April 14, 1959 P. H. JOHNSON 2,882,219

RECOVERY OF CRACKING FEED AND ASPHALT

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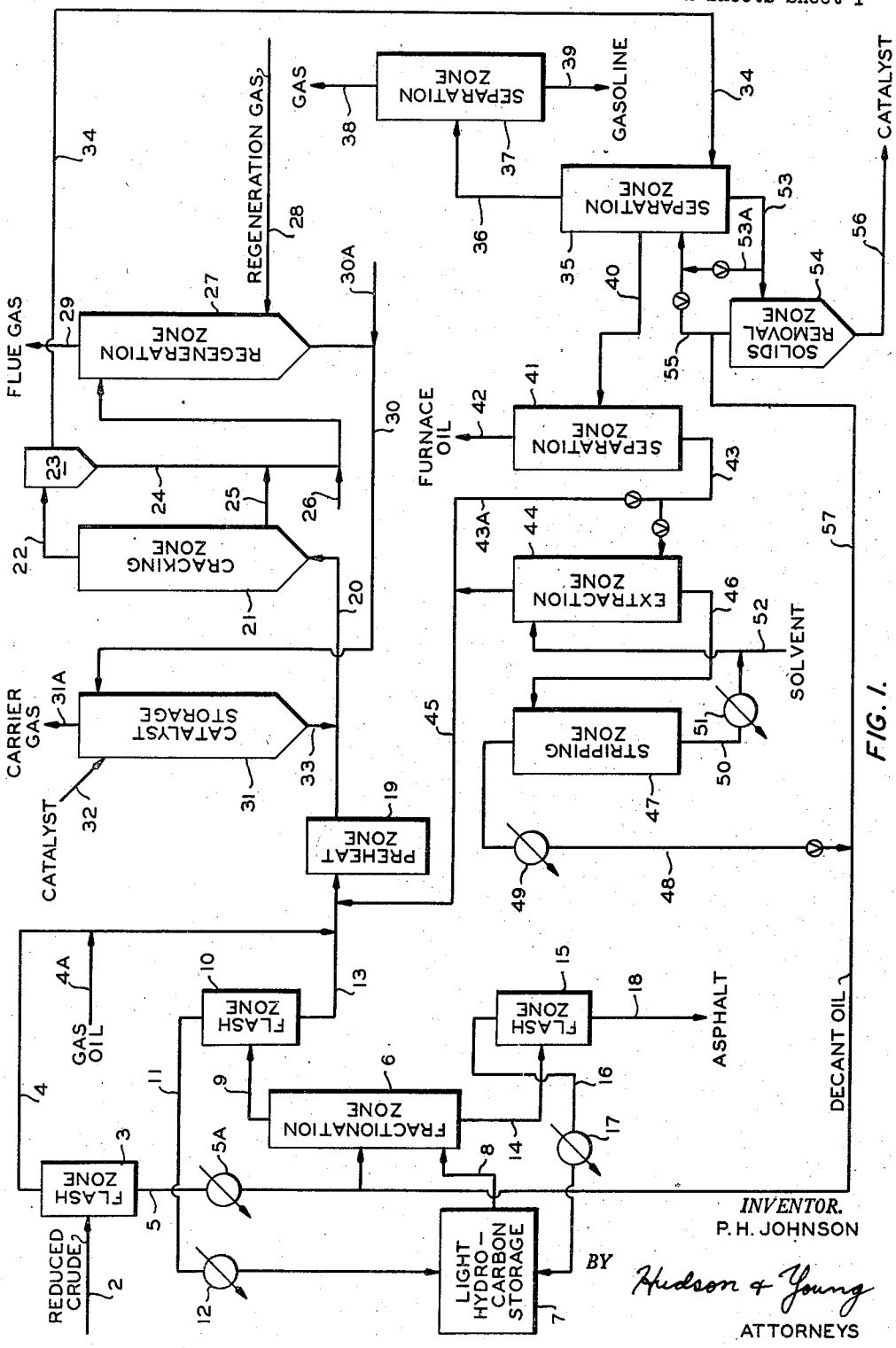

FIG. 1.

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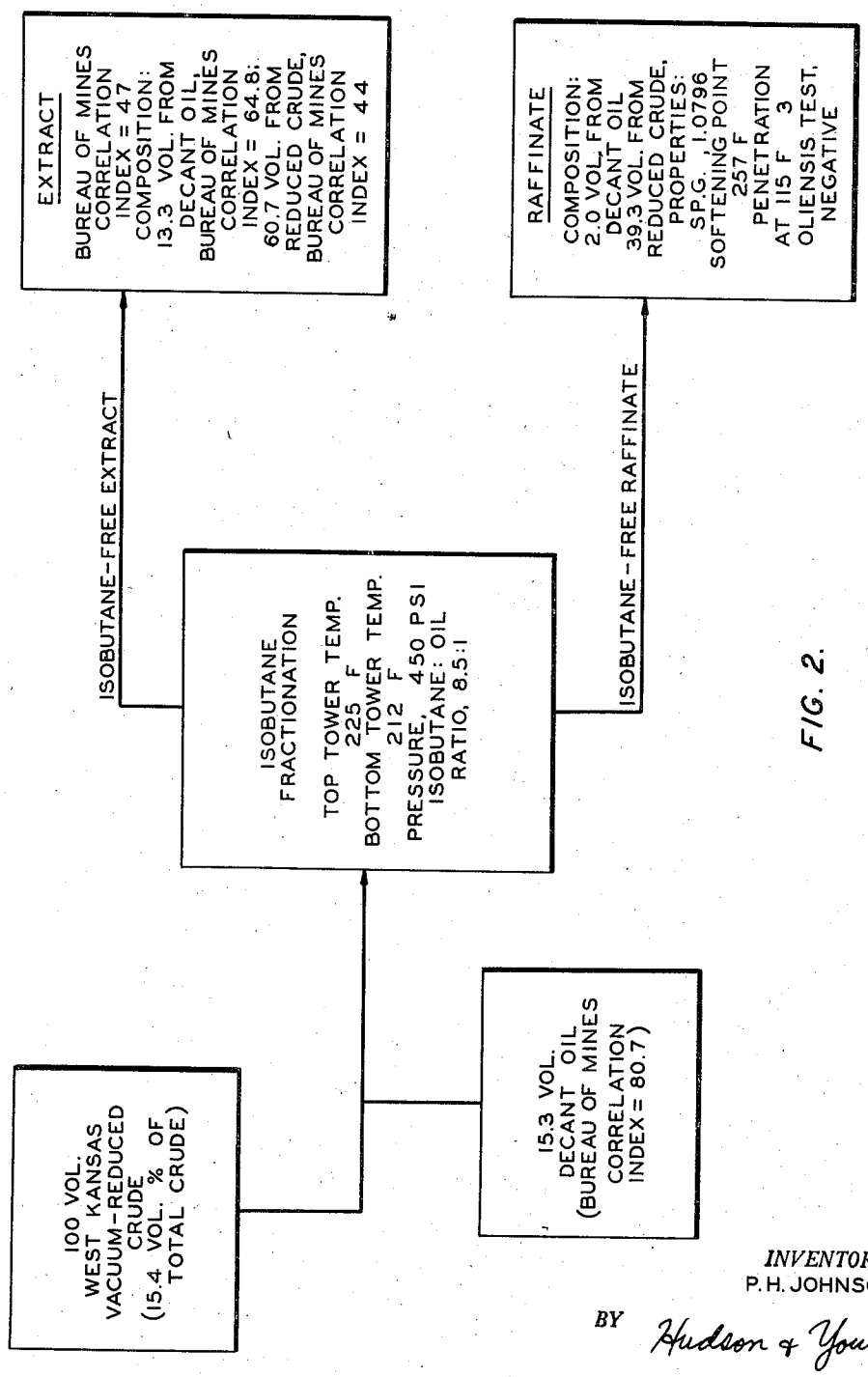

FIG. 2.

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RECOVERY OF CRACKING FEED AND ASPHALT

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Application April 26, 1954, Serial No. 425,457

6 Claims. (Cl. 208—86)

This invention relates to the fractionation of petroleum products. In one aspect, it relates to the production, in high yields, of a feed stock for a cracking process. In another aspect, it relates to the production of asphalt.

Recent developments in petroleum refining have made desirable the production of the maximum amount of catalytic cracking feed from a given volume of crude oil. Among the methods suggested for accomplishing such production is deeper or more extensive distillation of crude to increase the amount of heavy distillate recovered. A difficulty inherent in this method is that there is a limit to the depth of distillation which can be used to produce a suitable feed for a catalytic cracking process. This limit arises from the fact that, as the distillation is extended to higher temperatures to recover heavier distillate fractions, these fractions become contaminated with metal compounds and with aromatic, resinous or asphaltic compounds present in the crude. The metal compounds, when present in a feed to a cracking process, poison the cracking catalyst. The heavy aromatic, resinous and/or asphaltic compounds, when subjected to cracking, excessively deposit carbon upon the catalyst.

I have found that solvent fractionation is a very desirable method for recovering maximum yields of cracking stock from reduced crude oils. The solvent fractionation process is well known in the art (see, for example, Bray et al., U. S. 2,081,473, 1937). It comprises contacting, countercurrently or in a batch or single-stage operation, a heavy oil with a liquefied light hydrocarbon at an elevated temperature and pressure. The light hydrocarbon dissolves paraffinic materials and rejects heavy aromatic or asphaltic materials which are undesired as constituents of a feed for a cracking process. In addition, the light hydrocarbon rejects the metal compounds and the heavy aromatic, resinous and/or asphaltic compounds, as well as sulfur and nitrogen compounds, all of which are undesirable as constituents of a cracking feed. Compounds of metals, or sulfur, and of nitrogen are not undesirable as constituents of road asphalts.

In many refineries, there are available highly aromatic fractions which contain non-aromatic materials. Many of these fractions are sold as fuel oil at low prices. They ordinarily have a boiling point of at least 400° F.

I have found that such aromatic fractions which are free of asphaltenes contain materials which are valuable as feed to a cracking process and could be used as such if a method were available for separating them from the aromatic materials with which they exist in admixture.

Distillation, however, is substantially ineffective for such a separation.

Among these aromatic fractions are extract fractions obtained by the solvent extraction of materials such as lubricating oil fractions, cracked gas oils, and the like, and heavy fractions recovered during the fractionation of effluents from a catalytic cracking process.

The extract fractions are obtained by contacting an oil of the type described with a solvent which selectively dissolves the relatively nonparaffinic constituents and subsequently separating the dissolved materials from the solvent. Such processes and solvents are well known in the art. Among these solvents are phenol, furfural, liquid sulfur dioxide, and glycol ethers.

Among the fractions recovered from a catalytic cracking process is a type of oil, known as "decant oil" or "synthetic tower bottoms." This fraction is higher-boiling than the recycle gas oil fraction and ordinarily boils in the range of about 700° to 900° F. but sometimes has a boiling range as broad as 650 to 950° F. or even as broad as 600 to 1000° F. It contains relatively paraffinic constituents, which are valuable as feed for cracking, and condensed-ring cyclic or aromatic compounds which are undesirable as cracking stock but are very beneficial as asphalt constituents.

I have also found that solvent fractionation of asphaltene-free aromatic fractions of the type previously described herein, including decant oil, is not feasible, when such fractions are treated alone, because of the relatively low boiling range and the substantial absence of an asphaltene fraction.

I have further found, and my invention is based on this finding, that if an aromatic fraction of the type described is blended with a reduced crude oil and the mixture is subjected to solvent fractionation in the presence of a light hydrocarbon solvent, the following highly important and advantageous results are obtained, namely: (1) maximum recovery of the more highly paraffinic constituents of the reduced crude and of similar constituents of the aromatic fraction; (2) the recovered paraffinic constituents are substantially free of metal compounds and carbon depositing materials; (3) the cyclic or aromatic constituents of the aromatic fraction are recovered with the asphalt fraction, of which they are desirable constituents; and (4) when the solvent fractionation is conducted in combination with a fluid catalytic cracking process, a minimum production of residual fuel oil is obtained.

Thus, according to this invention, a reduced crude oil is blended with an aromatic fraction of the type described, and the blend is subjected to solvent fractionation in the presence of a light hydrocarbon to produce a cracking feed and an asphalt fraction.

The volume ratio of reduced crude to aromatic fraction is ordinarily in the range 3:1 to 10:1, although much higher proportions of reduced crude can be used.

The light hydrocarbon is ordinarily a paraffin containing from 1 to 5 carbon atoms per molecule. Methane, ethane, propane, isobutane, n-butane, isopentane, and n-pentane can be used. I ordinarily prefer propane or isobutane. In many instances isobutane is preferred because of its higher solvent power for the paraffinic materials. Olefins within the C_2 to C_5 range can be used if desired. Methane and ethane, when used according

to this invention, are ordinarily used in admixture with one or more of the heavier hydrocarbons named, e.g. propane or butane.

The solvent fractionation can be conducted as a single-stage contacting but is preferably conducted in a multi-stage tower in which the light hydrocarbon flows countercurrently with respect to the oil charge. The oil charge, i.e. the blend, enters the tower at an intermediate level, and the isobutane or other light hydrocarbon enters near the bottom. An isobutane-rich phase is withdrawn from the top of the tower, and an asphalt-rich phase is withdrawn from the bottom. Isobutane is recovered from each phase and recycled.

The fractionation temperature depends on the particular hydrocarbon solvent used and on the composition of the oil treated. Generally, the range is from about 75 to 400° F. A temperature gradient is preferably maintained in the tower to obtain a rectification effect. Since the solvent power of the light hydrocarbon is a direct function of the density of the hydrocarbon, the top of the tower is maintained at a higher temperature than the bottom. When propane is the solvent, the bottom temperature is preferably in the range 105 to 205° F. and the top temperature is preferably within the range 120 to 225° F. depending on the properties of the oil charged. When isobutane is the solvent, the top temperature is preferably in the range 200 to 290° F., depending on the properties of the oil charged, and the bottom of the tower is maintained at a lower temperature, preferably within the range 180 to 275° F. Ordinarily, the bottom of the tower is maintained at a temperature 10 to 15 degrees lower than the top. However, a larger or smaller gradient can be utilized. The specific temperatures to be used in any particular instance can readily be determined by one skilled in the art from this disclosure.

The fractionation pressure is at least sufficient pressure to maintain the light hydrocarbon solvent substantially in the liquid phase, or in the dense phase when the temperature is above the critical temperature of the solvent.

The solvent-to-oil volume ratio is generally in the range 3:1 to 15:1, preferably 4:1 to 10:1.

The solvent density can be adjusted as desired by using a mixed solvent comprising two or more of the light hydrocarbons herein disclosed, e.g. a mixture of ethane and propane, or a mixture of propane, isobutane, and n-butane.

Embodiments of this invention are illustrated in the drawings.

Figure 1 is a flow diagram illustrating the practice of this invention in combination with a fluid catalytic cracking unit.

Figure 2 illustrates results obtainable by the practice of this invention and is discussed in Example 2 hereof.

As illustrated in Figure 1, a reduced crude oil, i.e. one from which materials boiling below 700° F. have been removed, enters flash zone **3** through inlet **2**. Flash zone **3** is ordinarily operated under vacuum, e.g. from 5 to 50 mm. Hg absolute pressure, and at a temperature from 650 to 750° F. to obtain a flash distillate free of metal compounds and carbon-depositing compounds. The distillate is passed through conduits **4** and **13** to preheat zone **19**. A straight-run gas oil, e.g. of boiling range 400 to 700° F., can be added through inlet **4A**.

The residue passes through conduit **5** to fractionation zone **6**, being cooled to a temperature in the range 125° to 160° F. in cooler **5A**. It is mixed with, for example, one-seventh of its volume of decant oil from conduit **57**. The mixture enters fractionation zone **6** at an intermediate level, e.g. at the middle thereof.

Light hydrocarbon enters fractionation zone **6**, near the bottom thereof, being drawn from storage **7** through conduit **8**. As stated, isobutane is often the preferred solvent; however, propane is satisfactory and is often used on account of availability in large quantities at many refineries. The use of propane is illustrated here.

Fractionation zone **6** is ordinarily a vertical column of a type known in the art. The liquid propane enters the lower part of the column and rises therethrough in countercurrent flow with respect to the oil blend. A propane-rich, or extract phase is withdrawn through conduit **9** and passed to flash zone **10** wherein propane is flashed. Propane is recovered through conduit **11**, condensed in condenser **12**, and recycled to storage **7**.

The residue of the flashing in zone **10** is a clean, metal-free, low carbon residue, paraffinic oil suitable as cracking stock. This oil is mixed with the oil in line **4** and passed to preheat zone **19** wherein the mixed oil is vaporized and preheated to a cracking temperature, e.g. 900° F. It can be diluted with steam if desired.

A fluidized cracking catalyst, such as silica-alumina, or silica-alumina-zirconia is added through line **33** from storage **31**. The catalyst-oil mixture flows through conduit **20** to cracking zone **21**, which can be a cracking reactor of any type known in the art. The oil vapor flows upwardly through a dense, fluidized bed of catalyst and is converted to lower-boiling products. Most of the catalyst remains in zone **21**. Small amounts of catalyst fines suspended in the product are separated in separator **23** and passed through conduit **24** to regeneration zone **27**. Part of the catalyst is withdrawn from zone **21** through conduit **25** and passed to regeneration zone **27**, a suitable carrier gas being added through inlet **26**. The withdrawn catalyst is maintained as a dense, fluidized bed in zone **27** and is contacted with a regeneration gas, such as steam and/or air, which is supplied at a high temperature, e.g. 1000° F. through inlet **28**. Resulting flue gas is withdrawn through outlet **29**. Regenerated catalyst is returned to storage **31**, carrier gas being supplied through inlet **30A** and withdrawn through outlet **31A**. Fresh catalyst is added, as needed, through inlet **32**.

Cracked product is passed through conduit **34** to separation zone **35**, which is ordinarily a fractional distillation unit. A gas and gasoline fraction is recovered through conduit **36** and passed to separation zone **37** for separation of a gasoline fraction, withdrawn through outlet **39**, and a gas fraction, withdrawn through outlet **38**.

A gas oil fraction (400–700° F.) is recovered in zone **35** and passed through line **40** to separation zone **41**, from which a light fraction is withdrawn as furnace oil through outlet **42**.

A heavy cracked fraction, which contains any catalyst fines remaining in the product, is recovered through line **53** and passed to solids removal zone **54**, which comprises known equipment such as a settler, classifier, thickener, or filter, or any combination of these. Part of the oil is preferably returned, through conduits **53A** and **55**, to zone **35** at a level therein above the level of entry of material from line **34**. The returned material scrubs catalyst fines from upflowing vapor.

Solids-free oil, known as "decant oil" is withdrawn from zone **54** through line **55**. Part can be returned to zone **35**, as described. Catalyst-oil slurry is withdrawn through outlet **56**.

The decant oil is passed through conduit **57** to fractionation zone **6**, as previously described herein.

From fractionation zone **6**, a raffinate fraction is removed through conduit **14** and passed to flash zone **15**, wherein the dissolved propane is flashed off. The propane is passed through conduit **16** to storage **7**, being condensed in condenser **17**.

An asphalt product, containing asphaltic constituents of the crude and the heavy polycyclic constituents of the decant oil, is recovered through outlet **18**.

The gas oil recovered in zone **41** can be recycled, entirely or in part, through conduits **43**, **43A**, and **45**. Since this oil contains cyclic components which are undesirable as cracking stock, at least part of the oil is preferably passed through conduit **43** to extraction zone **44** in which the oil is contacted with a solvent such as furfural, phenol,

or liquid sulfur dioxide, supplied through inlet 52. The raffinate phase, comprising mainly paraffinc materials is recycled through conduit 45, preferably after removal of dissolved solvent by means not shown. The extract phase is passed to stripping zone 47 through conduit 46. Solvent-free extract, comprising cyclic materials and some paraffinic materials is recovered through conduit 48 and cooler 49 and passed to fractionation zone 6 along with the decant oil. Stripped solvent is recycled through conduit 50, cooler 51, and conduit 52.

Those skilled in the art will recognize that the apparatus diagrammatically shown in Figure 1 is conventional apparatus and that other apparatus can be used. Thus fixed-bed, moving-bed, or suspensoid cracking can be used in place of the fluid catalytic cracking unit shown.

Example I

Figure 2 is a diagrammatic oil material balance showing results obtainable according to this invention. Flow of isobutane is not shown, but is as described in connection with Figure 1.

A West-Kansas vacuum reduced crude is blended with a decant oil obtained from a fluid catalytic cracking process as previously described. The decant oil has a Bureau of Mines correlation index of 80.7, which indicates a substantial aromatic content. Distillation of the extract and of the raffinate show that, of the 15.3 volumes of decant oil treated, 13.3 volumes are recovered as cracking stock in the extract and 2.0 volumes as a part of the asphaltic raffinate. The 13.3 volumes recovered in the extract has a correlation index of 64.8, indicating a decidedly lower aromatic content than that of the original decant oil. The correlation index of the total extract is 47, indicating high paraffinicity and therefore desirability as a cracking stock.

The asphalt (raffinate) properties shown in Figure 2 show that the asphalt is satisfactory for a blending stock for the production of road asphalt. Ordinarily an asphalt having the properties shown is blended with a softening or solvent material to produce a paving composition.

The softening point is determined by the ring-and-ball method. The penetration value is determined by ASTM method D5–49, a 100-gram weight being used. The oliensis test is a spot test described in "Highway Materials, Part II, Methods of Sampling and Testing," by the American Association of State Highway Officials, page 157, Method T102–42. A negative oliensis test indicates the absence of unstable internal phase relationships. (See Abraham, "Asphalts and Allied Substances," volume two, page 925, fifth edition, 1945, D. Van Nostrand Co., New York, N.Y.)

In other respects, Figure 2 is self-explanatory.

Example II

A vacuum-reducer, West-Kansas crude oil was blended with a decant oil obtained in a fluid catalytic cracking process, and the mixture was subjected to fractionation in the presence of liquid isobutane.

The vacuum-reduced crude amounted to 15.4 volume percent of the total crude and had the following properties:

Gravity, ° API	10.3
Softening point, ° F	103
Penetration, 77 ° F., 100-gm. weight, 5 sec., in cm./100	213
Ramsbottom carbon residue, wt. percent	7.5
S, wt. percent	1.31
N, wt. percent	0.52

The decant oil had a Bureau of Mines correlation index of 81 and an A.P.I. gravity of 11.8.

The volume ratio of reduced crude to decant oil was 100:15.3.

The fractionation was conducted at a top tower temperature of 225° F., a bottom tower temperature of 212° F., a pressure of 450 p.s.i. and a volume ratio of isobutane to oil blend of 8.5:1.

Removal of the isobutane from the isobutane-rich phase resulted in recovery of 74 volumes (based on 100 volumes of reduced crude) of an oil having the following properties:

Bureau of Mines correlation index	47.6
Gravity, ° A.P.I	18.3
Ramsbottom carbon residue, wt. percent	3.3
S, wt. percent	0.79
N, wt. percent	0.22

Fractional distillation of the isobutane-free extract showed that, of the 74 volumes of said extract, 13.3 volumes were derived from the decant oil and 60.7 from the reduced crude. The vacuum distillation data (760 mm. Hg) for the decant oil, the total extract, and the extract derived from the decant oil were as follows:

Vol. percent distilled	Temperature, ° F. Corrected to 760 mm. Hg		
	Decant Oil	Total Extract	Extract from Decant Oil
IBP	520	604	549
5	629	734	630
10	662	802	669
20	713	930	719
30	747	1,001	752
40	770	1,045	777
50	796	1,076	796
60	818		817
70	836		843
80	869		884
90	919		952

The extract fraction derived from the crude has a Bureau of Mines correlation index of 43 (calculated) and an A.P.I. gravity of 18.7° (calculated). The extract fraction derived from the decant oil has a Bureau of Mines correlation index of 65 and an A.P.I. gravity of 16.8°.

Properties of the asphalt obtained by isobutane fractionation in the presence and in the absence of decant oil are as follows:

	Without Decant Oil	With Decant Oil
Sp. gr.	[1] 1.0850	1.0878
Softening point, ° F	[1] 280	275
Penetration, 115° F., 100 gm. weight, 5 sec. in cm./100	[1] 2	2
Yield, volumes/100 vol. reduced crude	39.3	41.3

[1] Interpolated from experimentally determined curves showing asphalt properties plotted against asphalt yield (with no decant oil added) from the same crude oil charge.

The foregoing data show that the blend of decant oil, according to this invention, when fractionated, yields an increased volume of good-quality cracking feed and an increased volume of asphalt having properties making it satisfactory as a paving material component.

Example III

The blend of reduced crude and decant oil described in Example II (115.3 volumes, total) was fractionated

by contacting with liquid isobutane at a top tower temperature of 252° F., a bottom tower temperature of 237° F., a pressure of 505 p.s.i. and a volume ratio of isobutane to blend of 6.7:1.

Volumes and properties of feed and product materials are as follows:

	Reduced Crude	Decant Oil	Total Extract (iC_4 free)	Extract from Crude	Extract from Decant Oil	Asphalt from Blend	Asphalt Obtained from Crude without Decant Oil
Volumes	100	15.3	63.4	49.5	13.9	51.9	50.4
Gravity, ° A.P.I.	10.3	11.8	20.2	[1] 21.0	17.3		
Softening Point, ° F.	103					220	[1] 228
Bur. Mines Corr. Index		81	42.5	[1] 39	64		
Penetration, 77/100/5, cm./100	213						
Ramsbottom Carbon Residue, wt. Percent	7.5		1.89				
S, wt. Percent	1.31		0.70				
N, wt. Percent	0.52		0.17				
Sp. gr.						1.0732	[1] 1.0665
Penetration, 115/100/5, cm./100						10	[1] 12
	Temperature, ° F., Corrected to 760 mm. Hg						
Distillation (5 mm.), Percent Distilled:							
IBP		520	625	542			
5		629	713	513			
10		662	790	549			
20		713	908	698			
30		747	975	730			
40		770	1,015	755			
50		796	1,050	777			
60		818	1,075	799			
70		836		821			
80		869		850			
90		919		902			

[1] Interpolated from experimentally determined curves showing asphalt properties plotted against asphalt yield (with no decant oil added) from the same crude oil charge.

The data show the production of good-quality cracking stock and asphalt according to this invention. The data also show that a further reduction, as compared with Example II, of the carbon residue, the sulfur content, and the nitrogen content of the cracking stock can be obtained by fractionation at higher temperatures.

Example IV

This example shows yields obtainable by propane fractionation of a crude residuum obtained by vacuum flashing as compared with yields obtainable by isobutane fractionation. The residuum fraction was 14.6 volume percent of the total crude. The data are as follows:

Solvent	Top Tower Temperature, ° F.	Solvent-Insoluble Residue (Raffinate), Vol. Percent of Total Crude
Propane	175	10.82
Propane	118	8.9
Isobutane	250	7.9
Isobutane	205	6.2

The data show that isobutane has a greater solvent power than does propane at a given temperature. The amount of raffinate increases as temperature increases. Therefore, at 205° F., the amount of raffinate produced by propane would be higher than 10.82.

As indicated in Figure 1, it is often desirable to remove from the crude, materials boiling below about 1000° F. However, a crude residuum containing materials (gas oil) boiling as low as 700–800° F. can be solvent fractionated according to this invention. In such a case, a higher yield of cracking stock (extract) and a lower yield of asphalt (raffinate) are obtained. The increased yield of cracking stock is accompanied by a decreased selectivity of separation. Thus, a greater proportion of the undesired materials, such as metal compounds and carbon formers, accompanies the increased yield of cracking stock. For this reason, it is often preferred to operate as described in connection with Figure 1.

Example V

Six runs were conducted to compare isobutane fractionation of a predominantly paraffinic crude residuum alone with isobutane fractionation of a mixture comprising 86.7 volume percent of the same residuum and 13.3 volume percent of a decant oil obtained, as previously described, from a fluid catalytic cracking process. The residuum was obtained from a Western Kansas crude by noncracking vacuum distillation and amounted to 15.4 volume percent of the total crude. It had an API gravity of 10.3°, an initial boiling point of 923° F., a "5 percent distilled" point of 982° F., and a "10 percent distilled" point of 1004° F., all of these temperatures being corrected to atmospheric pressure. The decant oil had an API gravity of 11.8°, a Bureau of Mines correlation index of 81, and distillation characteristics as follows:

Vol. percent distilled:	°F.
IBP	520
5	629
10	662
20	713
30	747
40	770
50	796
60	818
70	836
80	869
90	919

The data obtained in the six runs are shown in the following table.

Run No.	Without Decant Oil			With Decant Oil		
	1	2	3	4	5	6
iC_4/Oil, liquid volume ratio	3.1	12.4	7.0	3.2	9.8	4.9
Top Tower Temp, ° F.	225	205	206	224	205	206
Bottom Tower Temp., ° F.	212	191	191	211	192	190
Pressure, p.s.i.	500	450	450	450	500	513
Asphalt yield, vol. percent of crude	6.7	6.0	6.2	6.2	6.0	5.9
Asphalt Properties:						
Penetration, mm., 5 sec., 100 gm. weight—						
150° F.	11.5	9.5	8.0	7.8	6.3	4.5
130° F.	6.0	5.0	4.0	3.6	3.5	2.5
115° F.	3.0	2.5	2.0	1.9	1.9	1.7
77° F.	0	0	0	0	0	0
Sp. Gr., 60/60 F.	1.0816	1.0850	1.0818	0.0900	1.0923	1.0901
Softening Point, ring and ball, ° F.	272	280	283	257	285	296
CCl_4-soluble, wt. percent, 77° F.					99.91	

The foregoing data, which were obtained under comparable process conditions, show that asphalt of superior penetration characteristics is obtained by the process of this invention (runs 4–6).

In the foregoing examples, the fractionation tower was 3 inches in internal diameter and 25 feet in height. It contained staggered horizontal baffles spaced 2 inches apart. Each baffle covered one-half of the cross-sectional area of the tower. The tower was rated at from 3.5 to 4.0 theoretical stages of contacting.

Variation and modification are possible within the scope of the disclosure and claims to this invention. The essence of the invention is a process comprising blending an aromatic, asphaltene-free oil with a heavy petroleum residuum fraction, subjecting the blend to solvent fractionation in the presence of a low-boiling hydrocarbon, and recovering an extract and a raffinate. While certain structures, examples, and process steps have been described for purposes of illustration, the invention is clearly not limited thereto.

I claim:

1. A process which comprises blending together a reduced crude oil with a substantially asphaltene-free, aromatic-containing hydrocarbon extract having an initial boiling point of at least 400° F. and obtained by extraction of an aromatic-containing oil with a solvent which selectively dissolves aromatic hydrocarbons, contacting the resulting blend with a liquid hydrocarbon having not more than 5 carbon atoms per molecule, and recovering an extract comprising a hydrocarbon material suitable as a catalytic cracking feed and a raffinate comprising an asphalt.

2. A process which comprises blending together from 3 to 10 volumes of a reduced crude oil having an initial boiling point of at least 700° F. with one volume of a substantially asphaltene-free, aromatic- containing hydrocarbon extract having an initial boiling point of at least 400° F. and obtained by extraction of an aromatic-containing oil with a solvent which selectively dissolves aromatic hydrocarbons, contacting the resulting blend with a liquid hydrocarbon having not more than 5 carbon atoms per molecule, said contacting being conducted at a temperature in the range 75 to 400° F., recovering an extract comprising a hydrocarbon material suitable as a catalytic cracking feed, and recovering a raffinate comprising an asphalt.

3. A process according to claim 2 wherein said liquid contacting hydrocarbon is propane and said contacting is conducted in a zone having a top zone temperature in the range of 120 to 225° F. and a bottom zone temperature lower than said top zone temperature and in the range of 105 to 205° F.

4. A process according to claim 2 wherein said liquid contacting hydrocarbon is isobutane and said contacting is conducted in a zone having top zone temperature in the range of 200 to 290° F. and a bottom zone temperature from 10 to 15 degrees lower than said top zone temperature.

5. A process which comprises vacuum flashing a crude petroleum fraction having an initial boiling point of at least 700° F., said flashing being conducted at a temperature in the range 650 to 750° F. and an absolute pressure in the range 5 to 50 mm. Hg; recovering a distillate and a residue; blending said residue with a cracked fraction subsequently described, in a ratio in the range from 3 to 10 volumes of said residue per volume of said cracked fraction; passing the resulting blend to an intermediate level in a contacting zone; countercurrently contacting said blend in said zone with a liquid phase of propane; maintaining the top of said zone at a temperature in the range 120 to 225° F. and the bottom of said zone at a lower temperature in the range 105 to 205° F.; removing an extract phase from the top of said zone and a raffinate from the bottom of said zone; removing said propane from said extract phase; catalytically cracking the extract thus recovered in the presence of a finely divided, fluidized cracking catalyst under cracking conditions of temperature and pressure; fractionating a cracked product and recovering a gas fraction, a gasoline fraction, a gas oil fraction, and a heavier fraction which boils in the range 700 to 900° F.; extracting said gas oil fraction with a solvent which selectively dissolves aromatic hydrocarbons therefrom, recovering a hydrocarbon extract from the last-mentioned extraction step; mixing the last-mentioned extract with said heavier fraction to form said cracked fraction; blending said cracked fraction with said residue as aforesaid; and recovering an asphalt fraction from said raffinate phase.

6. A process which comprises vacuum flashing a crude petroleum fraction having an initial boiling point of at least 700° F., recovering a distillate and a residue; blending said residue with a cracked fraction subsequently described, in a ratio in the range from 3 to 10 volumes of said residue per volume of said cracked fraction; passing the resulting blend to an intermediate level in a contacting zone; countercurrently contacting said blend in said zone with a liquid phase of hydrocarbon having not more than 5 carbon atoms per molecule; removing an extract phase from the top of said zone and a raffinate phase from the bottom of said zone; removing said hydrocarbon from said extract phase; catalytically cracking the extract thus recovered in the presence of a cracking catalyst under cracking conditions of temperature and pressure; fractionating a cracked product and recovering a gas fraction, a gasoline fraction, a gas oil fraction, and a heavier fraction which boils in the range 700 to 900° F.; extracting said gas oil fraction with a solvent which selectively dissolves aromatic hydrocarbons therefrom; recovering a hydrocarbon extract from the last-mentioned extraction step; mixing the last-mentioned extract with said heavier fraction to form said cracked fraction; blending said cracked fraction with said residue as aforesaid;

and recovering an asphalt fraction from said raffinate phase.

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