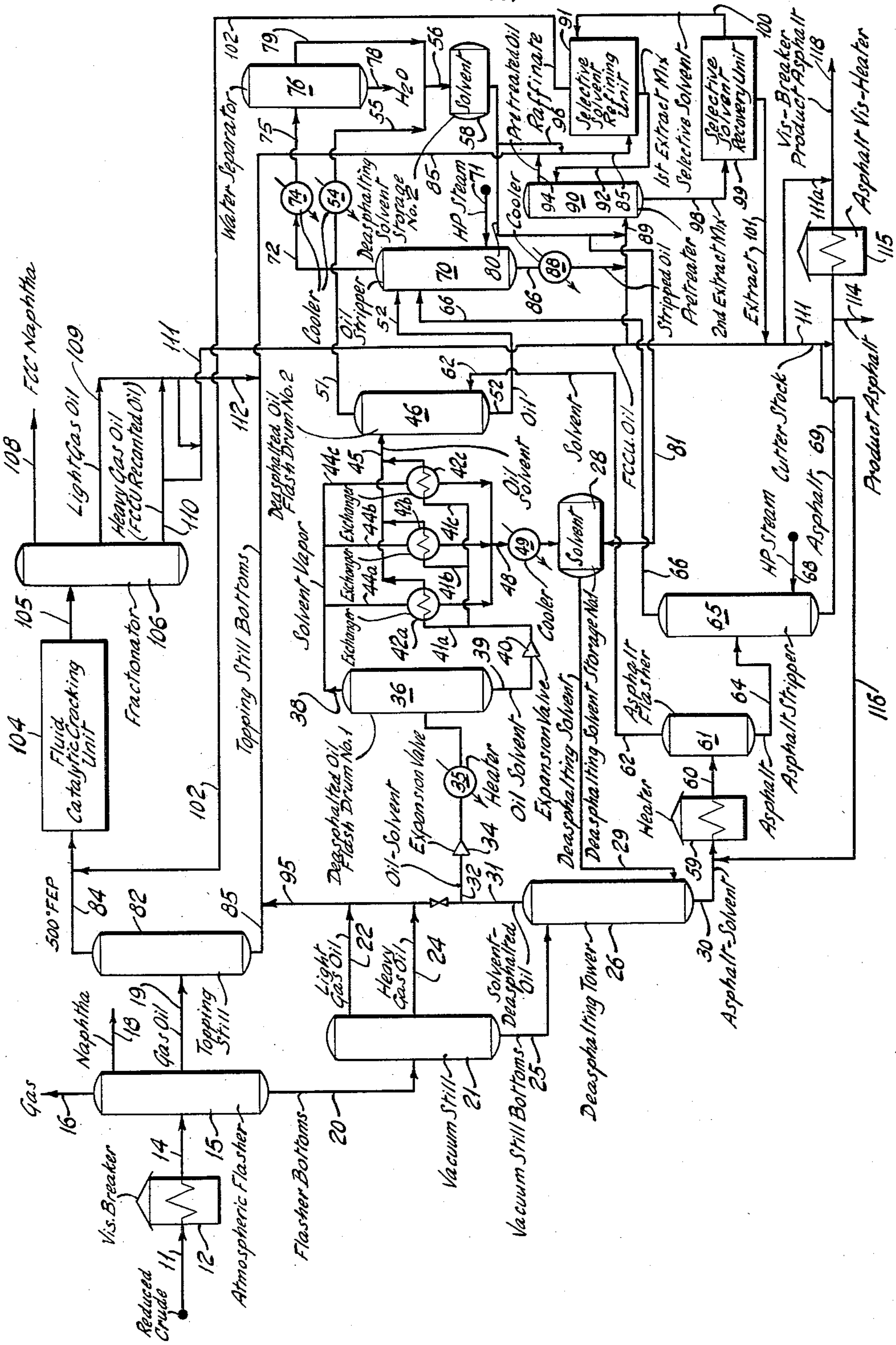
Sept. 2, 1958 R. SMITH 2,850,431

SOLVENT DEASPHALTING

Filed Dec. 30, 1955



United States Patent Office

2,850,431

Patented Sept. 2, 1958

2,850,431

SOLVENT DEASPHALTING

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Application December 30, 1955, Serial No. 556,496

8 Claims. (Cl. 196—14.46)

This invention relates to the treatment of asphaltic oils with a deasphalting solvent for the separation of asphaltic constituents therefrom. More particularly, this invention is concerned with the treatment of asphaltic residual hydrocarbon oils for the recovery of asphaltic constituents therefrom and for the production of a deasphalted oil suitable for use as a catalytic cracking feed stock. In accordance with one embodiment, this invention relates to a process for deasphalting residual hydrocarbon oils for the production of an asphalt fraction and a deasphalted oil fraction which is subsequently solvent refined for the preparation of a catalytic cracking feed stock characterized by a relatively low metals content.

It is an object of this invention to provide an improved solvent deasphalting process.

It is another object of this invention to provide an improved solvent deasphalting process employing a volatile deasphalting solvent, such as a normally gaseous hydrocarbon, e. g., ethane, propane, n-butane, isobutane, n-pentane, isopentane and mixtures thereof, wherein the deasphalting solvent after having been employed to separate asphaltic constituents from the asphaltic oil undergoing treatment is recovered in a deasphalting solvent recovery system which does not require the use of compressors to effect liquefaction and recovery of the deasphalting solvent.

It is another object of this invention to provide an improved and economical method for the recovery of deasphalting solvent employed in an operation involving the solvent deasphalting of asphaltic residual hydrocarbon oils.

How these and other objects of this invention are accomplished will become apparent with reference to the accompanying disclosure and drawing wherein there is schematically illustrated an embodiment of the practice of this invention directed to the solvent deasphalting of an asphaltic residual hydrocarbon oil. In at least one embodiment of this invention at least one of the foregoing objects will be achieved.

In accordance with this invention an asphaltic oil is solvent deasphalted by contact with a deasphalting solvent under deasphalting conditions of temperature and pressure to effect separation of asphaltic constituents from said oil. There is recovered from the aforesaid deasphalting operation a liquid deasphalted oil phase having a reduced amount of asphaltic constituents and containing a portion of said deasphalting solvent and a liquid asphalt phase containing another portion of said deasphalting solvent. The deasphalted oil phase at substantially the deasphalting conditions of temperature and pressure is partially volatilized or vaporized, as by pressure reduction, to produce a resulting first liquid phase and a resulting first vapor phase containing deasphalting solvent at a temperature T_1 and at a pressure P_1. The resulting first liquid phase is further treated, e. g., partial vaporization by pressure reduction, to produce a resulting second liquid phase comprising deasphalted oil and a resulting second vapor phase comprising deasphalting solvent at a temperature T_2 and a pressure P_2, T_2 being lower than T_1 and P_2 being lower than P_1. The aforesaid first and second vapor phases are then passed in indirect heat exchange relationship to each other whereby the temperature of said first vapor phase is reduced such that the vapor pressure of the deasphalting solvent therein is substantially lower than P_1, preparatory to or leading to the ready liquefaction and condensation of the deasphalting solvent in said first vapor phase. The resulting second vapor phase after heat exchange with said vapor phase is then cooled to a temperature sufficiently low to effect condensation of the deasphalting solvent therein. By operating in accordance with the above-broadly-indicated method the deasphalting solvent contained in the deasphalted liquid oil phase issuing from the solvent deasphalting operation is substantially completely recovered in liquid form without requiring the use of compressors and the like and is available for recycle to the solvent deasphalting operation. Also by operating a solvent deasphalting operation in accordance with the above-indicated method, substantial heat economy is possible.

Referring now in detail to the drawing a reduced crude, such as a mixture of reduced California crudes, having an initial boiling point greater than about 650° F., usually having a boiling point greater than about 800° F., amounting to about 35–75% by volume of the original crude, is supplied via line **11** to vis-breaker **12** where it is subjected to temperature, pressure and throughput conditions so as to mildly lower the viscosity of the reduced crude. A temperature in the range 800–1000° F. and a pressure in the range 50–800 p. s. i. g. are usually sufficient to effect mild vis-breaking of the reduced crude.

Vis-breaking of the reduced crude serves to reform or otherwise alter some of the high molecular weight or high boiling constituents of the reduced crude into relatively low molecular weight or low boiling constituents. The vis-breaking operation tends to produce lower boiling, more aromatic constituents which are generally more refractory in a catalytic cracking operation than lower boiling, more paraffinic hydrocarbons which are also produced. The vis-breaking operation complements and otherwise cooperates with a subsequent combination of deasphalting and solvent refining operations described hereinafter. The vis-breaking operation increases the yield of naphtha recoverable from the reduced crude in that the relatively more aromatic hydrocarbons produced during the vis-breaking operations are separated in a subsequent combination of fractionation, and deasphalting and solvent refining steps with the resulting production of a more paraffinic catalytic cracking charge stock suitable for the production of a catalytic cracked naphtha.

The mildly vis-broken reduced crude from vis-breaker **12** is introduced via line **14** into fractionator or atmospheric flasher **15** from which there is recovered overhead via line **16** a gas fraction comprising normally gaseous hydrocarbons such as propane and the butanes, a naphtha fraction via line **18**, such as a 430° F. end point naphtha, and a gas oil fraction via line **19**. There is also recovered from flasher **15** a bottoms fraction via line **20**. The flasher bottoms is then introduced via line **20** into vacuum still or distillation zone **21** where it undergoes further fractionation for the production of a light gas oil fraction recovered via line **22** and a heavy gas oil fraction recovered via line **24**. Vacuum bottoms is recovered from vacuum still **21** via line **25**.

The vacuum bottoms fraction recovered from vacuum still **21** via line **25**, usually having a gravity ° A. P. I. in the range 3–12 and a Conradson carbon residue in the range 15–40%, more or less, is introduced via line **25** into the upper part of solvent deasphalting tower or zone **26**. The solvent deasphalting operation may be a batch operation, a multiple vessel operation or a substantially continuous liquid-liquid counter-current treating operation, as indicated in the drawing, wherein the vacuum bottoms to be deasphalted is introduced via line **25** into the top of deasphalting tower **26** and flowed therein in countercurrent liquid-liquid contact with a suitable deasphalting solvent, such as a liquefied normally gaseous hydrocarbon, e. g., propane, n-butane, isobutane. The deasphalting solvent is introduced via line **29** into the bottom portion of deasphalting tower **26** from deasphalting solvent storage tank **28**.

A suitable deasphalting solvent in accordance with the practice of this invention is a liquefied normally gaseous hydrocarbon such as ethane, ethylene, propane, propylene, normal butane, isobutane, n-butylene, isobutylene, pentane, isopentane and mixtures thereof, either alone or in admixture with a minor amount of additive materials to improve the deasphalting operation or otherwise increase the yield and quality of the deasphalted oil and/or the recovered asphalt. The deasphalting operation is carried out at any suitable deasphalting temperature and pressure, the temperature and pressure being adjusted so as to maintain the deasphalting solvent in the liquid phase during the deasphalting operation. A deasphalting temperature in the range 150–325° F., usually not more than 75 degrees Fahrenheit lower than the critical temperature of the deasphalting solvent, and a pressure in the range 200–800 p. s. i. g., are employed depending upon the composition of the deasphalting solvent employed and to some extent the composition of the vacuum bottoms undergoing deasphalting. Generally, a deasphalting solvent to vacuum bottoms volume charge ratio in the range 2–10 is employed within deasphalting tower **26**. Deasphalting tower **26** may be operated under substantially isothermal conditions or under a temperature gradient, e. g., top tower temperature greater than bottom tower temperature by not more than about 40 degrees Fahrenheit. Also deasphalting tower **26** may be operated so that the vacuum bottoms is introduced thereinto at a number of points along the height of the tower and/or so that the deasphalting solvent is introduced thereinto at a number of points.

Following the deashpalting operation there is recovered from deasphalting tower **26** a deasphalted oil solvent mix via line **31** and an asphalt solvent mix via line **30**. The deasphalted oil in the mix in line **31** may have a gravity ° A. P. I. in the range 10–25 and a Conradson carbon residue in the range 1–10% and a viscosity in the range 200–600 SUS at 210° F., more or less. The deasphalted oil solvent mix is transferred from line **31** via line **32** through a vaporizing device, such as pressure reducing or expansion valve **34**, and through a heater **35** into deasphalted oil flash drum **36**. From flash drum **36** there is removed overhead via line **38** a first vapor phase containing deasphalting solvent vapor. There is also removed from the bottom of flash drum **36** via line **39** a first liquid phase containing deasphalted oil admixed with deasphalting solvent. The first liquid phase is passed via line **39** through a second vaporizing device, such as pressure reducing valve **40**, whereby it is partially vaporized to a lower temperature and pressure than the temperature and pressure prevailing in line **38**. The resulting partially vaporized first liquid phase is then passed in indirect counter-current heat exchange relationship via lines **41*a*, 41*b*** and **41*c*** by means of heat exchangers **42*a*, 42*b*** and **42*c*** with said first vapor phase introduced into the heat exchangers via lines **44*a*, 44*b*** and **44*c***, respectively. After the above-described heat exchange has taken place the resulting partially vaporized first liquid phase is recovered via line **45** and introduced into deasphalted oil flash drum **46**. The resulting cooled first vapor phase, approaching the temperature of the partially vaporized first liquid phase in lines **41*a*, 41*b*** and **41*c***, is recovered via line **48** and, if necessary, after having been cooled in cooler **49** is introduced into deasphalting solvent storage tank **28** from which the resulting liquefied deasphalting solvent can be returned to deasphalting tower **26** via line **29**.

The partially vaporized first liquid phase introduced into deasphalted oil flash drum **46** via line **45** is separated into an overhead solvent vapor phase via line **51** comprising substantially only deasphalting solvent and a liquid oil phase via line **52** comprising substantially only deasphalted oil. The deasphalting solvent vapor phane in line **51** is cooled in cooler **54** and the resulting liquefied deasphalting solvent is passed via lines **55** and **56** into deasphalting solvent storage tank **58**.

The liquid asphalt deasphalting solvent mix leaving deasphalting tower **26** is passed via line **30** through a heater **59** and line **60** into asphalt flasher **61**. The resulting vaporized deasphalting solvent is removed overhead from asphalt flasher **61** via line **62** for introduction into deasphalted oil flash drum **46** for the eventual liquefaction and recovery of the deasphalting solvent as indicated hereinabove. There is removed from asphalt flasher **61** a liqued asphalt bottoms via line **64** which is introduced into asphalt stripper **65** for the removal overhead via line **66** of residual deasphalting solvent by the injection of high temperature, high pressure steam into asphalt stripper **65** via line **68**. The resulting steam stripped asphalt is removed as liquid bottoms from asphalt stripper **65** via line **69**.

The resulting admixture of steam and vaporized deasphalting solvent removed from asphalt stripper **65** via line **66** is introduced into the upper portion of deasphalted oil stripper **70** wherein it is admixed with the deasphalted oil bottoms removed from deasphalted oil flash drum **46** via line **52**. High pressure, high temperature steam is introduced into the lower portion of deasphalted oil stripper **70** via line **71** and there is removed overhead from oil stripper **70** via line **72** a vaporous admixture of deasphalting solvent and steam. This vaporous admixture is cooled in cooler **74** to a temperature sufficiently low to condense or liquefy substantially all of the deasphalting solvent and steam present in the admixture, e. g., cooled to a temperature about 100° F. and lower. The resulting cooled admixture is then introduced via line **75** into water separator **76** from which water condensate is removed via line **78** and the resulting condensed liquefied deasphalting solvent is removed via lines **79** and **56** into deasphalting solvent storage tank **58** for reuse in the deasphalting operation. If necessary or desired, the liquid deasphalting solvent in storage tank **58** can be employed via lines **80** and **81** to supplement the deasphalting solvent in deasphalting solvent storage tank **28**.

Referring now to the gas oil fraction recovered from atmospheric flasher **15** via line **19**, this gas oil fraction is introduced into topping still **82** where there is produced overhead via line **84** a 500° F. end point naphtha fraction particularly suitable as a catalytic cracking charge stock. The bottoms fraction recovered from topping still **82** via line **85** is combined therein with the gas oil fractions removed from vacuum still **21** via lines **22**, **24** and **95**.

The deasphalted oil recovered from deasphalted oil stripper **70** via line **86** after cooling in cooler **88** is introduced via line **89** into pretreater **90** wherein it is contacted with a liquid selective solvent for aromatic hydrocarbons, such as furfural. Pretreater **90** may be any suitable device for effecting liquid-liquid contact between the liquid selective solvent employed and the deasphalted oil being pretreated. Preferably pretreater **90** is an apparatus suitable for effecting continuous counter-current liquid-liquid contact, such as a packed tower, a centrifugal contactor or a rotating disc contactor. If desired, there may be blended or otherwise admixed with the deasphalted oil introduced via line **89** into pretreater **90** added deasphalting solvent introduced via line **80** into admixture with the deasphalted oil in line **89**. The deasphalted oil introduced via line **89** into pretreater **90** is contacted therein with a solvent extract mix comprising selective solvent, such as furfural, together with the dissolved hydrocarbons therein, which is recovered from solvent refining unit 91, described hereinafter, and introduced into pretreater 90 via line 92. The resulting deasphalted oil raffinate from pretreater 90 is recovered via line 94 and introduced into line 85 for introduction into selective solvent refining unit 91 in admixture with the bottoms fraction recovered from topping still 82 and the gas oil fractions removed from vacuum still 21 via lines 22, 24 and 95. If desired, liquid deasphalting solvent from deasphalting solvent storage tank 58 may be admixed via lines 80 and 96 with the pretreated deasphalted oil prior to introduction into selective solvent refining unit 91. Also, if desired, a portion of the deasphalted oil solvent mix recovered from deasphalting tower 26 via line 31 may be introduced via line 95 into line 85 for eventual admixture with the pretreated deasphalted oil in selective solvent refining unit 91.

The resulting extract effluent from pretreater 90 is recovered via line 98 and introduced into selective solvent recovery unit 99 wherein the selective solvent, e. g., furfural, is recovered and recycled to selective solvent refining unit 91 via line 100. The resulting separated extract is recovered from selective solvent refining unit 99 via line 101. Various selective solvents may be employed in selective solvent refining unit 91, these include furfural, phenols (Selecto), nitrobenzene, sulfur dioxide, β,β'-dichloroethyl ether (Chlorex), dimethyl formamide and other selective solvents for aromatic hydrocarbons.

The resulting admixture in line 85 comprising the bottoms fraction from topping still 82, the gas oil fractions from vacuum still 21, selective solvent pretreated deasphalted oil from pretreater 90 and, if desired, the liquid deasphalting solvent recovered from deasphalting solvent storage tank 58 via lines 80 and 96 or a portion of the deasphalted oil-deasphalting solvent mix recovered from deasphalting tower 26 via lines 31 and 95, is introduced into selective solvent refining unit 91 wherein it flows in liquid-liquid counter-current contact with a liquid selective solvent, such as furfural, which selectively dissolves or extracts the more aromatic hydrocarbons therefrom. As previously indicated, the resulting extract mix from selective solvent refining unit 91 comprising selective solvent and extracted hydrocarbons is recovered via line 92 and introduced into pretreater 90.

The aromatic type hydrocarbons contained in the extract mix introduced into pretreater 90 via line 92 and employed to contact and pretreat the deasphalted oil introduced thereinto via line 89 further increase the solvent power of the selective solvent for the metal-containing components in the deasphalted oil being thus pretreated and thus assist in the removal of these metal-containing components (the presence of which is undesirable in a catalytic cracking charge stock) from the deasphalted oil. Furthermore, since the concentration of the metal-containing components would be greater in the deasphalted oil than in the admixture in line 85 introduced into selective solvent refining unit 91 a greater overall degree of metals removal is possible. Also, the selective solvent contained in the deasphalted oil raffinate recovered from pretreater 90 via line 94 serves to predilute the deasphalted oil raffinate introduced in admixture with the gas oils and bottoms fraction via line 85 into selective solvent refining unit 91. This predilution of the feed to the selective solvent refining unit 91 increases the efficiency of the selective solvent refining operation therein. Still further, the deasphalted oil introduced into pretreater 90 via line 89 removes from the extract mix introduced thereinto via line 92 the lower molecular weight, more paraffinic hydrocarbons therein which may have been taken into solution in the extract mix during the refining of the combined feed admixture supplied to the selective solvent refining unit 91 via line 85. These more paraffinic materials are returned continuously to the selective solvent refining unit 91 and thus the overall yield of the raffinate recovered from selective solvent refining unit 91 via line 102 is increased. The contacting or scrubbing of the extract mix within pretreater 90 should result in a reduction in the quantity of the more paraffinic materials withdrawn from pretreater 90 as solvent effluent via line 98 and eventually removed from the system as extract suitable as cutter stock via line 101.

The raffinate removed from selective solvent refining unit 91 via line 102 having a reduced metals content, e. g., vanadium, nickel, copper, iron and similar heavy metals, in the range 0.2–5 p. p. m., after having been freed of its selective solvent content is combined via line 84 with the 500° F. end point naphtha fraction recovered from topping still 82 and introduced as feed stock to fluid catalytic cracking unit 104 where it is contacted with fluidized cracking catalyst.

A cracking catalyst usually comprises an oxide of metals of groups II, III, IV and V of the periodic table, for example, a silica-alumina catalyst containing about 5–30% by weight alumina. The average particle size of the cracking catalyst particles is usually below about 200 microns, a size sufficient to produce a dense fluidized bed of cracking catalyst.

The resulting cracked catalyst effluent from fluid catalytic cracking unit 104 is introduced via line 105 into fractionator 106 wherein it is fractionated into a catalyic cracked naphtha recovered via line 108, a catalytic cracked light gas oil recovered via line 109 and a relatively heavy cycle gas oil, e. g., FCCU decanted oil, recovered via line 110.

To the asphalt recovered from asphalt stripper 65 via line 69, which asphalt may have a ring and ball softening point in the range 180°–325° F., is added at least a portion of the gas oil fractions recovered from catalytic cracking fractionator 106 via lines 109, 110 and 111 and at least a portion of the selective solvent-free extract recovered from selective solvent recovery zone 99 via line 101, the resulting stream of combined catalytic cracked gas oils and selective solvent extract being added via line 111 as cutter stock to the asphalt in line 69.

If desired, at least a portion of the catalytic cracked light gas oil recovered from fractionator 106 via line 109 and/or the heavy gas oil or FCCU decanted oil recovered via line 110 are passed via lines 111 and 89 to pretreater 90 or in admixture via lines 112 and 85 to selective solvent refining unit 91 for the recovery of the more paraffinic constituents therefrom as raffinate via line 102 to provide additional catalytic cracking charge stock and for the eventual recovery of the more aromatic constituents therefrom as extract via line 101 as cutter stock. When the gas oil recovered from catalytic cracking fractionator 106, such as the FCCU decanted oil, possesses a relatively high metals content, e .g., more than about 30 p. p. m. heavy metals, the gas oils are preferably introduced via lines 111 and 89 as feed to pretreater 90 in order to reduce its metals content.

Pretreater 90 is operated at any suitable temperature and pressure for effecting liquid-liquid contacting and for the removal of the more aromatic components contained in the feed thereto. The operating conditions and solvent dosages employed within pretreater 90 are influenced to some extent by the composition of feed thereto and the type of selective solvent employed therein. In the instance where furfural is employed as the selective solvent pretreater 90 is operated at a solvent dosage in the range 75–250%, e. g., 125%, basis oil charge whereas selective solvent refining unit 91, employing the same solvent (furfural), might be operated at a relatively lower solvent dosage in the range 10–100%, e. g., about 25%, basis oil charge thereto. By operating in accordance with this feature of the invention the yield of recoverable catalytic cracked naphtha is further increased.

Cutback product asphalt is recovered via line **114**. Desirably, however, especially when a heavy crude such as a San Ardo, California, crude is the source of the reduced crude introduced into the above-described operations via line **11**, the asphalt in line **69**, prior to the addition of cutter stock thereto via line **111**, is subjected to vis-breaking as indicated by asphalt vis-breaker **115** in the drawing and the cutter stock added to the resulting vis-broken asphalt via line **111***a*. The resulting cutback vis-broken asphalt is then removed as product via line **118**. Desirably a portion of the combined stream employed as cutter stock in line **111** is admixed via line **116** with the solvent asphalt mix recovered from deasphalting tower **26** via line **30** prior to introducing the same into asphalt heater **59**. This addition of cutter stock to the asphalt deasphalting solvent mix prior to introduction into asphalt heater **59** is desirable in order to alleviate coke deposition and reduce cracking which might otherwise occur within the furnace heating tubes and upon the heated surfaces within the asphalt-deasphalting solvent recovery system.

The following is illustrative of the practice of this invention. A mixture comprising California crude was atmospherically distilled to about 50–55% volume reduced crude based on the original crude mixture and charged through a heater operated under mild viscosity breaking conditions at an outlet temperature of 850° F. The resulting mildly viscosity broken reduced crude was introduced into an atmospheric flasher from which was recovered overhead approximately 46% total volume yield of gas oil, naphtha and atmospheric viscosity broken gas oil, basis reduced crude, in the following amounts: gas 1% volume; 430° F. end point naphtha 3.5% volume; gas oil 41.5% volume, the atmospheric flasher being operated at a maximum temperature of about 790°–800° F. The atmospheric flasher bottoms having a gravity of about 12° A. P. I. and a Conradson carbon residue of about 15 was introduced into a vacuum still operated at about 25 mm. Hg at a temperature of 665° F. There was recovered overhead from the vacuum still gas oil fractions amounting to about 42% by volume of the vacuum still charge and a heavy bottoms fraction amounting to about 16% by volume basis original crude mixture or about 33.8% volume basis reduced crude. The vacuum still bottoms had a gravity of about 3.6° A. P. I., a penetration (100 gm./5 sec./77° F. cm.$\times 10^{-2}$) in the range 27–29 and a Conradson carbon residue in the range 26–33.

Portions of the above-identified vacuum still bottoms were solvent deasphalted with liquid isobutane as the deasphalting solvent, employing a solvent:oil volume ratio of 5:1 at various temperatures in the range 200°–275° F. and at a pressure in the range 200–500 p. s. i. g. The results of these operations are set forth in accompanying Table No. I.

Table No. I

Solvent	Deasphalting		Deasphalted oil				
	Temp., ° F.	Press., p.s.i.g,	Yield, weight percent	Carbon residue, percent	P.p.m. Fe	P.p.m. Ni	P.p.m. V
Charge	------	------	------	26	80	150	350
Isobutane	200	230	46.0	5.9	6	11	9
Do	235	335	40.1	5.0	6	8	5
Do	245	385	42.0	4.1	------	------	------
Do	270	475	35.6	3.0	8	3	3

There was directly recovered from a deasphalting operation carried out in the manner described hereinabove a liquid deasphalting solvent-deasphalted oil mix containing deasphalted oil and isobutane at a temperature of about 248° F. and at a pressure of about 390

p. s. i. g.; there was also directly recovered a liquid deasphalting solvent-asphalt mix containing asphalt and liquid isobutane at about the same aforesaid temperature and pressure. The liquid deasphalted oil-isobutane mix leaving the deasphalting operation at a pressure of about 390 p. s. i. g. was partially vaporized by passage through an expansion valve to yield a first vapor phase at a temperature of about 190° F. and at a pressure of at least about 175 p. s. i. g., e. g., about 210 p. s. i. g., and a first liquid phase at substantially the same temperature and pressure as said first vapor phase. The first liquid phase is then partially vaporized by passage through an expansion valve to yield a partially liquefied admixture containing deasphalted oil and vaporous isobutane at a temperature of about 145° F. and at a pressure of at least about 75 p. s. i. g., preferably about 100 p. s. i. g. The resulting vaporous admixture is then passed in indirect heat exchange relationship with said first vapor phase to yield a resulting relatively cooled first vapor phase at a temperature in the range 190°–200° F. (at a pressure about 205 p. s. i. g.) whereby the isobutane deasphalting solvent in said first vapor phase is condensed and liquefied or is readily condensed and liquefied by supplemental cooling to a temperature of about 190° F. the pressure in the resulting cooled first vapor phase being at least about 160 p. s. i. g. and higher if necessary in order to effect liquefaction of the isobutane deasphalting solvent. The resulting admixture of liquid deasphalted oil and vaporous isobutane derived from first said liquid phase, after having been passed in indirect heat exchange relationship with said first vapor phase, now at a temperature of about 160° F. and is passed to a gas liquid separator from which there is recovered overhead, at a pressure of about 100 p. s. i. g., vaporous isobutane which is liquefied and condensed by cooling to a temperature of about 126° F. at a pressure of at least about 95 p. s. i. g. The separated deasphalted oil is then steam stripped to effect substantially complete removal of isobutane therefrom and the resulting steam stripped isobutane is recovered by cooling the effluent resulting from the steam stripping operation to a temperature of about 90°–100° F., more or less, at a pressure of at least about 50 p. s. i. g., preferably above about 75 p. s. i. g. and at least sufficient to effect liquefaction of the deasphalting solvent at said temperature, and passed to storage at a temperature of about 126° F. at a pressure of about 95 p. s. i. g.

The deasphalted oil recovered from a solvent recovery operation described hereinabove has a gravity in the range 15.3°–16.8° A. P. I., a viscosity SUS 210° F. in the range 238–281 and a K factor of about 11.7.

The liquid asphalt deasphalting solvent mix phase containing asphalt admixed with isobutane, after the addition of an amount of cycle gas oil cutter stock, is passed to the asphalt heater and heated to a temperature of about 500° F. at a pressure of about 100 p. s. i. g. The resulting heated asphalt-isobutane stream was passed to an asphalt separator from which there is recovered overhead vaporous isobutane which is admixed with vaporous isobutane from the deasphalted oil flash drum, from which admixture liquid isobutane is condensed by cooling the resulting vaporous stream to a temperature of about 126° F. at a pressure preferably at least about 100 p. s. i. g. The liquid asphalt bottoms recovered from the asphalt separator is then steam stripped for the removal of any residual isobutane and recovered as a product. There was recovered from the aforementioned operations an asphalt having a ring and ball softening point in the range 200°–300° F.

A high boiling petroleum fraction comparable to the deasphalted oil recovered from the asphalt deasphalting operation is subjected to liquid-liquid contact with furfural solvent extract mix at a solvent dosage in the range 100–200% volume, e. g., 125%, basis oil charge, the furfural solvent extract mix having been derived from the furfural solvent refining of the resulting deasphalted oil raffinate in admixture with VPS gas oil, said subsequent furfural refining being carried out at a solvent dosage in the range 15–75%, basis oil charge. The raffinate resulting from the subsequent furfural refining operation possesses a significantly lower metals content, substantially below 30 p. p. m., in the range 5–20 p. p. m. and lower.

It is also advantageous in the practice of this invention to carry out the subsequent solvent refining operation and/or the selective solvent pretreatment of the deasphalted oil in the presence of a substantial amount of a light liquid hydrocarbon, such as the deasphalting solvent, in an amount in the range 10–200% volume, more or less, based on the deasphalted oil charged to the pretreater or to the selective solvent refining unit. By so operating the metals content of the resulting raffinate (selective solvent refined deasphalted oil) is further reduced, e. g., below about 5 p. p. m. The advantages of carrying out a solvent refining operation in the presence of a liquid low molecular weight hydrocarbon, e. g., deasphalting added thereto or present in the deasphalted oil due to the incomplete removal of deasphalting solvent therefrom is more completely set forth in copending, coassigned patent application Serial No. 547,638, filed November 18, 1955. Also the advantages of carrying out a solvent refining operation by pretreating a deasphalted oil by contact with a solvent extract mix and then subjecting the resulting pretreated deasphalted oil to contact with fresh selective solvent in a selective solvent refining unit in order to produce a suitable catalytic cracking charge stock is more completely set forth in copending, coassigned patent application Serial No. 556,495, filed December 30, 1955. The disclosures of the above-referred patent applications are herein incorporated and made part of this disclosure.

As will be apparent to those skilled in the art in the light of the foregoing disclosure, many substitutions, changes and alterations are possible in the practice of this invention without departing from the spirit or scope thereof.

I claim:

1. A method of treating an asphaltic oil which comprises contacting said oil with a deasphalting solvent under deasphalting conditions of temperature and pressure to effect separation of asphaltic constituents from said oil, recovering from the aforesaid operation a liquid oil phase having a reduced amount of asphaltic constituents and containing a portion of said deasphalting solvent and a liquid asphalt phase containing another portion of said deasphalting solvent, treating said liquid oil phase to produce a resulting first liquid phase and a resulting first vapor phase comprising deasphalting solvent at a temperature T_1 and at a pressure P_1, treating said first liquid phase to convert the same to a resulting second liquid phase and a resulting second vapor phase comprising deasphalting solvent at a temperature T_2 and a pressure P_2, T_2 being lower than T_1 and P_2 being lower than P_1, passing said first vapor phase and second vapor phase in indirect heat exchange relationship to each other whereby the temperature of said first vapor phase is reduced such that the vapor pressure of the deasphalting solvent therein is substantially reduced, condensing deasphalting solvent from said first vapor phase, heating said liquid asphalt phase to produce a third vapor phase comprising deasphalting solvent and a third liquid phase comprising asphalt, admixing said third vapor phase with said second vapor phase after said second vapor phase has been passed in indirect heat exchange relationship with said first vapor phase, recovering the resulting combined second and third vapor phases and cooling the resulting combined second and third vapor phases to a temperature sufficiently low to condense the deasphalting solvent therein.

2. A method of treating an asphaltic oil which comprises contacting said oil with a deasphalting solvent under deasphalting conditions of temperature and pressure to effect separation of asphaltic constituents from said oil, recovering from the aforesaid operation a liquid oil phase having a reduced amount of asphaltic constituents and containing a portion of said deasphalting solvent and a liquid asphalt phase containing another portion of said deasphalting solvent, treating said liquid oil phase to produce a resulting first liquid phase comprising deasphalting solvent and a resulting first vapor phase comprising deasphalting solvent at a temperature T_1 and a pressure P_1, treating said first liquid phase to convert the same to a resulting second liquid phase and a resulting second vapor phase comprising deasphalting solvent at a temperature T_2 and a pressure P_2, T_2 being lower than T_1 and P_2 being lower than P_1, passing said first vapor phase and said second vapor phase in the presence of said second liquid phase in indirect heat exchange relationship to each other whereby said first vapor phase is reduced to a temperature such that the vapor pressure of the deasphalting solvent is substantially reduced, condensing deasphalting solvent from said first vapor phase, heating said liquid asphalt phase to produce a third vapor phase comprising deasphalting solvent and a third liquid asphalt phase, admixing said third vapor phase with said second vapor phase in the presence of said second liquid phase after said second vapor phase has been passed in indirect heat exchange relationship with said first vapor phase, recovering from the aforesaid admixing operation the resulting combined second and third vapor phases and said second liquid phase, cooling the resulting combined second and third vapor phases to a temperature sufficiently low to condense the deasphalting solvent therein, steam stripping the recovered second liquid phase to remove substantially all of said deasphalting solvent therefrom and recovering from the aforesaid steam stripping operation said second liquid phase comprising a deasphalted oil substantially free of deasphalting solvent.

3. A method of treating an asphaltic oil which comprises contacting said oil with a deasphalting solvent under deasphalting conditions of temperature and pressure to effect separation of asphaltic constituents from said oil, recovering from the aforesaid operation a liquid oil phase having a reduced amount of asphaltic constituents and containing a portion of said deasphalting solvent and a liquid asphaltic phase comprising another portion of said deasphalting solvent, treating said liquid oil phase to produce a resulting first liquid phase comprising deasphalting solvent and a resulting first vapor phase comprising deasphalting solvent at a temperature T_1 and a pressure P_1, treating said first liquid phase to convert the same to a resulting second liquid phase and a resulting second vapor phase comprising deasphalting solvent at a temperature T_2 and a pressure P_2, T_2 being lower than T_1 and P_2 being lower than P_1, passing said first vapor phase and said second vapor phase in the presence of said second liquid phase in indirect heat exchange relationship to each other whereby said first vapor phase is reduced to a temperature such that the deasphalting solvent therein is condensed, recovering the resulting condensed deasphalting solvent, heating said liquid asphalt phase to produce a third vapor phase comprising deasphalting solvent and a third liquid phase, admixing said third vapor phase with said second vapor phase in the presence of said second liquid phase after said second vapor phase has been passed in indirect heat exchange relationship with said first vapor phase, separately recovering from the aforesaid admixing operation the resulting combined second and third vapor phases and said second liquid phase, cooling the resulting combined second and third vapor phases to a temperature sufficiently low to condense the deasphalting solvent therein, steam stripping said third liquid phase to re-

move substantially all of said deasphalting solvent therefrom and to produce overhead a fourth vapor phase comprising steam and deasphalting solvent, steam stripping the recovered second liquid phase to remove substantially all of said deasphalting solvent therefrom and to produce overhead a fifth vapor phase comprising steam and vaporized deasphalting solvent, recovering from the immediate aforesaid steam stripping operation said second liquid phase comprising a deasphalted oil substantially free of deasphalting solvent, admixing said fourth and fifth vapor phases and cooling the resulting combined vapor to a temperature sufficiently low to condense the steam and deasphalting solvent contained in said admixed steam and separately recovering the resulting condensed deasphalting solvent and condensed steam.

4. In a process wherein an asphaltic oil is treated with a deasphalting solvent under deasphalting conditions of temperature and pressure to separate asphaltic constituents from said oil and wherein there is recovered from the aforesaid deasphalting operation a liquid deasphalting solvent-oil mix containing deasphalted oil and deasphalting solvent, the deasphalting solvent being subsequently separated therefrom and liquefied, the improvement which comprises passing said deasphalting solvent-oil mix into a low pressure zone to produce a first vapor phase comprising deasphalting solvent and a first liquid comprising deasphalted oil and deasphalting solvent, passing said first liquid phase into a lower pressure zone to yield a second vapor phase comprising a deasphalting solvent at a temperature lower than said first liquid phase and a second liquid phase containing deasphalted oil, passing said first vapor phase in indirect heat exchange relationship with said second vapor phase to substantially reduce the temperature of said first vapor phase to produce a resulting first vapor phase substantially saturated with respect to said deasphalting solvent and recovering liquefied deasphalting solvent resulting from said first vapor phase.

5. A process in accordance with claim 4 wherein said deasphalting solvent comprises isobutane.

6. A process in accordance with claim 4 whereby the pressure differential between said lower pressure zone and said low pressure zone is in the range of 50–200 p. s. i. g.

7. A process in accordance with claim 4 wherein the temperature of said resulting first vapor phase is in a range 20–60 degrees Fahrenheit lower than first said vapor phase.

8. A method in accordance with claim 4 wherein the temperature of said first vapor phase after heat exchange is reduced to a value so that substantially all of the deasphalting solvent therein is liquefied.

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