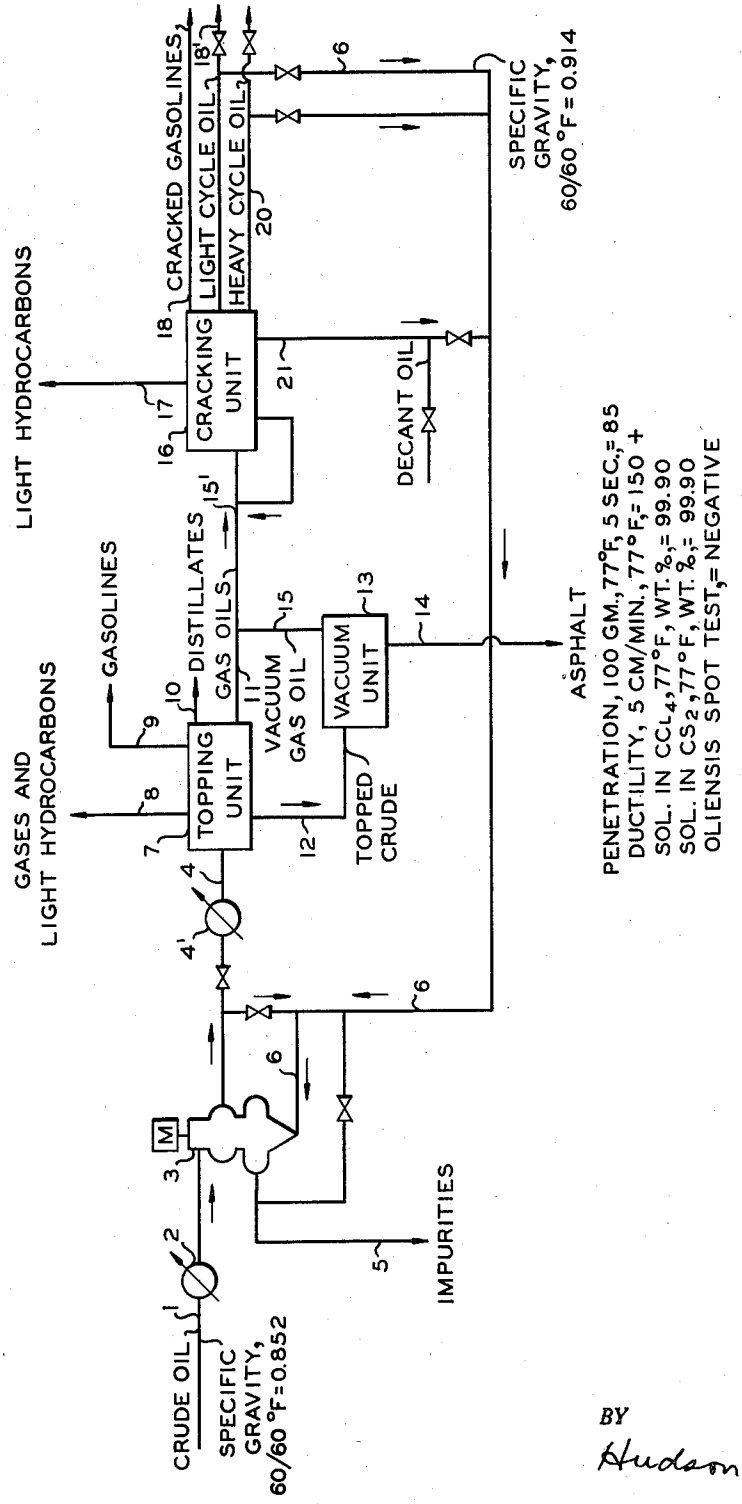
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CRUDE OIL CENTRIFUGING PROCESS

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CRUDE OIL CENTRIFUGING PROCESS

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8 Claims. (Cl. 208—39)

This invention relates to the separation of materials from admixture with each other by centrifugation. In one aspect, this invention relates to a centrifuging process for the removal of impurities from oils. In still another aspect this invention relates to the separation of solids, semi-solids, and heavy liquid materials, all as impurities, from a crude oil, by centrifugation and maintaining in the centrifugation zone a liquid hydrocarbon having a specific gravity higher than that of the said oil at centrifuging conditions. In still another aspect, this invention relates to a combination of steps wherein a crude petroleum oil is processed, including a centrifugation step, and wherein a liquid hydrocarbon fraction especially suitable for improving throughput of the said centrifugation, is formed, and is cycled to the said centrifugation step.

In the copending application of D. W. Gagle, G. J. Steeves and R. F. Berger, Serial Number 514,262, filed June 9, 1955, is disclosed and claimed a centrifuging method for removal of undesirable components from crude oils wherein the centrifugation temperature is maintained below about 100° F., preferably in the range of about 30 to 80° F., more preferably from 40 to 70° F., whereby asphaltic components of the oil, subsequently recovered, exhibit markedly improved properties particularly in respect of penetration, ductility, solubility in carbon tetrachloride, solubility in carbon disulfide, and the Oliensis spot test, whereas asphalts ordinarily recovered subsequent to centrifugation of the crude at temperatures outside the above ranges exhibit "borderline" specifications as to properties such as the foregoing.

This invention is concerned with a method for improving the amount of crude oil that can be centrifuged per unit time when employing a centrifugation such as that referred to with reference to the above said copending application.

An object of this invention is to provide for removal of impurities from oils. Another object is to provide for an increase in the amount of a crude oil that can be centrifuged per unit time. Another object is to provide a combination of steps containing a centrifugation step, in which combination is produced a liquid hydrocarbon fraction which is especially suitable for cycling to the centrifugation step to increase the amount of material that can be centrifuged therein per unit time. Another object is to provide steps for centrifuging an asphalt-containing crude oil whereby to provide for recovery from resulting crude, asphalt product exhibiting markedly improved properties, particularly with reference to penetration, solubility, and spot test above-referred to. Another object is to provide for incorporation of a selected hydrocarbon fraction in an oil under centrifugation conditions whereby to markedly increase the amount of oil that can be centrifuged per unit time. Other aspects and objects of this invention and its several related particulars are evident from a perusal of this disclosure, the drawings, and the appended claims.

In accordance with this invention, an oil containing impurity materials separable by centrifugation is centrifuged in the presence of an added hydrocarbon having a specific gravity higher than that of the said oil, whereby to markedly increase the amount of said oil that can be centrifuged to remove the said impurities, per unit time; the invention providing a process in accordance with another concept, comprising centrifuging a crude petroleum oil containing impurities, removable by centrifugation, in the presence of a hydrocarbon fraction as described hereinafter, topping resulting impurity-free crude oil to separate a topped crude and a gas oil fraction therefrom, vacuum reducing said topped crude to form asphalt and gas oil fractions, cracking at least one of said gas oils, recovering a light cycle oil from said cracking and recycling same to said centrifuging step, whereby the amount of oil centrifuged per unit time is markedly increased, and recovering said asphalt as a product of the process.

Any oil mutually soluble with the added hydrocarbon and containing impurities substantially insoluble in the said hydrocarbon which impurities can be separated from the oil by centrifugation, can be treated in accordance with this invention, although the invention in a now preferred form is applied to crude petroleum oils. Exemplary of oils other than crude petroleum oils which can be treated in accordance with this invention are residual fuel oils, thermally cracked oils, and the like; exemplary of various types of crude petroleum oils processed in accordance with this invention are Rangely (Colorado), Williston Basin (North Dakota), Bowes' Dome (Montana), and Santa Maria (California) crude oils.

Crude oil impurities removable in the practice of this invention are solid, semi-solid, and heavy liquid materials generally present in the crude, on a weight basis, within a range of about 0.5 to 10.0 percent. They are substantially insoluble in the oil from which they are to be removed and have a specific gravity higher than that oil and higher than that of the hydrocarbon added to the said oil. Among such impurity materials are those which have been identified as insoluble in carbon disulfide, carbon tetrachloride, standard naphtha, and xylene-normal heptane.

Any hydrocarbon fraction having a specific gravity higher than that of the oil treated can be employed in the practice of this invention, i.e., for incorporation into the oil in the centrifugation system, a preferred hydrocarbon fraction being one having a pour point below about 70° F., preferably in the range of about —45 to 30° F. and a viscosity below about 60, preferably in the range of about 32 to 50 seconds (SUV @ 100° F.). Exemplary of suitable hydrocarbon fractions that can be added to the centrifugation system in accordance with this invention are light cycle oils, heavy cycle oils, decant oils, and other oils having relatively low pour points, low viscosities, and higher specific gravities than the oil being processed.

Although added hydrocarbon fractions having a pour point outside the above-described pour point range and/or a viscosity outside the above described viscosity range can be employed in the practice of this invention, such fractions are less preferred because the higher pour points and viscosities prevent optimum operation of the centrifuging step at the desired temperature range.

The volume ratio of added hydrocarbon to crude oil treated is generally within the range of 0.005 to 0.2:1 although values outside this range can be employed when desired. However, ratios outside this range are less preferred because below these limits, the extent of improvement in throughput is often only slight, and above these limits, the handling of the recycle is often not desirable from an economic point of view.

Preferred centrifugation temperatures are in the range of 30 to 85° F. as set forth in the copending application referred to herein whereby asphalt subsequently recovered has been found to exhibit unpredicted improved properties particularly with reference to penetration, spot test and solubilities in carbon disulfide and carbon tetrachloride.

My invention is illustrated with reference to the attached drawing which exemplifies a combination process containing a centrifugation step in which process a hydrocarbon fraction suitable for addition to the centrifugation step therein, in accordance with this invention, is formed, and cycled to the said centrifugation step. With reference to the attached drawing, a crude oil of the type described herein, as, for example, a Rangely, Colorado, crude, having a specific gravity in the order of about 0.85 (a typical range of crude oil gravities being from about 0.80 to 0.93), is passed via line **1** and heater **2**, or cooler, as required, wherein it is heated or cooled to a temperature below about 100° F., preferably in the range of from about 30 to 85° F., into centrifuge **3** which can be of the Merco type. A cycle oil described hereinafter is also introduced into the centrifuge element **3** by way of line **6**. Centrifugation is conducted in centrifuge **3** at a temperature within the said range whereby impurities are separated and are withdrawn by way of line **5** and improved crude oil, i.e., free from impurities, is separated and withdrawn by way of line **4** and preheater **4'** wherein it is heated to a temperature for topping such as in the range of about 600 to 800° F. Crude oil in line **4** is passed into topping unit **7** wherein various fractions are separated and are withdrawn as light hydrocarbon gases via line **8**, gasolines via line **9**, distillates via line **10**, gas oils via line **11**, and residual topped crude via line **12**. Topped crude from line **12** is passed to vacuum reduction unit **13** wherein it is vacuum reduced to produce a vacuum gas oil fraction and a residual asphalt fraction, the former being withdrawn via line **15** and the latter via line **14**. Vacuum gas oil in line **15** and gas oil in line **11** are together, or one alone, as desired, charged via line **15'** to cracking zone **16** which can be thermal or catalytic. In vacuum reduction zone **13**, the pressure employed is generally in the range of from about 5 to 75 mm. Hg, the initial reduction temperature being generally that of the topped crude withdrawn from zone **7**.

Cracking in zone **16** is advantageously carried out at a temperature in the range of about 800 to 1000° F., a contact time in the range of about 1 to 15 seconds being generally preferred which when employing a catalyst is in terms of space velocity, from about 0.3 to 7.0 pounds of the vapor feed per pound of catalyst per hour. Cracking pressures employed are those within any suitable range such as in the range of 0 to 20 p.s.i.g. Exemplary of cracking catalysts that can advantageously be employed in cracking zone **16** are, e.g., natural and synthetic clay type catalysts, etc. Product fractions from cracking in zone **16** are a light hydrocarbon fraction withdrawn via line **17**, cracked gasolines withdrawn via line **18**, a light cycle oil withdrawn via line **18'**, a heavy cycle oil withdrawn via line **20**, and a decant oil withdrawn via line **21**. Gas oil feed streams to cracking zone **16**, i.e., in lines **11** and/or **15**, generally have a boiling range within the limits of 400 to 1100° F.

The light cycle oil fraction withdrawn from zone **16** by way of line **18'** for cycling to centrifugation zone **3**, I have found, is especially suitable for that purpose, the throughput in zone **3** in terms of crude oil processed, being substantially doubled as compared with that possible without cycling of the said cycle oil in line **6** thereto. Light cycle oil in line **6** has a pour point generally in the range of −30 to 30° F., a viscosity in the range of about 35 to 40 SUV at 100° F., and a specific gravity in the range of about 0.907 to 0.93, and higher

than that of the crude oil processed in zone **3**. The ratio of cycled oil from line **6**, to that of crude oil from line **1**, on a volume basis, is generally in the range of 0.005:1 to 0.3:1 dependent to an extent upon the specific crude being processed. Thus, when processing a Rangely, Colorado, crude, as referred to herein, the light cycle oil fraction has a specific gravity in the order of about 0.914, the specific gravity of the said crude being about 0.852, and has a pour point of about zero, and is cycled to zone **3** in a volume ratio to the said crude oil of about 2 percent.

The following examples illustrate my invention and particularly point out that a markedly improved throughpoint of crude oil is obtained in the centrifugation step when incorporating a hydrocarbon fraction in the said step, having a specific gravity higher than that of the crude oil processed. In Table I are data giving a comparison of the properties of asphalt products produced by treatment of Rangely crude according to the invention wherein light cycle oil is recycled separately into the centrifuge (column A), asphalt products produced by treatment of the same crude by the method of the above-identified application Serial No. 514,262 (column B), and asphalt products produced from the same crude which has not been centrifuged (column C). These examples show that the amount of crude oil that can be processed in the practice of this invention can be substantially doubled as compared with that otherwise possible.

Table I

	A	B	C
Gallons per hour centrifuged, maximum throughput	1,500	750	
Light cycle oil recycle, gal./hr	30		
Temperature of centrifuging, ° F	65	65	
Treated crude recycled, gal./hr	377	202	
Asphalt:			
Penetration, 77° F., 5 sec., 100 gm	85	86	89
Ductility, 5 cm./min., 77° F., cm	150+	150+	130
Sol. in CCl_4, 77° F., weight percent	99.90	99.91	98.7
Sol. in CS_2, 77° F., weight percent	99.90	99.90	99.1
Oliensis spot test:			
Standard naphtha (30 min.)	Neg.	Neg.	Pos.
35-65% xylene-n-heptane (30 min.)	Neg.	Neg.	Pos.
Cut back asphalt:			
Gravity, ° API at 60/60° F	13.1	13.0	13.4
Flash, tag open cup, ° F	80+	80+	80+
SUV at 140° F., sec	320	215	325
Distillation: Vol. percent of total distillate to 680° F.—			
To 437	27.5	27.0	28.0
To 500	64.0	63.0	65.5
To 600	91.0	90.0	91.5
Residue (by difference)	84.9	85.0	84.7
Tests on residue from distillation:			
Penetration, 5 sec., 100 gm., 77° F	89	88	92
Ductility, 5 cm./min., 77° F., cm	150+	150+	145
Sol. in CCl_4, 77° F., weight percent	99.69	99.70	98.9
Sol. in CS_2, 77° F., weight percent			99.0
Oliensis spot test:			
Standard naphtha (30 min.)	Neg.	Neg.	Pos.
35-65% xylene-n-heptane (30 min.)	Neg.	Neg.	Pos.
Diesel fuel:			
°API at 60/60° F	34.8	34.7	34.8
IBP, ° F	337	342	338
10% evap., (vol.), ° F	493	495	490
90% evap., ° F	609	608	604
End point, ° F	640	642	638
Pour point, ° F	−5	−5	+10
Flash point, tag closed cup, ° F	154	156	154

These data demonstrate that, by the process of this invention, about twice the amount of crude oil can be treated by centrifuging to produce asphaltic materials and distillates of improved quality, than can be treated in the absence of such added hydrocarbon.

Reasonable variation and modification are possible within the scope of the foregoing disclosure, the drawing, and the appended claims to the invention, the essence of which is that in the separation of impurity materials from an oil containing the same by centrifugation, the improvement is provided comprising adding to the zone of the said centrifugation a hydrocarbon having a specific gravity higher than that of the said oil whereby substantially improved throughput of oil in the centrifugation zone is achieved, crude petroleum oils being

processed in accordance with a now preferred form of the invention; the invention in accordance with another concept providing a combination of steps wherein a crude petroleum oil is processed, including a centrifugation step, and wherein a liquid hydrocarbon fraction especially suitable for improving throughput of the said centrifugation, is formed, and is cycled to the centrifugation, all as described herein.

I claim:

1. A separation process comprising passing a crude petroleum oil containing impurities removable by centrifugation into a centrifuge, centrifuging said crude petroleum to separate said crude petroleum oil into an oil phase and an impurity phase, adding directly to said oil phase undergoing centrifugation in said centrifuge a hydrocarbon oil as a separate stream having a specific gravity higher than that of said crude petroleum oil and mutually soluble therewith, said added hydrocarbon oil having a lower specific gravity than said impurities, said impurities being insoluble in said added hydrocarbon oil and recovering an oil fraction of reduced impurity content.

2. The improvement of claim 1 wherein said oil is a crude oil, said hydrocarbon has a pour point in the range of about —45 to 30° F., a viscosity in the range of about 32 to 50 SUV at 100° F. and a specific gravity in the range of about 0.907 to 0.93 and the temperature of said centrifugation is below about 100° F.

3. A process comprising passing a crude petroleum oil containing impurities removable by centrifugation into a centrifugation zone; also separately passing into said zone a separate hydrocarbon stream described hereinafter; centrifuging the resulting crude oil-hydrocarbon mixture in said zone at a temperature below about 100° F. to separate said impurities; withdrawing impurities from said zone; passing remaining crude oil-hydrocarbon admixture from said zone to a topping zone, and topping said crude oil therein; separating a gas oil fraction and a residual topped crude fraction in said topping zone and withdrawing each said fraction therefrom; passing said residual fraction to a vacuum reducing zone and therein separating same into a residual asphalt and a gas oil fraction; passing at least one of said gas oil fractions to a cracking zone and therein cracking same to produce cracking product including a light cycle oil; cycling said light cycle oil to said centrifugation zone as the said hydrocarbon fraction added thereto, above described, whereby the amount of crude oil centrifuged per unit time is markedly increased, and recovering said asphalt as product.

4. A process of claim 3 wherein the specific gravity of said crude oil is in the range of from 0.80 to 0.93, the pour point of said cycle oil is in the range of about —45 to 30° F., the viscosity of said cycle oil is in the range of about 32 to 50 SUV at 100° F., and the volume ratio of said cycle oil to said crude oil is in the range of 0.005:1 to 0.2:1.

5. A process of claim 4 wherein said crude oil is a crude selected from the group consisting of Rangely (Colorado), Williston Basin (North Dakota), Bowes' Dome (Montana), and Santa Maria (California) crude oils.

6. A process of claim 4 wherein said cracking is effected at a temperature in the range of 800 to 1000° F. at a contact time of from 1 to 15 seconds and each said gas oil has a boiling range within the limits of about 400 to 1100° F.

7. A process of claim 6 wherein said cracking is carried out in the presence of a catalyst selected from the group consisting of natural catalyst and synthetic clay type catalysts.

8. A process of claim 2 wherein said hydrocarbon fraction is selected from the group consisting of light cycle oils, heavy cycle oils, decant oils, and combinations thereof.

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