil, wt. percent on feed	15.6	22.3
Inspection Data on Gasoline to 430° F.:		
S. G.	.7420	.7625
Total sulphur, wt. percent	0.004	0.14
Octane Number	80.1	77.6
Wt. percent yield on original feedstock	31.4	32.5
Inspection Data on Gas Oil, 430–680° F.:		
S. G. @ 60° F.	0.9310	0.9305
Sulphur, wt. percent	0.06	1.70
Pour Point (upper) ° F.	<−30	−5
Carbon Residue (Con.)	0.010	0.35
Diesel Index	13	14

It will be seen from a consideration of Tables I and II, that the process of the invention has resulted in a yield amounting to 19% by wt. on the original feedstock of a gas oil fraction having a diesel index of 33 as compared with a cracked gas oil fraction having a diesel index of 14.

The yield of cracked gasoline based on the original feedstock has only fallen from 32.5% to 31.4% by weight on the original feedstock, while the octane number of the cracked gasoline has risen from 77.6 to 80.1.

We claim:

1. A process for the production from a sulphur-containing petroleum feedstock boiling in the wax distillate range of cracked gasoline and of a good quality diesel fuel without appreciable reduction in the maount of cracked gasoline which may be obtained from the wax distillate, which consists in passing the wax distillate to a hydrofining stage where it is contacted with a sulphur-resistant hydrogenation catalyst in the presence of hydrogen and under conditions of temperature and pressure to effect the conversion of organically combined sulphur present in the feedstock into hydrogen sulphide, removing the hydrogen sulphide from the hydrofined feedstock, separating from the hydrofined feedstock a gas oil fraction suitable for use as a diesel fuel passing the residue boiling above the gas oil range to a catalytic cracking stage, and recovering gasoline from the cracked products.

2. A process for the production from a sulphur-containing petroleum feedstock boiling in the wax distillate range of cracked gasoline and of a good quality diesel fuel without appreciable reduction in the amount of cracked gasoline which may be obtained from the wax distillate, which consists in passing the wax distillate to a hydrofining stage where it is contacted with a sulphur-resistant hydrogenation catalyst in the presence of hydrogen and under conditions of temperature and pressure to effect the conversion of organically combined sulphur present in the feedstock into hydrogen sulphide and to increase the content of material boiling within the range 200–400° C., removing the hydrogen sulphide from the hydrofined feedstock, separating a gas oil fraction boiling within the range 200–400° C. and suitable for use as a diesel fuel from the hydrofined feedstock passing the residue boiling above the gas oil range to a catalytic cracking stage, and recovering gasoline from the cracked products.

3. A process for the production from a sulphur-containing petroleum feedstock boiling in the wax distillate range of cracked gasoline and of a good quality diesel fuel without appreciable reduction in the amount of cracked gasoline which may be obtained from the wax distillate, which consists in passing the wax distillate to a hydrofining stage where it is contacted with a catalyst of the cobalt molybdate type in the presence of hydrogen and under conditions of temperature and pressure to effect conversion of organically combined sulfur present in the feedstock into hydrogen sulphide and to increase the amount of material boiling within the range 200–400° C., removing the hydrogen sulphide from the hydrofined feedstock, separating a gas oil fraction boiling within the range 200–400° C. and suitable for use as a diesel fuel from the hydrofined feedstock, passing the residue boiling above the gas oil range to a catalytic cracking stage and separating from the catalytically cracked products a gasoline fraction of increased octane number and in substantially the same amount as would have been recovered from the products of catalytically cracking the feedstock without removal of said gas oil fraction.

4. A process for production from a sulphur-containing petroleum feedstock boiling in the wax distillate range of cracked gasoline and of a good quality diesel fuel without appreciable reduction in the amount of cracked gasoline which may be obtained from the wax distillate, which consists in passing the wax distillate at the rate of 1.0 v./v./hr. to a hydrofining stage maintained at a temperature of about 780° F. and a pressure of 1000 lb./sq. in. together with hydrogen amounting to 4000 cu. ft. per barrel of feedstock,

to effect conversion of organically combined sulphur present in the feedstock into hydrogen sulphide and to increase the amount of material boiling within the range 200–400° C., removing the hydrogen sulphide from the hydrofined feedstock, separating from the hydrofined feedstock a gas oil fraction boiling within the range 200–400° C. and suitable for use as a diesel fuel, the diesel index of said gas oil fraction being considerably higher than the diesel index of the corresponding fraction that can be recovered from the products of catalytically cracking the original feedstock, passing the residue boiling above the gas oil range to a catalytic cracking stage and recovering from the catalytically cracked products a gasoline fraction of increased octane number and in substantially the same amount as would have been recovered from the products of catalytically cracking the feedstock without removal of said gas oil fraction.

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