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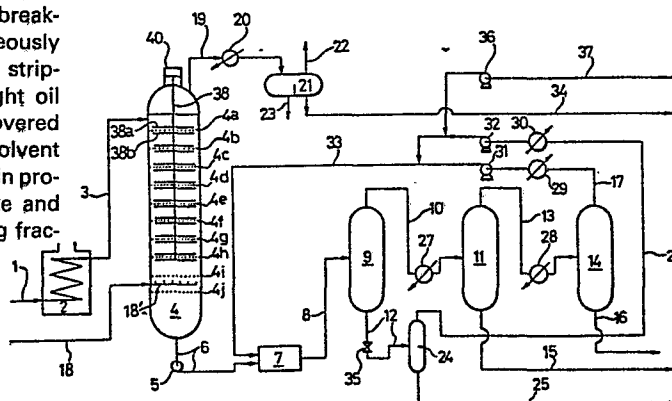
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54 Process for treating heavy petroleum oil resids.

57 Disclosed is a process for treating heavy petroleum oil resids to produce high yields of useful oil products therefrom. The process comprises thermally cracking the heavy petroleum oil resids under conditions more severe than visbreaking but less severe than delayed coking while simultaneously subjecting said thermally cracking oil resids to steam stripping to separate and recover cracked gases and light oil vapors. The thermally-cracked heavy fluid resid recovered from the thermal cracking step then is subjected to solvent extraction under temperature and pressure conditions in proximity of the critical point of the solvent to separate and recover heavy metal containing asphaltene-containing fractions and low metal oil products therefrom.



PROCESS FOR TREATING HEAVY PETROLEUM OIL RESIDS

FIELD OF THE INVENTION

This invention relates to a process for the treatment of heavy petroleum oil resid streams. More particularly, this invention relates to a process for the treatment of heavy petroleum oil resid streams to obtain therefrom useful oil fractions substantially free of asphaltenes and heavy metals.

BACKGROUND OF THE INVENTION

Many processes have been proposed for treating heavy petroleum oil resid streams to separate and recover the useful components contained therein including processes based on the use of catalysts or hydrogen under high pressure. However, such processes have not been found to be entirely satisfactory. For example, processes based on the use of a catalyst to treat heavy petroleum oil resid streams usually encounter the problem of catalyst deterioration with time. This deterioration is, most usually, caused by heavy metals and asphaltenes that are present in large amounts in the heavy oil resid. Processes which employ the addition of hydrogen under high pressure to treat heavy petroleum oil resid streams are not economical especially when a high consumption of hydrogen is required.

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As a consequence of the above mentioned drawbacks associated with the use of catalytic and hydrocracking processes other processes, including both thermal cracking and solvent extraction processes, have been proposed and practiced as alternative means for treating heavy petroleum oils resids. These processes do not require the use of either catalysts or hydrogen and thus avoid the problems encountered with those processes. Known thermal cracking processes include the visbreaking process, such as exemplified by U. S. 4,454,023, and the delayed coking process both of which have been extensively practiced for effecting the thermal cracking of heavy petroleum oil.

However, even these alternative thermal cracking processes are not entirely free of problems. For example, in utilizing a visbreaking process for treating a heavy petroleum oil the heat treatment is carried out under such mild conditions, due to the specific application of the intended products thereof, that only a very small portion of the total macromolecular components in the heavy oil feed is decomposed. In contrast, in the delayed coking process the heat treatment is carried out under such severe conditions that coking and dehydrogenation of the hydrocarbon components in the heavy oil feed are needlessly promoted.

Accordingly, these two processes represent the extremes of thermal cracking.

Solvent extraction processes also have been proposed. However, the use of such processes by themselves alone provide for the recovery of only a limited amount of useful oil products. This is especially true when the feedstock contains a very high content of heavy metals. From the viewpoint of effectively utilizing both resources and energy, it is clear that further improvements in the treatment of heavy petroleum oils resids are needed.

SUMMARY OF THE INVENTION

A process now has been developed wherein a heavy petroleum oil resid feed stream containing large amounts of asphaltenes and heavy metals is treated by a novel combination of reliable and simple steps to cause a conversion of this feed stream into high-valued components, to remove asphaltenes and heavy metals therefrom and to maintain the loss of useful components to a minimum level, all in an economical and efficient manner.

More particularly, the present invention relates to a novel and improved process for treating heavy petroleum oil resid feed streams. The novel and improved process of the present invention comprises

introducing a heavy petroleum oil feed stream, which has been preheated to a temperature in the range of from about 450°C to about 550°C in a preheater, into an upper portion of an adiabatic thermal cracker.

5 The preheated heavy petroleum oil feed stream is caused to flow downwardly through the thermal cracker in a plug-flow condition through the use of multi-stage horizontally positioned perforated plates which are spaced at intervals throughout the thermal cracker.

10 The operating conditions employed within the thermal cracker include temperatures in the range of from about 390°C to about 450°C, pressures of at least atmospheric pressure and residence times in the range of from about 1 to about 5 hours.

15 As the heavy petroleum oil resid feed stream flows downwardly through the thermal cracker, distillate vapors and gaseous products resulting from the thermal cracking of the heavy petroleum oil resid feed stream are removed by means of steam introduced into a lower
20 portion of the thermal cracker, which steam flows upwardly in a countercurrent direction to the descending heavy petroleum oil resid feed stream undergoing thermal cracking. Under the above conditions, from 30 to 65 percent of the components in the heavy petroleum oil
25 resid feed stream having boiling points above about

500°C convert to components having boiling points below about 500°C. From the lower portion of the thermal cracker there is withdrawn a cracked resid bottoms stream, which resembles a liquid pitch. This bottoms stream, which contains an asphaltene fraction, heavy metals and useful oil components, then is mixed with a solvent and the mixture subjected to solvent extraction. The solvent extraction is carried out at temperatures and pressures at or near the critical point of the solvent and above the softening point of the asphaltene fraction. Under such conditions a mixture of the asphaltene fraction and heavy metals is rapidly and efficiently separated from the useful oil components in said bottom stream.

DESCRIPTION OF THE DRAWING

The single Figure is a schematic flow diagram illustrating one embodiment of the process of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

The novel process of the present invention is comprised of a series of steps, whereby the overall yield and quality of useful oil components therefrom are improved. The steps comprise subjecting a heavy petroleum oil resid feed stream, such as an atmospheric

or vacuum distillation column bottom resid (i.e., an atmospheric or vacuum residue) to selective thermal cracking. The selective thermal cracking is carried out under conditions whereby cracking of the heavy petroleum oil resid feed stream is confined to the decomposition of only those high molecular hydrocarbon constituents or components in the feedstock that are relatively easily decomposed. During this selective thermal cracking step, separation and recovery of the light hydrocarbons formed is accelerated by simultaneous steam stripping. The use of simultaneous steam stripping minimizes any further decomposition of the light hydrocarbon components formed and the needless evolution of gaseous by-products is thereby avoided. Thermally-cracked heavy petroleum oil resid withdrawn from the bottom of the thermal cracker then is subjected to a highly efficient critical solvent extraction-separation treatment which comprises the second step of the process of the present invention. Through the use of this critical solvent extraction-separation step, substantially all of any remaining useful oil components remaining in the thermally-cracked heavy oil resid are recovered.

In carrying out the process of the present invention, the operating conditions employed in both the thermal cracking step and the critical solvent

extraction-separation step are selected in accordance with the composition of the heavy petroleum oil resid feed stream such that the total yield of useful oil components recovered as well as the quality thereof is maximized. When carried out under optimum conditions, said yield and quality are much higher than can be obtained from more conventional processes such as the catalytic cracking, hydrocracking, visbreaking, delayed coking or solvent extraction processes. In addition, the resid or bottom stream recovered from the thermal cracking step of the present process is in a highly fluid state as is the heavy metals containing asphaltene fraction recovered in the solvent extraction-separation step. The highly fluid nature of these materials makes them more easily handled than those recovered from the more conventional processes mentioned above.

In the process of the present invention, the operating conditions employed in the thermal cracking will be conditions which promote the selective concentration of nickel, vanadium and other heavy metals present in the heavy petroleum oil resid feedstock into the asphaltene fraction of the thermally-cracked heavy oil resid stream withdrawn from the bottom of the thermal cracker. In this regard, it has been found

that in order to promote the selective concentration of the heavy metals into the asphaltene fraction of the thermally-cracked heavy oil resid, it is necessary to carry out the thermal cracking treatment to a degree such that at least about 30 percent by weight or more, and preferably at least about 40 percent by weight or more of those components in the heavy petroleum oil resid feed, having atmospheric boiling points above about 500°C, are decomposed to components having atmospheric boiling points below about 500°C. However, to avoid excessive dehydrogenation and evolution of gaseous fractions and to maximize the total yield of useful oil components, the degree of cracking carried out in the thermal cracking step of the process of the present invention is restricted such that about 65 percent by weight or more, and preferably about 60 percent by weight or more of the components in the heavy petroleum oil resid feed having atmospheric boiling points above about 500°C are not decomposed to components having atmospheric boiling points below about 500°C. By contrast, in visbreaking processes, wherein the thermal cracking reaction is carried out under pressures ranging from 10 to 30 kg/cm² and residence times of approximately from 10 to 40 minutes,

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only about 15 percent to 25 percent by weight of the components having atmospheric boiling points about 500°C are decomposed to the components in the feedstock having atmospheric boiling points below 500°C.

5 The significance of the above disclosed upper limit imposed on the degree of decomposition carried out in the thermal cracking step is closely related to the overall economy and stable operation of the process constituting the present invention. It has
10 been found, for example, that if the degree of thermal cracking exceeds the aforesaid upper limit, a large amount of low-value gaseous products will be generated and, at the same time, the formation of coke is greatly increased. It further has been found that as the amount
15 of coke in the thermally-cracked heavy oil resid withdrawn from the thermal cracker increases, the final resid or asphaltene fraction which is separated and recovered in the extraction step of the process of this invention does not remain liquid but instead,
20 solidifies into a hard-to-handle mass. In such event, the separation, recovery, transportation and the like, of the final resid or asphaltene fraction becomes extremely difficult requiring complex apparatus to accomplish these tasks. Thus, the degree of thermal
25 cracking carried out in the first step of the process

of the present invention is limited such that the thermally-cracked heavy oil residue recovered therefrom contains minimal amounts of coke. As a result, the final resid or asphaltene fraction extracted therefrom
5 in the extraction step of the present invention will be in a highly fluid state at process temperatures. Such highly fluid state facilitates its separation, recovery and the like and simplifies the type of equipment employed and the arrangement thereof. Further
10 teachings relating to the operating conditions, equipment and the like for carrying out this selective thermal cracking or first step in the process of the present invention can be found in U. S. Patent Nos. 4,435,276 and 4,443,328. The teachings of these U. S.
15 patents are incorporated herein by reference in their entirety.

The thermally-cracked heavy oil resid or bottoms stream withdrawn from the thermal cracker is subjected to a critical solvent extraction-separation which
20 comprises the second step of the present invention. In this second step, the thermally-cracked heavy oil resid is mixed with a critical solvent. This mixture then is subjected to temperatures higher than the softening point of the asphaltene fraction in the
25 thermally-cracked resid and preferably to conditions

of temperature and pressure within the proximity of the critical point of the solvent. Under these conditions, the asphaltene fraction is less soluble in the critical solvent than the useful oil components and a rapid separation of the asphaltene fraction from the mixture can be effected. The remaining mixture of critical solvent and useful oil components, following removal of the separated asphaltene fraction, then is further heated to raise the temperature of the mixture (or the pressure reduced) so that the solubility of the useful oil components in the solvent is lowered thereby resulting in rejection of the useful oil components from the solvent. Upon recovery of the rejected useful oil components, the solvent is easily recovered for reuse in further extracting additional bottoms resid streams withdrawn from the thermal cracker utilized in the first step of the process of the present invention. Teachings regarding specific operating conditions of temperature, pressure and materials useful as extraction solvents and employed in this second step of the present invention can be found in U. S. Patent Nos. 2,940,920; 2,967,818; 2,980,602; 3,003,945; 3,003,946; 3,003,947; 3,005,769; 4,125,459; 4,239,616 and 4,273,644. The teachings of these references are incorporated herein by reference in their entirety.

With reference to the single Figure, a heavy petroleum oil resid feedstock, such as an atmospheric or vacuum distillation bottoms resid, is introduced through conduit 1 into a preheater 2. In preheater 2, the heavy petroleum oil resid feedstock is heated to temperatures in the range of from about 450°C to above 550°C under pressures in the range of from about 1 to about 10 kg/cm². In order to avoid coking of the feedstock it is passed through preheater 2 at a velocity in the range of from about 2 to about 20 m/sec.

The preheated feedstock then is conveyed from preheater 2 through conduit 3 to an upper portion of upright cylindrical thermal cracker 4. Steam, and preferably superheated steam, is introduced into a bottom portion of thermal cracker 4 through conduit 18 and steam distributing means 18'. This superheated steam flows upwardly and countercurrent to the downwardly flowing feedstock which is undergoing thermal reaction. The countercurrently flowing superheated steam facilitates the evaporation and removal of cracker light oil components from the downwardly flowing thermally reacting feedstock, thus eliminating the need of subjecting the thermally-cracked resid recovered from thermal cracker 4 to vacuum distillation. The amount of superheated steam introduced to thermal

cracker 4 through conduit 18 and distributing means 18' to evaporate and remove cracked light oil components will be in the range of from about 5 percent to about 20 percent by weight of the feedstock stream undergoing thermal reaction in thermal cracker 4.

In general, thermal cracker 4 is operated at atmospheric pressure and at temperatures ranging from about 390°C to about the temperature of the preheated feedstock introduced thereto. The residence time of the feedstock in thermal cracker 4 will be at least two times that for a visbreaking process or from about 1 to about 10 hours.

In carrying out the process of the present invention, it is desirable that the thermally reacting feedstock be made to descend downwardly through thermal cracker 4 in a substantially plug-flow manner and that it not be allowed to stagnate at or near the internal surfaces of thermal cracker 4. Failure to maintain plug-flow also can result in the formation of channels and vortexes in the descending column of thermally reacting feedstock. Such channels and vortexes, once formed, provide paths along which portions of the feedstock can quickly pass through, and out of, thermal cracker 4. The shorter residence time for these portions of the thermally reacting feedstock in thermal

cracker 4 can lead to an undesirable lowering of the overall conversion of the feedstock to the more desirable useful oil products.

To achieve plug-flow for and to prevent stagnation
5 of the downwardly flowing thermally reacting feedstock, thermal cracker 4 is equipped with multiple horizontal perforated partition plates 4a through 4j.

Thermal cracker 4 also is equipped with a drive shaft 38 driven by motor 40. Drive shaft 38 is fitted
10 with multiple horizontal scraper blades, two of which (38a and 38b) are designated on the Figure. The horizontal scraper blades attached to drive shaft 38 are located immediately adjacent to each of the multiple horizontal perforated partition plates 4a through 4h
15 and extend outwardly from drive shaft 38 to near the internal surface of thermal cracker 4. The purpose of drive shaft 38 and the multiple horizontal scraper blades affixed thereto is to provide for the even distribution throughout the downwardly flowing thermally
20 reacting feedstock of the meso-phase coke precursors produced as part of the thermal cracking reaction. By maintaining these meso-phase coke precursors evenly distributed throughout the descending reactions stream, agglomeration of these precursors and, therefore, the
25 accumulation of coke within thermal cracker 4 substantially is prevented.

A mixture comprising cracked light oil vapors, a small amount of cracked gas and steam flows upwardly through thermal cracker 4 and the multiple horizontal perforated partition plates 4a through 4g countercurrent to the descending thermally reacting feedstock. This mixture then is discharged from the upper portion of thermal cracker 4, through conduit 19 and condenser 20 to separator 21. In separator 21, the mixture is separated into a cracked gas stream, a condensed water stream and a cracked light oil stream which are removed from separator 21 through conduits 22, 23 and 34, respectively.

A fluid, thermally-cracked resid stream is removed from the bottom portion of thermal cracker 4. This fluid bottoms resid stream is removed from thermal cracker 4 and conveyed by means of pump 5 and communicating conduit 6 directly to mixer 7. In mixer 7, the fluid resid stream is mixed with a suitable solvent introduced into mixer 7 by way of conduit 33 in a volumetric ratio in the range of from about 1:8 to about 1:12.

The mixture of thermally-cracked bottoms resid and solvent then is conveyed through conduit 8 to first separating column 9 wherein the mixture is maintained at elevated temperatures ranging up to and above the

critical temperature of the solvent and elevated pressures of at least about the vapor pressure of the solvent at the temperature being maintained. Within first separating column 9 and under the operating temperature disclosed said mixture of thermally-cracked bottoms resid and solvent undergoes separation into a first fluid light phase comprising resinous components, useful oil components and solvent and a fluid-like first heavy phase containing asphaltenes and heavy metals. The first fluid light phase is withdrawn from the top of first separating column 9 via communicating conduit 10 and conveyed to second separating column 11 through heater 27. By means of heater 27, the first fluid light phase further is heated to a temperature greater than the temperature employed in first separating column 9.

The fluid-like first heavy phase which comprises asphaltenes, heavy metals and some solvent is withdrawn from the bottom portion of first separating column 9 via conduit 12, containing pressure reducing valve 35, and introduced into separator 24. In separator 24 the pressure further is reduced to thereby effect vaporization of the solvent. The solvent is recovered from separator 24 through conduit 26. This recovered solvent then can be returned to mixer 7 through communicating condenser 30, pump 32, and conduit 33. The

asphaltenes, upon vaporization and removal of the solvent in separator 24, are removed and recovered therefrom in a highly fluid state through conduit 25.

5 The first light phase is withdrawn from first separating column 9 and conveyed into second separating column 11 after being heated in heater 27 to a temperature higher than the temperature employed in first separating column 9. In second separating column 11 the first light phase separates into a second fluid
10 light phase comprising the useful oil components and solvent, and a fluid-like second heavy phase comprising the resinous components and some solvent. The second fluid light phase is withdrawn from the top of second separating column 11 through a conduit 13 and introduced
15 into third separating column 14 after being heated to above the critical temperature of the solvent in heater 28. The fluid-like second heavy phase comprising the resinous components is discharged in a fluid state from the bottom of second separating column 11 through
20 conduit 15 for recovery, or for recycle to preheater 2 for mixing with fresh feedstock and further cracking in thermal cracker 4.

In third separating column 14 wherein the solvent is in a supercritical state the second light phase
25 undergoes separation into a third light phase and a

fluid-like third heavy phase comprising the desired product, i.e., a deasphalted oil. This product is withdrawn from the bottom of third separating column 14 through conduit 16 and recovered. The third light
5 phase comprising the bulk of the original extraction solvent is withdrawn from the top of third separating column 14 through conduit 17 and recycled via communicating cooler 29 and pump 31 back to mixer 7. Make-up solvent can be supplied to mixer 7 by means of pump
10 36 through conduit 37 to replenish solvent lost in small amounts from the system in company with the asphaltenes, resins and useful oil components being separated and recovered in this portion of the process of the present invention.

15 The following example is presented as being illustrative of the process of the present invention and is not intended nor is it to be construed as limiting the scope of the present invention in any way.

EXAMPLE

20 A feed oil, comprising a mixed vacuum distillation column bottoms oil (vacuum resid) obtained from Middle and Near East crude oils and containing 83 ppm of nickel and 272 ppm of vanadium was preheated to 480°C and introduced into the upper portion of a thermal cracker
25 having 10 spaced-apart horizontal, perforated, partition

plates. The vacuum resid flowed downwardly through the thermal cracker under reaction conditions of atmospheric pressure and a cracker bottom temperature of 420°C. The residence time of the thermally reacting vacuum resid within the thermal cracker was about 120 minutes. As the thermally reacting vacuum resid flowed downwardly through the thermal cracker steam was charged to the bottom of the thermal cracker to provide a steam to resid ratio of about 10 percent by weight. Under these conditions 55 percent by weight of the components having boiling points above 500°C in the vacuum resid feed oil were converted to the components having boiling points below 500°C.

A vaporous, mixed effluent stream was removed from the top of the thermal cracker which was composed of steam and 4 percent by weight of cracked gaseous products and 51 percent by weight of thermally-cracked light oil vapors based on the weight of the original vacuum resid feed. In addition, a fluid effluent stream was recovered from the bottom of the thermal cracker. This fluid effluent stream comprised thermally-cracked resid representing the remaining 45 percent by weight of the initial vacuum resid feed. The thermally-cracked fluid resid had a softening point of 150°C when measured in accordance with the ring and ball test and an asphaltene content of 40 percent by weight.

The thermally-cracked fluid resid then was fed from the bottom of the thermal cracker to a mixer where it was mixed with cyclohexane solvent in a ratio of resid to solvent of 1:10 by volume and thereafter introduced into the first of a series of three separating columns. The first separating column was maintained at a temperature of 282°C and a pressure of 53.7 kg/cm² (52 atm.). Under these conditions, the mixture in the first separating column separated into an asphaltene-containing heavy fluid phase and a light fluid phase of a mixture of a resinous oil component, a lighter oil component and cyclohexane solvent. The asphaltene-containing heavy fluid phase containing about 30 percent of the cyclohexane solvent, then was withdrawn from the lower portion of this first separating column and reduced in pressure to atmospheric pressure to flash and recover the solvent therefrom. About 98 percent of the cyclohexane solvent contained in this heavy fluid phase was recovered leaving an asphaltene-rich fluid product representing a yield of 45 percent by weight based on the weight of the thermally-cracked fluid resid feed to the first separating column. This asphaltene-rich fluid product contained 460 ppm of nickel and 1500 ppm of vanadium and had a softening point of 240°C when measured in accordance with the ring and ball test.

The light liquid phase comprising the mixture of a resinous oil component, a lighter oil component and the cyclohexane solvent was withdrawn from the upper portion of the first separating column and heated.

5 Thereafter, the heated light liquid phase was introduced into a second separating column being operated at an internal temperature of 290°C and an internal pressure of 51.6 kg/cm² (50 atm.). Under these conditions, the mixture separated into a second heavy fluid phase comprising the resinous oil component and a second light
10 liquid phase comprising a mixture of the lighter oil component and the cyclohexane solvent. The second heavy fluid phase comprising the resinous oil components was discharged and recovered from the bottom of the
15 second separating column in a yield of 10 percent by weight based on the thermally-cracked fluid resid feed to the first distilling column.

The second light liquid phase was withdrawn from the upper portion of the second separating column,
20 further heated and thereafter introduced into a third separating column. This third separating column was operated at an internal temperature of 316°C and an internal pressure of 50.6 kg/cm² (49 atm.) to effect a separation of the lighter oil component from the
25 cyclohexane solvent. The lighter oil component was

discharged from the bottom portion of the third separating column while the cyclohexane solvent was withdrawn from the upper portion of the column. The withdrawn cyclohexane solvent then was cooled and thereafter recycled to the mixer for reuse.

5 The lighter oil component recovered in the third separating column represented a yield of 45 percent by weight based on the thermally-cracked fluid resid feed to the first distilling column and had an asphaltene content of 0.5 percent by weight, a nickel content
10 of 10 ppm and a vanadium content of 20 ppm.

 The combined yield of the thermally-cracked light oils recovered directly from the thermal cracker and the lighter oil components extracted and separated by the solvent was 71.25 percent by weight and the
15 extent of removal of heavy metals present in the initial thermally-cracked fluid resid feed was 98.3 percent. The amount of cyclohexane solvent consumed during the extraction and separation steps was 0.05 percent by weight based on the weight of the resid feed to the
20 thermal cracker.

COMPARATIVE EXAMPLE

 The same vacuum resid feed oil as used in the above Example was preheated to 450°C and fed to the same thermal cracker as used in the above Example.

Within the thermal cracker the vacuum resid feed oil was subjected to thermal decomposition under the conditions of 14.8 atm. pressure, 430°C and a residence time of 10 minutes without steam stripping. Under these conditions, which are similar to those employed in conventional visbreaking processes, only 20 percent by weight of the components having boiling points above 500°C was converted to the components having boiling points below 500°C.

A thermally-cracked fluid resid was withdrawn from the bottom of the thermal cracker and combined in a mixer with pentane in a ratio of solvent to resid of 10:1 by volume and the resulting mixture then introduced into a first separating column operated at an internal temperature of 177°C and an internal pressure of 43.4 kg/cm² (42 atm.). Under these conditions, the mixture in the first separating column separated into an asphaltene-containing heavy fluid phase and a light liquid phase of a mixture of a resinous oil component, a lighter oil component and pentane solvent.

The asphaltene-containing heavy fluid phase containing some pentane solvent was discharged from the bottom of the first separating column and reduced in pressure to atmospheric pressure whereby the solvent pentane was vaporized through flashing for the separation and

recovery thereof. An asphaltene-rich fluid product was recovered in a yield of 50 percent by weight based on the weight of the thermally-cracked fluid resid feed to the first separating column. This asphaltene-rich fluid product contained 111 ppm nickel and 363 ppm of vanadium.

The light liquid phase comprising the mixture of a resinous oil component, a lighter oil component and the pentane solvent was discharged from the upper portion of the first separating column and introduced into a second separating column operated at an internal temperature of 200°C and an internal pressure of 47.5 kg/cm² (46 atm.). Within the second separating column the light liquid phase was separated into a second heavy fluid phase of the resinous oil components which was discharged from the bottom of the second separating column and recovered in a yield of 10 percent by weight based on the weight of thermally-cracked fluid resid feed introduced into the first distilling column.

The second light liquid phase was withdrawn from the upper portion of the second separating column, heated and thereafter introduced into a third separating column operated at an internal temperature of 227°C and an internal pressure of 45.4 kg/cm² (44 atm.).

In the third separating column, the lighter oil component was separated from the solvent. The lighter oil

component was discharged from the bottom of the third distilling column while the solvent was discharged from the upper portion thereof, cooled and thereafter circulated to the mixer for reuse. The lighter oil component recovered in the third separating column was obtained in a yield of 40 percent by weight based on the weight of thermally-cracked fluid resid feed to the first distilling column and had an asphaltene content of 0.1 percent by weight or less, a nickel content of 42 ppm and a vanadium content of 136 ppm.

The combined yield of the thermally-cracked light oils recovered directly from the thermal cracker and the lighter oil component extracted and separated by the solvent was only 52 percent by weight. This yield is substantially lower than the 71.25 percent yield of the previous Example. The extent of removal of heavy metals present in the initial thermally-cracked fluid resid feed in this Example was only 80 percent compared to 98.3 percent in the previous Example.

The amount of the pentane solvent consumed in this Example was 0.5 percent by weight based on the weight of the thermal cracker vacuum resid feed compared to only 0.05 percent in the previous Example.

While the present invention has been described with respect to that which at present is considered

to be the preferred embodiment, it is to be understood that changes and modifications can be made without departing from the spirit and scope of the invention as defined in the following claims.

CLAIMS:

1. A process for treating heavy petroleum oil
resids comprising:

preheating a heavy petroleum oil resid containing
heavy metals to a temperature in the range
5 of from about 450°C to about 500°C;

introducing said preheated resid into an adiabatic
thermal cracking vessel having upper and lower
portions, said preheated resid being introduced
into the upper portion of said vessel and
10 caused to flow downwardly through said vessel
in a plug flow manner and into the lower
portion of said vessel;

subjecting said downwardly flowing resid within
said vessel to thermal cracking by maintaining
15 said resid to elevated temperatures in the
range of from about 390°C to about 450°C and
under a pressure of at least one atmosphere;

simultaneously introducing steam into the lower
portion of the vessel, said steam flowing
20 in an upwardly direction countercurrent to
the downwardly flowing resid;

removing cracked gas and light oil vapors and
steam from the upper portion of said vessel
and a thermally-cracked fluid resid from the
25 lower portion of said vessel;

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mixing said thermally-cracked fluid resid with
an extraction solvent to form a mixture and
introducing said mixture into an extraction
vessel;

5 maintaining said mixture in said extraction vessel
under elevated temperatures and pressures
to effect a separation of said mixture into
a heavy fluid phase containing heavy metals
and an asphaltene fraction and light fluid
10 phase containing resinous oil components,
light oil components and solvent; and

recovering, individually, said separated heavy
fluid phase containing the heavy metals and
asphaltene fraction and said light phase
15 containing the resinous oil components, light
oil components and solvent.

2. The process of claim 1 further defined as comprising:

introducing the light fluid phase containing the resinous oil components, light oil components and solvent into a second extraction vessel;
maintaining said light fluid phase in said second extraction vessel under elevated temperatures and pressures to effect a separation of said light fluid phase into a second heavy fluid phase containing the resinous oil components and a second light fluid phase containing the light oil components and solvent; and
recovering, individually, said separated second heavy fluid phase and said second light liquid phase.

3. The process of claim 2 further defined as comprising:

introducing the second light fluid phase containing
the light oil components and solvent into
5 a third extraction vessel;
maintaining said second light fluid phase in said
third extraction vessel at elevated
temperatures and pressures to effect a
separation of the second light fluid phase
10 into a fluid light oil component phase and
a solvent phase; and
recovering, individually, said separated fluid
light oil component phase and said solvent
phase.

15 4. The process of claim 1 wherein the residence
time of the heavy petroleum oil within the adiabatic
cracking vessel ranges from about 1 to about 10 hours.

5. The process of claim 1 where, within the
adiabatic thermal cracking vessel, at least about 30
20 percent to about 65 percent by weight of components
in the heavy petroleum oil, undergoing thermal cracking
therein, and having atmospheric boiling points above
about 500°C are decomposed to components having
atmospheric boiling points below about 500°C.

6. The process of claim 1 wherein the steam introduced into the lower portion of the adiabatic thermal cracking vessel is an amount ranging from about 5 percent to about 20 percent by weight of the preheated
5 resid introduced into the upper portion of said adiabatic thermal cracking vessel.

7. The process of claim 1 wherein the thermally-cracked fluid resid is mixed with the extraction solvent in a volumetric ratio ranging from about 1:8 to about
10 1:12.

8. The process of claim 1 wherein the mixture is maintained at elevated temperatures ranging up to and above the critical temperature of the solvent.

9. The process of claim 8 wherein the mixture
15 is maintained at elevated pressures of at least about the vapor pressure of the solvent of the temperature being maintained.

