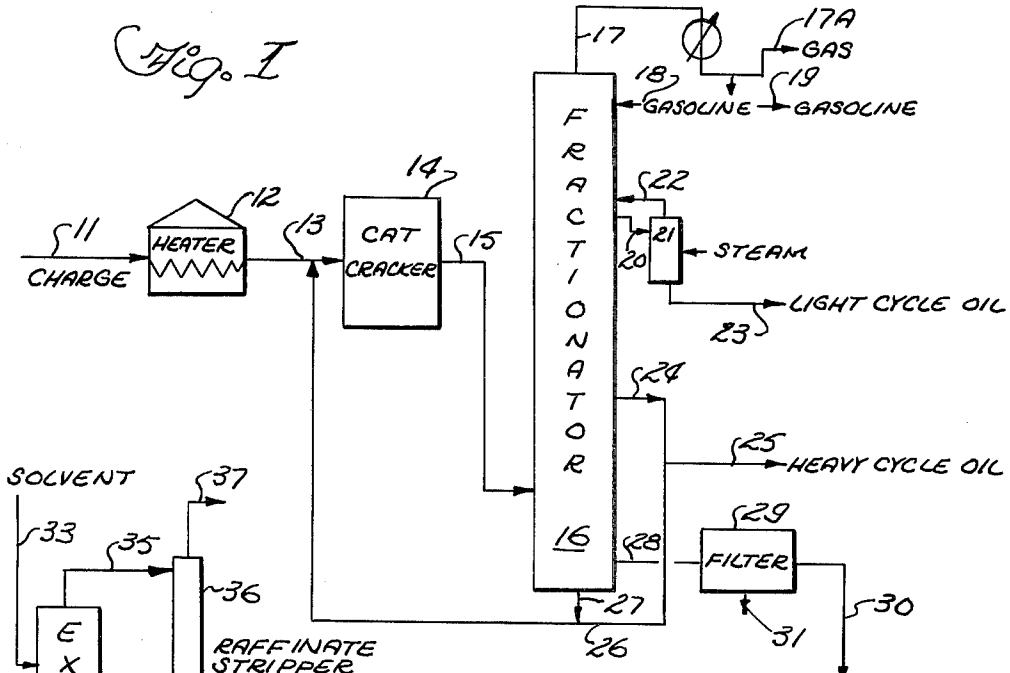
April 19, 1966 J. W. CONWELL 3,247,096

HYDROCARBON CONVERSION PROCESS TO PRODUCE LUBRICATING OILS AND WAXES

Filed Nov. 5, 1963 3 Sheets-Sheet 1

Fig. I



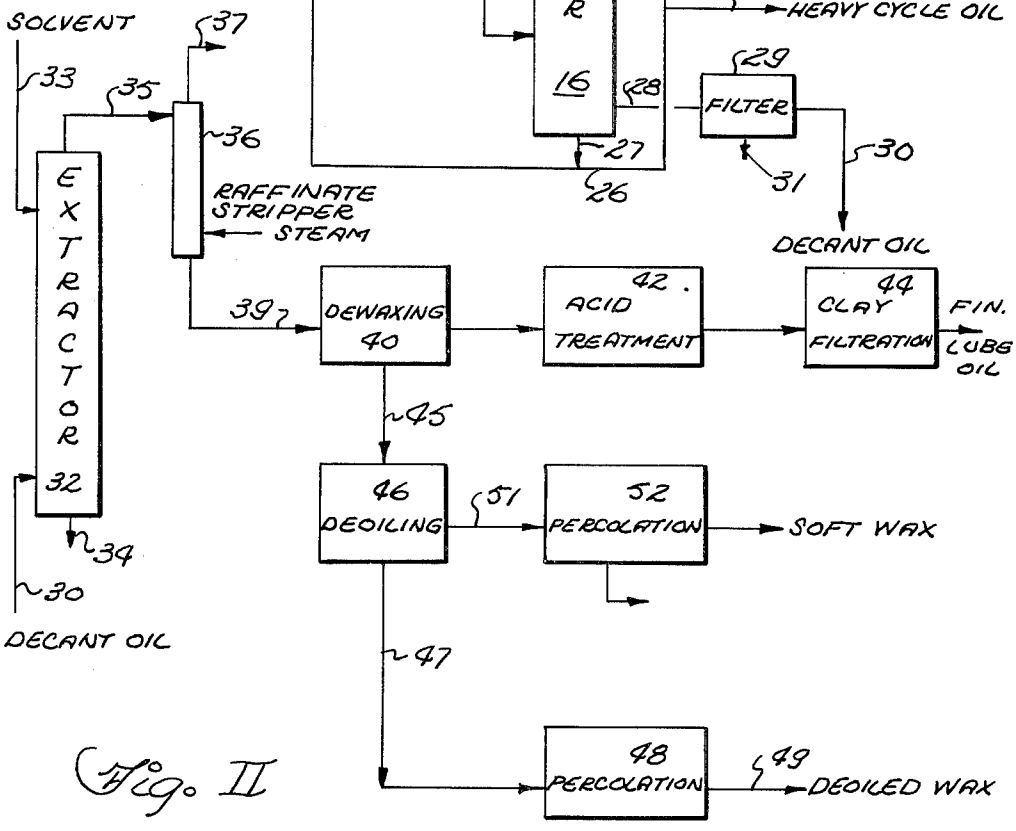


Fig. II

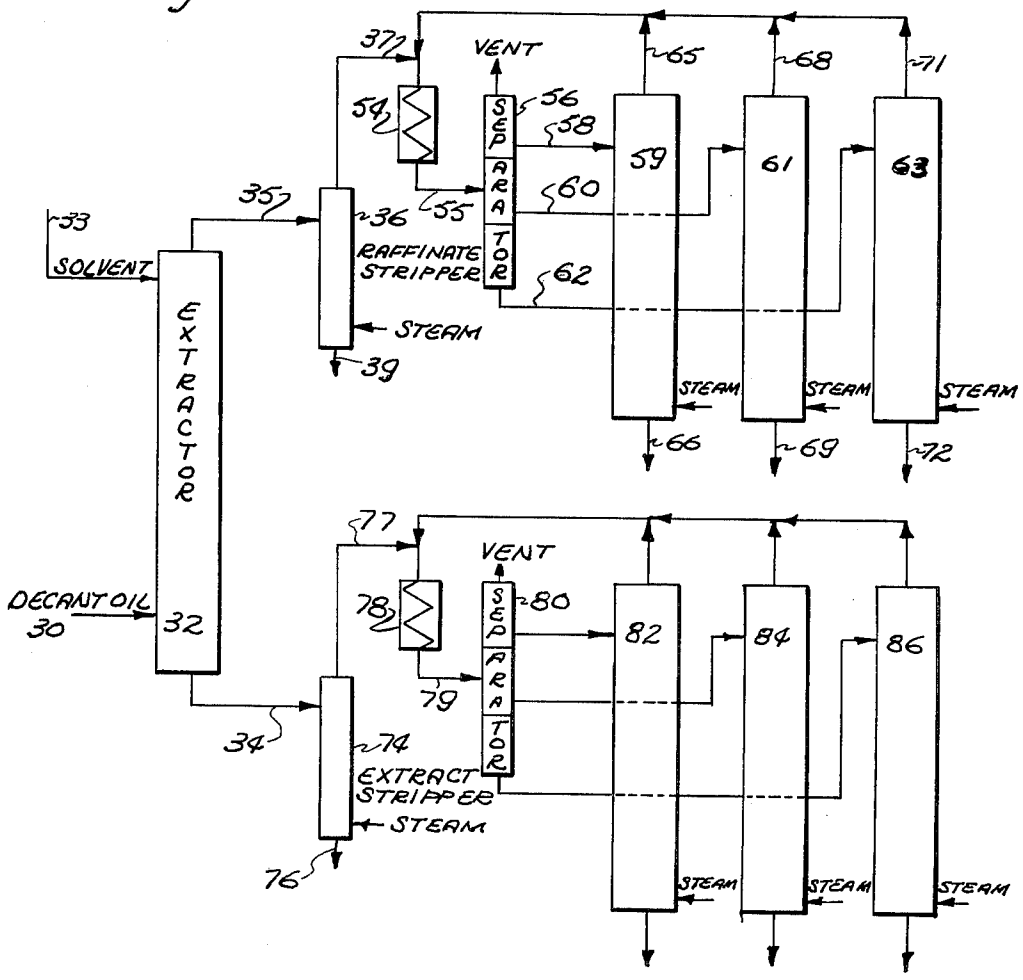
INVENTOR.
John W. Conwell
BY
Pendleton, Neuman, Seibold & Williams
Atty's

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HYDROCARBON CONVERSION PROCESS TO PRODUCE LUBRICATING OILS AND WAXES

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Fig. III



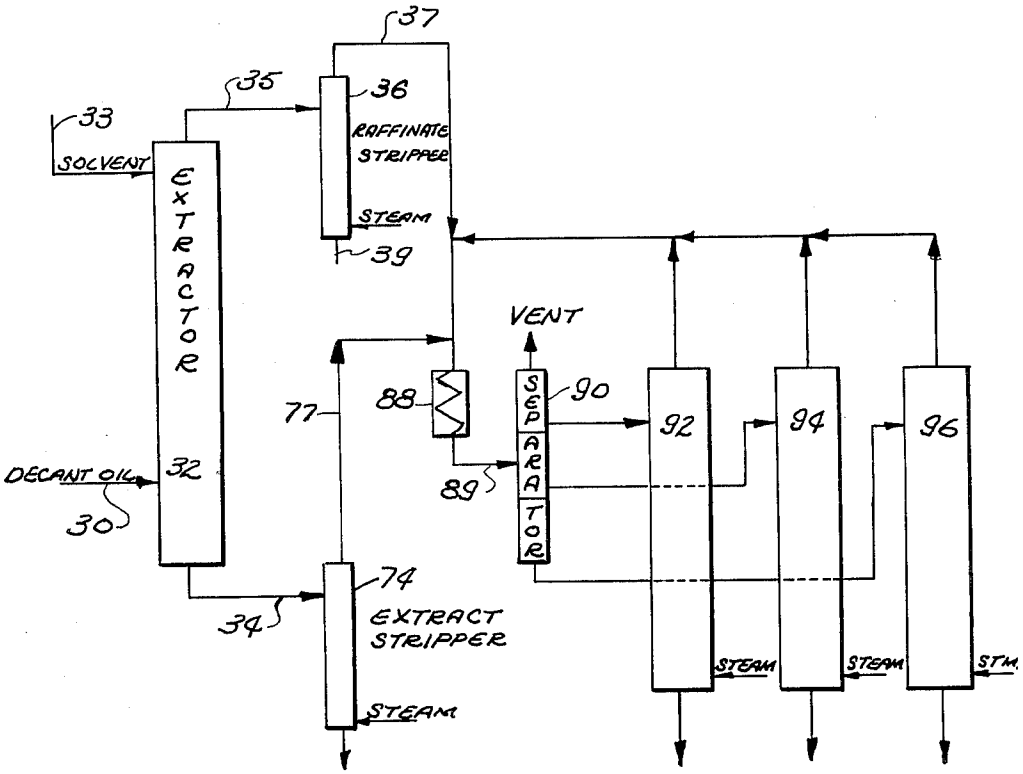
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HYDROCARBON CONVERSION PROCESS TO PRODUCE LUBRICATING OILS AND WAXES

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Fig. IV



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3,247,096

HYDROCARBON CONVERSION PROCESS TO PRODUCE LUBRICATING OILS AND WAXES

John W. Conwell, Tulsa, Okla., assignor to Sunray DX Oil Company, Tulsa, Okla., a corporation of Delaware

Filed Nov. 5, 1963, Ser. No. 321,647

10 Claims. (Cl. 208—96)

This invention relates in general to the conversion of petroleum oils to produce therefrom lubricating oils and petroleum waxes of high quality. More specifically, the invention relates to the production of high quality lubricating oils and petroleum waxes from hydrocarbon stocks resulting from petroleum catalytic cracking operations.

The initial processing of crude petroleum oil in a modern oil refinery is more or less standardized. The crude oil is generally first subjected to distillation at relatively low pressure with fractionation of the crude oil to produce gas, light naphtha, heavy naphtha, kerosine, and/or jet fuel, distillates, and light gas oils, as the principal products. The reduced crude can then be subjected to further reduction by distilling it, usually under vacuum, to produce gas oils of various distillation ranges. These gas oils, in part, may be used for lubricating oil and wax manufacture or may be catalytically cracked to produce additional quantities of fuels boiling in the gasoline and distillate boiling ranges. The residual crude from the vacuum distillation operation may be employed for lubricating oil manufacture or it may be used as charge stock to a coking reactor unit.

In the modern integrated oil refinery, those materials from crude oil not valuable as products are generally eventually processed into products by either catalytic cracking or coking. The feasibility of a charge stock for catalytic cracking is based to large extent on the carbon lay-down on the catalyst that occurs during the catalytic cracking operation. The carbon deposited on the catalyst not only reduces the conversion efficiency of the catalyst, but the deposit must be removed from the catalyst during the regeneration of the catalyst. Usually the regeneration capacity of a catalytic cracking unit limits the hydrocarbon charge to the unit. For this reason, charge stocks for the catalytic cracker are generally chosen not only on their conversion potential, but also on their coke lay-down propensities. Generally materials from crude oil not suitable for sale or processing in the catalytic cracker due to the above deficiencies are charged to a delayed coking unit for conversion into coke and ancillary products therefrom.

The catalytic cracking operation is generally carried out under drastic conditions utilizing temperatures of from about 900° to 1050° F. to produce volatilizable products such as gas, gasoline, distillates and gas oil. The catalyst used is of such composition, physical and chemical, that on contact with the hydrocarbon stock as a vapor at high temperature a change in molecular composition occurs. Predominant in this change is the formation of aromatic compounds which can be controlled by

choice of catalyst and operating conditions. These aromatic compounds that are formed up-grade the resultant products sufficiently to warrant this type of processing.

As a consequence, the exigencies of a modern integrated refining operation require that the catalytic cracking operation be flexible in order to charge those stocks for this service as they become available due to internal product and stream manufacture along with local marketing and storage requirements. Under such conditions, many potentially marketable products may not be so processed, but will be catalytically cracked due to absence of an immediate market or storage facilities. As a consequence, the charge stock composition to a catalytic cracker varies from day to day. A typical charge stock to a catalytic cracker in a modern integrated refinery may have the following composition:

	Vol., percent
Crude unit, light gas oil	60
Crude unit, waxy lube stocks	18
Lube stocks, extracts	2
Coker, gas oils and distillates	20
Total	100

It has been found that high quality lubricating oils and petroleum waxes can be produced from certain distillate hydrocarbon fractions resulting from the catalytic cracking of petroleum stocks. The present invention is, therefore, directed to a process for producing lubricating oils and waxes from distillate fractions produced from a catalytic cracking operation thereby advantageously utilizing hydrocarbon materials in a novel manner rather than disposing of them as residual fuel oil stocks as is customary practice.

According to the present invention, distillates from a catalytic cracking operation boiling in the lubricating oil range and specifically the hydrocarbon fraction known as decant oil are separated and processed to produce high viscosity index lubricating oils and petroleum waxes of novel properties. The processing of the lubricating oils include the steps of solvent refining, solvent dewaxing and, if desired, can include the steps of acid treating and clay contacting.

Normally decant oil, the gas oil used in this invention, has a low gravity in the range of 0 to 20 API. As such, its marketability has heretofore generally been limited to such uses as No. 6 fuel oil and/or carbon black charge stock. The prices obtained for decant oil when sold for these purposes are well below the price of the original crude oil from whence the decant oil is eventually obtained. As a consequence, the marketing of decant oil is generally economically unattractive and must be offset by the prices obtained for the other products obtained by catalytic cracking. According to the present invention, decant oil is advantageously employed to produce high quality lubricating oils and waxes thus affording an economically advantageous use for decant oil.

Under severe catalytic cracking conditions, hydrocarbon molecules charged to the catalytic cracker are trans-

formed into other molecular configurations with the result that products surviving or resulting from this severe molecular cataclysm have high thermal and atmospheric stabilities. The catalytic cracking operation produces either a lower free energy product such as an aromatic or by thermal decomposition retains or forms in the decant oil waxes and lubricating oil stocks that are exceedingly thermally stable.

One important characteristic of a lubricating oil indicative of quality is its viscosity index; that is, the resistance of the oil to change in viscosity with change in temperature. As a general rule, in the petroleum industry commercial lubricating oils must have a viscosity index of 95 or higher to be considered satisfactory high viscosity index lubricating oils. In accordance with the invention, lubricating oils having viscosity indices of 95 or higher can be consistently produced in high yields from certain distillate fractions resulting from a catalytic cracking operation. Moreover, the lubricating oils produced by the process of the invention have outstanding oxidation stability and are superior to conventional lubricating oils for service where high temperatures and oxidation conditions coexist. In addition to the high quality lubricating oils, the process of the invention provides petroleum waxes having melting points generally in the range of 122° to 132° F. and which are eminently satisfactory for all uses for which such petroleum waxes are normally employed.

The manner of carrying out the process of the present invention as well as the advantages thereof will be more readily understood from the following description in conjunction with the accompanying drawings in which:

FIGURE I is a schematic flow diagram showing diagrammatically the catalytic cracking of a charge stock and fractionation of the catalytic cracking distillate in accordance with the present invention;

FIG. II is a schematic flow diagram showing the refining of the decant oil resulting from catalytic cracking to produce lubricating oils and waxes in accordance with the invention;

FIG. III is a diagrammatic flow diagram showing steps concerned with the recovery of extraction solvents employed in the process of the invention;

FIG. IV is a diagrammatic showing of an alternate solvent recovery processing sequence.

Referring to FIGURE I, a catalytic cracking charge stock such as that described above is passed through line **11** into heater **12**. After being heated in heater **12**, the charge passes through line **13** into the catalytic cracker **14**. The catalytic cracker is maintained at a temperature of about 900 to about 1050° F., preferably about 960° F. and a pressure of about 10 to 50 p.s.i.g., preferably 23 p.s.i.g. Under these conditions, the hydrocarbons in the charge stock are catalytically cracked. The effluent vapors from the catalytic cracker **14** pass through line **15** to the fractionator **16**. Fractionator **16** is operated at suitable conditions so as to separate a gas stream, gasoline, a relatively light cycle oil, a heavy cycle oil, a decant oil boiling substantially in the lubricating oil boiling range which is further processed in accordance with the present invention.

Thus, for example, fractionator **16** is operated at 13.5 p.s.i.g. and the fractionator top temperature is maintained at 278° F. to take overhead through line **17** a gas and gasoline fraction. The gasoline in this fraction can be condensed and either returned to the fractionator **16** as reflux through line **18** or discharged through line **19** as product gasoline. The non-condensable hydrocarbon gases are discharged through line 17A. A light catalytically cracked cycle oil stream is removed at 458° F. from the fractionator through line **20** and is stripped with steam in a stripper **21** with the overhead therefrom being returned to the fractionator **16** through line **22**. The product, a light cycle oil stripped to flash specification is discharged through line **23**.

A heavy cracked cycle oil is removed from the fractionator **16** at 590° F. through line **24**. It may be removed as a product via line **25** or recycled back to the catalytic cracker **14** through line **26** in which it may be commingled with fractionator bottoms from line **27**.

A small amount of catalyst employed for catalytic cracking is entrained in the vapors from the catalytic cracker **14** and these catalyst fines gradually accumulate in the lower section of the fractionator **16**. These are slurried in line **27** and are returned to the catalytic cracker **14** through line **26**. The lowest side stream from the fractionator **16**, withdrawn through line **28** at a temperature of about 690° F., is a gas oil from which most of the catalyst fines have been removed by decanting. This stream is designated decant oil and is the stream employed in accordance with the invention. A filter **29** is needed to remove the trace quantities of catalyst and the filtered decant oil is passed through line **30** for further processing in accordance with this invention. Catalyst fines are removed from the filter **29** through line **31**.

The operation of a catalytic cracking unit is very complicated. In order to obtain maximum yields of saleable and profitable products such as gasoline and light cycle oil (#2 Fuel Oil), much of the heavy catalytic cracker gas oil (line **25**) is recycled back to the catalytic cracking unit. The greater the quantity of heavy catalytic cracker gas oil (**25**) that is recycled, the larger will be the percentage yield of gasoline and light catalytic cycle oil. It is often practical in certain market situations to recycle all heavy catalytic cycle gas oil (line **25**) to extinction. When this occurs, the product or stream distribution of the bottom of the fractionator **16** changes. As a consequence, more of the above described decant oil (line **28**) is withdrawn as heavy cycle oil through line **25**. This in turn decreases the gravity of the decant oil. For this reason, the composition of the decant oil in line **28** is very closely allied with the recycle processing sequence of the catalytic cracker operation. This invention is concerned in a preferred embodiment with processing a decant oil having an API gravity in the range of 0 to 20 and most preferably a decant oil having a gravity of from about 8 to 13. The boiling range of the decant oil employed is such that it is in the lubricating oil range, that is, more than about 90% thereof boils above about 550° F. The quantity of high quality lubricating oil and wax present in the decant oil increases as the API gravity of the decant oil is increased. As a consequence, the catalytic cracking operation and this invention are integral in respective to operation of one and the other.

The filtered decant oil withdrawn through line **30** is processed to a finished lubricating oil by a series of refining treatments including solvent extraction, solvent dewaxing, acid treating and clay treating. The decant oil is conveniently subjected to refining with a solvent such as furfural, sulfur dioxide, dimethylsulfoxide, chlorex or phenol, to remove cyclic and olefinic and other desired compounds present in the oil in order to thereby improve the viscosity index of the oil. A preferred solvent for this purpose is furfural. The refining process admits of flexibility and the decant oil may or may not be dewaxed prior to the solvent extraction step depending upon the type of solvent and the conditions employed in the solvent extraction. As is known in the art, with some solvents, miscibility of the separated oil is such that phase separations may occur at temperatures which necessitate dewaxing the oil before solvent extraction, while with other solvents miscibility occurs at temperatures sufficiently high so that it is not necessary to dewax prior to the solvent extraction operation.

A typical decant oil utilized according to the present invention to produce lubricating oils and waxes has the

following inspection in comparison to a typical catalytic cracker charge stock:

	Catalytic cracker charge stock	Decant oil	Catalytic cracking conditions
Physical Tests:			
Gravity, ° API	30.2	12.8	960° F.
Flash, COC, ° F	230	305	23 p.s.i.g.
Pour point, ° F	+70	+80	
Viscosity, SSU at 100° F	69.0	225.0	
Distillation, D-1160, ° F:			
IBP	325	394	
5% Distilled	525	536	
10% Distilled	560	616	
50% Distilled	697	786	
90% Distilled	906	949	

The decant oil leaving the filter 29 via line 30 is conveyed to a solvent extraction zone 32 wherein the decant oil is subjected to contact with a solvent exerting a selective solvent action principally towards aromatic and olefinic constituents. Solvent extraction zone 32 comprises a conventional countercurrent contacting unit to which a solvent such as furfural is introduced at a point near the top thereof as through line 33. While the contacting of the solvent and oil may be conducted in any desired contacting equipment of a batch or continuous nature, countercurrent treating technique is preferably employed with wide variation in operating conditions such as temperatures, solvent/oil ratios, etc., as is known to the art. Extracting tower 32 is provided with packing, perforated plates, rotating discs or equivalents, to secure effective liquid-liquid contacting. The oil passes upwardly through the tower while the solvent passes downwardly through the tower, permitting removal from the bottom of the tower of what is known as an extract phase through line 34. The extract phase will consist principally of the solvent such as furfural together with the constituents selectively extracted from the oil consisting principally of aromatic and olefinic hydrocarbons. This extract generally has an API gravity of from about 0 to −5 and is useful as a feed for carbon black or petrochemical manufacture after removal of solvent therefrom.

The material withdrawn from the top of tower 32 through line 35 is known as the raffinate phase and consists principally of the initial decant oil feed minus the aromatic and olefinic constituents originally present therein, admixed with small proportions of the solvent employed during the contacting. The raffinate is passed to a raffinate stripping column 36 wherein residual solvent is driven overhead through line 37 while the solvent refined lubricating oil product is removed as a bottoms product through line 39. The oil stream of line 39 derived as indicated is then conducted to suitable dewaxing facilities identified by rectangle 40 on the drawing. The operation conducted in zone 40 can be chosen from any of the conventional dewaxing processes of a nature to reduce the wax content of the hydrocarbon fraction treated to any desired extent. In general, it is preferred that a solvent dewaxing operation be employed. One commercial solvent dewaxing process is the "ketone dewaxing process." While other ketones may be employed in this process it has been the general practice to employ methyl ethyl ketone (in admixture with aromatics such as toluene) as the solvent so that the process has generally been known as the methyl ethyl ketone, or "MEK dewaxing process." Commercial MEK dewaxing processes simply require the addition of a suitable quantity of the MEK solvent to the oil to be dewaxed so as to permit complete solution of all wax present in the oil when the mixture is heated. After the wax has been dissolved, upon cooling the mixture of oil and ketone, the wax is precipitated and is removed from the oil by filtration. In a preferred manner of dewaxing, the waxy oil is diluted with some solvent (primary) and is cooled, then additional solvent (secondary) is added on further cooling, and the resultant wax crystals separated from the dewaxed oil by filtration and washed with solvent. Typical preferred dewaxing conditions are as follows:

Primary solvent/charge oil ratio	0.75/1
Secondary solvent/charge oil ratio	1.25/1
Wash solvent/charge oil ratio	1.10/1
Filtration temperature, ° F.	−15
Solvent, MEK/toluene, vol. percent	45/55

Following dewaxing at 40 the solvent refined, dewaxed, lubricating oils are subjected to acid treating at 42 and clay filtered at 44 to a finished lubricating oil status by procedures known in the art. Acid treating at the zone identified by rectangle 42 is employed to improve the color, stability and resistance to oxidation of the oils and consists, for example, in treating the dewaxed oil with eleven pounds of 93% sulfuric acid per barrel of oil at a temperature of around 105° to 110° F. After removing the resultant sludge, the acid treated oil is contacted with a small amount of water (0.1 to 0.2% by weight) in order to coagulate any pepper sludge which is then removed on settling. The washed oil is then contacted or filtered with adsorbent clay or bauxite (for example 8000 gallons oil/1 ton clay) at zone 44 to further improve the color and to neutralize the oil after acid treating. Inspection of two typical finished lubricating oils produced by the process of the present invention is as follows:

Physical Tests	Finished lubricating stock #1	Finished lubricating stock #2	Treatment
Gravity, ° API	31.8	33.8	11 lbs. acid/ bbl. 8000 gal./ton clay.
Flash, ° F. COC	375	395	
Cold test, ° F	+6	+4	
Viscosity, SSU at 100° F	105.1	109.3	
Viscosity index	106.4	110.5	
Color, ASTM D-1500	3.5	L 2.5	

It will be observed that the finished lubricating oils have viscosity indices of 106.4 and 110.5, indicating that the process of the invention is operative to provide high viscosity index lubricating oils. Moreover, the lubricating oils produced in accordance with the invention are characterized by their outstanding resistance to oxidation in comparison with commercial lubricating oils having similar viscosity characteristics. One test for evaluating the oxidation resistance of lubricating oils is known as the Indiana oxidation test wherein the lubricating oil is subjected to controlled oxidation conditions and the reaction sludge which is formed determined quantitatively. Commercial lubricating oils prepared by conventional processes have been found to possess an Indiana oxidation rating of approximately 17 hours, which is the time required to form a specific quantity of sludge, whereas lubricating oils of similar viscosity characteristics produced in accordance with this invention have been found to possess ratings above 100 hours.

The crude wax separated from dewaxing at 40 is transferred via line 45 to suitable deoiling facilities at 46. Deoiling of the wax at 46 can be accomplished according to conventional procedures by dispersing the crude wax in a deoiling solvent and chilling to a temperature (usually higher than the dewaxing temperature) so as to thoroughly contact and reprecipitate the wax while leaving any contaminating oils and/or soft waxes in the deoiling solvent. The deoiling solvent can be the same as that employed for dewaxing, such as, for example, 45% by volume methyl ethyl ketone and 55% toluene. Preferably, a two-stage deoiling procedure is employed; in the first stage the crude wax, containing some solvent from the dewaxing operation, is heated with additional solvent in two stages of dilution and then chilled to cause precipita-

tion of the wax. The precipitated wax is filtered and the wax filter cake washed with solvent. The resultant wax filter cake is then repulped in additional solvent, filtered and again washed with solvent to produce a deoiled wax, which is removed through line **47**. The deoiled wax can be percolated through clay at **48** to improve the color thereof, with the finished deoiled wax being removed through line **49**. The deoiled waxes so produced, in yields depending upon the original wax content of the decant oil employed, generally have melting points in the range of about 120 to 135° F. Petroleum waxes melting in the range of about 120 to 135° F. are used in large quantities in the dairy industry as an impregnant for paper and other containers for milk and other dairy products. The relatively high melting points of the waxes produced by eminently suitable for use as dairy waxes. The waxes of this invention are generally twice as adhesive than waxes of comparable melting point prepared by prior art proc- the process of the invention as well as their exceptional adhesion and sealing strength properties render them esses and their sealing strength characteristics are from 8 to 10 times greater. A typical deoiled wax product obtained at **49** has the following physical properties:

Color, Saybolt	+30
Refractive Index at 212° F.	1.4420
Oil Content, wt., percent	0.09
Paraffin M.P., ° F.	123.6
Penetration at 77° F.	45
Absorptivity at 290 mμ	0.003

A waxy product resulting from deoiling at **46** is found to be relatively soft with a congealing point of approximately 70–75° F. and is suitable for use in polish formulations, etc. This soft wax product containing wax and raffinate oil can be removed through line **51** or percolated through clay at **52** to improve its color, etc.

As described, the process of the invention for producing high quality lubricating oils and waxes involves the refining of a decant oil with suitable solvents at solvent extracting zone **32** to remove aromatic and olefinic compounds therefrom. The raffinate stream **35** and extract stream **34** from solvent extractor **32** normally contain appreciable quantities of solvent and for economy and other processing advantages these streams are processed to achieve recovery of the solvent.

Referring to FIG. III of the drawings which illustrates one processing scheme, the decant oil raffinate stream from extractor **32** passes through line **35** to raffinate stripper **36**. Steam for stripping the raffinate is introduced into the lower section of stripper **36** and passes upwardly therethrough. The stripped raffinate is discharged from stripper **36** through line **39** and processed to provide finished lubricating oil and wax as previously described. The overhead from stripper **36** consists of steam, extraction solvent and a portion of the hydrocarbon raffinate of somewhat lighter boiling range than the stripped raffinate which is removed through line **39**. These three components are passed vial line **37** to condenser **54**. Thereafter, the condensed mixture is passed through line **55** to a liquid separator **56** wherein the mixture separates into three phases. The top phase is principally a hydrocarbon layer which is removed through line **58** and passed to stripping column **59**; the middle phase is principally water which is passed through line **60** to stripping column **61**; the third or bottom phase principally comprises solvent and is passed through line **62** to stripping column **63**. Each of these separated phases are contaminated with the other two components, requiring that each phase stream be stripped free of the other components which is accomplished by means of steam stripping in columns **59**, **61** and **63**.

In column **59**, the hydrocarbon phase is steam stripped and solvent and water present removed as overhead through line **65** for recycling, while the stripped hydrocarbon is discharged from the bottom of the stripper through line **66**. In column **61** the water phase from separator **56** is steam stripped free of solvent and hydrocarbon; solvent and hydrocarbon being removed as overhead through line **68**, while the water is discharged from the bottom of the stripper through line **69**. In column **63** the solvent phase from separator **56** is steam stripped with water and hydrocarbon leaving the stripper **63** as overhead through line **71** and the stripped solvent removed from the bottom of the stripper through line **72**. This recovered solvent is recycled for further use in the solvent extraction operation at **32**. The stripping steam overheads from stripping columns **59**, **61** and **63** are condensed in condenser **54**.

The decant oil extract stream from solvent extractor **32** passes through line **34** to extract stripper **74** and is steam stripped in a manner similar to the raffinate. The stripped extract is discharged from extract stripper **74** through line **76** and can be used for the manufacture of carbon black, coke and/or asphalt, as well as for other petroleum and petrochemical uses. The overhead from extract stripper **74**, containing solvent, steam and a portion of the lighter hydrocarbons present in the extract is passed through line **77** to condenser **78**. The condensate from condenser **78** flows through line **79** to liquid separator **80** wherein the mixture separates into three phases; a light hydrocarbon phase, a water phase and a solvent phase. Each separated phase contains some of the other components and each phase must be stripped in order to remove the minor components present therein. This is accomplished in similar manner as described above with reference to the raffinate stream. Thus, the three phases are separated and the top hydrocarbon phase is steam stripped in column **82**, the water phase steam stripped in column **84** and the bottom solvent phase steam stripped in column **86**. The overheads from stripping columns **82**, **84** and **86**, which are essentially steam and solvent, solvent and hydrocarbon, and hydrocarbon and water, respectively, and stripping steam are recycled to condenser **78**.

FIG. IV illustrates an alternative processing scheme to that shown in FIG. III. In this embodiment, a common recovery system is used to recover the extraction solvent and the light hydrocarbon product obtained as overhead from the raffinate and extract strippers **36** and **74**.

Thus, the raffinate from solvent extractor **32** passes through line **35** to reaffinate stripper **36** wherein it is stripped by means of steam. The stripped raffinate is removed through line **39** and processed to a finished lubricating oil as hereintofore described. The overhead from reaffinate stripper **36** consisting of solvent, steam and a light hydrocarbon product, is passed through line **37** to condenser **88**. Similarly, the decant oil extract from solvent extractor **32** passes through line **34** to extract stripper **74** wherein it is steam stripped. The stripped extract is removed through line **76** while the overhead from the stripper **74** consisting of solvent, steam and a light hydrocarbon product, is passed to condenser **88**. The condensate in condenser **88** representing the overheads from raffinate stripper **36** and extract stripper **74** is transferred through line **89** to liquid separator **90** wherein three phases separate. Each phase is then separately steam stripped in stripping columns **92**, **94** and **96** with the overheads from each stripping column being recycled to condenser **88**.

As indicated, the overheads, from raffinate stripper **36** and extract stripper **74** comprise the solvent utilized in the solvent extraction operation **32** and a light low boiling fraction of the hydrocarbon product comprising the reaffinate and extract streams from the solvent extraction. By processing these overheads as illustrated in FIG. III or FIG. IV, the solvent is substantially completely recovered for further use in the process and a light hydrocarbon oil obtained which is useful as a diesel fuel and/or as a charge stock for catalytic cracking operations. Data concerning these overhead hydrocarbon products are tabu-

lated below. These data were obtained in two runs utilizing a 12.8 API gravity decant oil having an initial boiling point of 394° F. and employing furfural as the extraction solvent. The processing sequence illustrated in FIG. III was employed and the following products were obtained:

	Overheads		Overheads	
	Stripper 36	Stripper 74	Stripper 36	Stripper 74
Operating conditions:				
Extractor top temp., ° F	160		180	
Extractor, btm. temp., ° F	120		140	
Solvent/oil ratio, v./v.	0.75/1		3/1	
Yield, vol. percent (charge)	2.0	0.7	3.2	0.9
Physical tests:				
Gravity, API	29.4	33.4	29.6	33.8
Flash, COC, ° F	190	250	225	230
Cold test, ° F	−6	+52	−4	+50
Viscosity, SSU at 100° F	35.1	49.6	38.0	46.2
Carbon residue, rams., wt. percent	0.06	0.12	0.04	0.18
Color, D-1500	L 2	L 8	L 1.5	L 7
Sulfur, wt. percent	0.16	0.07	0.12	0.21
Aniline pt., ° F	121.3	187.5	162.8	196.2
Diesel index	35.7	62.6	48.2	66.3
Cetane index	37.5	61.7	42.4	67.6
Distillation, D-158° F.				
IBP	340	406	422	298
10%	450	568	487	579
50	519	632	551	655
90	586	686	612	725
EP	654	740	662	740

As seen, the above hydrocarbon products obtained as overheads from the raffinate stripper 36 and extract stripper 74 are suitable for use as catalytic cracking charge stocks or as diesel fuels as indicated by the Cetane Index and Diesel Index values.

It will be apparent from the foregoing that by means of the process of the invention superior quality lubricating oils and superior waxes are produced from charge stock heretofore considered unsuitable for the production of such products. The major advantages of the improved process of the invention include the following: (1) an integrated catalytic cracking operation contributing toward the production of superior quality lubricating oils and superior petroleum waxes, (2) utilization of decant oil for production of superior quality lubricating oils, and superior waxes thereby eliminating the necessity for disposal of the stock (decant oil) as a No. 6 Fuel Oil and/or a carbon black feed stock, (3) the process provides in addition to the principal lubricating oil and petroleum waxes hydrocarbon by-products which are valuable and have various uses, (4) a unitary continuous system enabling the recovery and re-use of solvents employed in the production of lubricating oil and providing desired control over the composition of products produced, and (5) significant economic advantages due to use of low solvent/oil ratio.

The economic attractiveness of lubricating oil solvent extraction processes is to a large extent dependent upon the amount of solvent in relation to the oil (solvent/oil ratio) required to achieve a specific product quality. For example, at a solvent/oil ratio of 2/1 , one-third of the charge to the extracting unit is oil and two-thirds of the charge is solvent. At higher solvent/oil ratios, still greater proportions of the charge to the extracting unit is solvent. As a consequence, with high solvent to oil ratios much greater quantities of solvent must be recovered thereby greatly increasing processing costs and capital investment for equipment.

In conventional lubricating oil extraction processes utilizing normal lubricating oil charge stocks, solvent/oil ratios on the order of 15/1 to 20/1 are required in order to achieve a lubricating oil product possessing a viscosity index of 115–120. By means of the present invention, lubricating oils having desirably high viscosity indices on this order are produced utilizing relatively small amounts of solvent as indicated.

Those modifications and equivalents which fall within the spirit of the invention and the scope of the appended claims are to be considered part of the invention.

I claim:

1. A process for treating hydrocarbon oil to produce a lubricating oil and a petroleum wax which comprises charging a hydrocarbon oil containing constituents in part distilling in the lubricating oil boiling range into a catalytic cracking unit operating at a temperature of from about 900 to 1050° F. and at a pressure from about 10 to 50 p.s.i.g. wherein the hydrocarbon oil is severely catalytically cracked; subjecting the vaporous hydrocarbon products from said catalytic cracking operation to fractionation, withdrawing from said fractionation a highly aromatic decant oil fraction having a gravity of 0 to 20 API, and boiling in the lubricating oil distillation range with approximately 90% boiling above 550° F. and having a viscosity at 100° F. in excess of 200 Saybolt Universal Seconds; subjecting said decant oil fraction to a series of refining steps including a solvent extraction step and a dewaxing step on the raffinate therefrom to yield a lubricating oil and a wax product.

2. A process for treating hydrocarbon oil to produce a lubricating oil and a petroleum wax which comprises charging a hydrocarbon oil containing constituents in part distilling in the lubricating oil boiling range into a catalytic cracking unit operating at a temperature of from about 900 to 1050° F. and at a pressure from about 10 to 50 p.s.i.g. wherein the hydrocarbon oil is severely catalytically cracked; subjecting the vaporous hydrocarbon products from said catalytic cracking operation to fractionation, withdrawing from said fractionation a highly aromatic decant oil fraction having a gravity of 8 to 13 API, and boiling in the lubricating oil distillation range with approximately 90% boiling above 550° F. and having a viscosity at 100° F. in excess of 200 Saybolt Universal Seconds; subjecting said decant oil fraction to a series of refining steps including a solvent extraction step and a dewaxing step on the raffinate therefrom to yield a lubricating oil and a wax product.

3. A process for treating hydrocarbon oil to produce a lubricating oil and a petroleum wax which comprises charging a hydrocarbon oil containing constituents in part distilling in the lubricating oil boiling range into a catalytic cracking unit operating at a temperature of about 960° F. and at a pressure of about 23 p.s.i.g. wherein the hydrocarbon oil is severely catalytically cracked; subjecting the vaporous hydrocarbon products from said catalytic cracking operation to fractionation, withdrawing from said fractionation a highly aromatic decant oil fraction having a gravity of about 8 to 13 API, and boiling in the lubricating oil distillation range with approximately 90% distilling above 550° F. and having a viscosity at 100° F. in excess of 200 Saybolt Universal Seconds; subjecting said decant oil fraction to a series of refining steps including a solvent extraction step and a

dewaxing step on the raffinate therefrom to yield a lubricating oil and a wax product.

4. A process for treating hydrocarbon oil to produce a lubricating oil and a petroleum wax which comprises charging a hydrocarbon oil containing constituents in part distilling in the lubricating oil boiling range into a catalytic cracking unit operating at a temperature of about 960° F. and at a pressure of about 23 p.s.i.g. wherein the hydrocarbon oil is severely catalytically cracked; subjecting the vaporous hydrocarbon products from said catalytic cracking operation to fractionation, withdrawing from said fractionation a highly aromatic decant oil fraction having a gravity of about 13 API, and boiling in the lubricating oil distillation range with approximately 90% distilling above 550° F. and having a viscosity at 100° F. of about 225 Saybolt Universal Seconds; subjecting said decant oil fraction to a series of refining steps including a solvent extraction step and a dewaxing step on the raffinate therefrom to yield a lubricating oil and a wax product.

5. A process for treating hydrocarbon oil to produce a lubricating oil and a petroleum wax which comprises charging a hydrocarbon oil containing constituents in part distilling in the lubricating oil boiling range into a catalytic cracking unit operating at a temperature of from about 900 to 1050° F. and at a pressure from about 10 to 50 p.s.i.g. wherein the hydrocarbon oil is severely catalytically cracked; subjecting the vaporous hydrocarbon products from said catalytic cracking operation to fractionation, withdrawing from said fractionation a highly aromatic decant oil fraction having a gravity of 0 to 20 API, and boiling in the lubricating oil distillation range with approximately 90% boiling above 550° F. and having a viscosity at 100° F. in excess of 200 Saybolt Universal Seconds, contacting said decant oil fraction with a selective solvent for aromatic and olefinic compounds to remove aromatic and olefinic compounds therefrom, dewaxing the solvent extracted decant oil raffinate fraction with a solvent capable of securing dissolution of the wax therein when cooled and recovering a solvent extracted dewaxed lubricating oil and the wax separated in said dewaxing step.

6. A process for treating hydrocarbon oil to produce a lubricating oil and a petroleum wax which comprises charging a hydrocarbon oil containing constituents in part distilling in the lubricating oil boiling range into a catalytic cracking unit operating at a temperature of from about 900 to 1050° F. and at a pressure from about 10 to 50 p.s.i.g. wherein the hydrocarbon oil is severely catalytically cracked; subjecting the vaporous hydrocarbon products from said catalytic cracking operation to fractionation, withdrawing from said fractionation a highly aromatic decant oil fraction having a gravity of 0 to 20 API, and boiling in the lubricating oil distillation range with approximately 90% boiling above 550° F. and having a viscosity at 100° F. in excess of 200 Saybolt Universal Seconds; contacting said decant oil fraction with a selective solvent for aromatic and olefinic compounds to remove aromatic and olefinic compounds therefrom, dewaxing the solvent extracted hydrocarbon oil reaffinate fraction with a solvent capable of securing dissolution of the wax therein when cooled, recovering a solvent extracted dewaxed lubricating oil and the wax separated in said dewaxing step, and subjecting the solvent extracted dewaxed lubricating oil to treatment with acid and clay to improve the properties thereof.

7. A process for treating hydrocarbon oil to produce a lubricating oil and a petroleum wax which comprises charging a hydrocarbon oil containing constituents in part distilling in the lubricating oil boiling range into a catalytic cracking unit operating at a temperature of from about 900 to 1050° F. and at a pressure from about 10 to 50 p.s.i.g. wherein the hydrocarbon oil is severely catalytically cracked; subjecting the vaporous hydrocarbon products from said catalytic cracking operation to fractionation, withdrawing from said fractionation a highly aromatic decant oil fraction having a gravity of 0 to 20 API, and boiling in the lubricating oil distillation range with approximately 90% boiling above 550° F. and having a viscosity at 100° F. in excess of 200 Saybolt Universal Seconds; contacting said decant oil fraction with a selective solvent for aromatic and olefinic compounds to remove aromatic and olefinic compounds therefrom, stripping with steam the raffinate resulting from the solvent extraction, dewaxing the steam stripped raffinate with a solvent capable of securing dissolution of the wax therein when cooled, recovering a solvent extracted dewaxed lubricating oil and wax separated in said dewaxing step, condensing the overhead from said steam stripping operation, permitting a phase separation to occur between the components of said overhead and then separating each of the components substantially free of the other components present therein.

8. A process for treating hydrocarbon oil to produce a lubricating oil and a petroleum wax which comprises charging a hydrocarbon oil containing constituents in part distilling in the lubricating oil boiling range into a catalytic cracking unit operating at a temperature of from about 900 to 1050° F. and at a pressure from about 10 to 50 p.s.i.g. wherein the hydrocarbon oil is severely catalytically cracked; subjecting the vaporous hydrocarbon products from said catalytic cracking operation to fractionation, withdrawing from said fractionation a highly aromatic decant oil fraction having a gravity of 0 to 20 API, and boiling in the lubricating oil distillation range with approximately 90% boiling above 550° F. and having a viscosity at 100° F. in excess of 200 Saybolt Universal Seconds; contacting said decant oil fraction with a selective solvent for aromatic and olefinic compounds to remove aromatic and olefinic compounds therefrom, dewaxing the solvent extracted decant oil raffinate fraction with a solvent capable of securing dissolution of the wax therein when cooled, recovering a solvent extracted dewaxed lubricating oil and the wax separated in said dewaxing step, subjecting the solvent extracted dewaxed lubricating oil to treatment with acid and clay to improve the properties thereof, deoiling said separated wax and percolating said deoiled wax over clay to obtain a deoiled clay-percolated wax product.

9. A process for treating hydrocarbon oil to produce a lubricating oil and a petroleum wax which comprises charging a hydrocarbon oil containing constituents in part distilling in the lubricating oil boiling range into a catalytic cracking unit operating at a temperature of from about 900 to 1050° F. and at a pressure from about 10 to 50 p.s.i.g. wherein the hydrocarbon oil is severely catalytically cracked; subjecting the vaporous hydrocarbon products from said catalytic cracking operation to fractionation, withdrawing from said fractionation a highly aromatic decant oil fraction having a gravity of 0 to 20 API, and boiling in the lubricating oil distillation range with approximately 90% boiling above 550° F. and having a viscosity at 100° F. in excess of 200 Saybolt Universal Seconds; contacting said decant oil fraction with a selective solvent for aromatic and olefinic compounds to remove aromatic and olefinic compounds therefrom, stripping with steam the raffinate resulting from the solvent extraction, dewaxing the steam stripped raffinate with a solvent capable of securing dissolution of the wax therein when cooled, recovering a solvent extracted dewaxed lubricating oil and wax separated in said dewaxing step, condensing the overhead from said steam stripping operation, permitting a phase separation to occur between the components of said overhead and then separating each of the components substantially free of the other components present therein, stripping with steam the extract resulting from the solvent extraction, condensing the overhead from said last-mentioned steam stripping operation, permitting a phase separation to occur between the components of said last-mentioned overhead and then separating each of the components substantially free of the other components present therein.

10. A process for treating hydrocarbon oil to produce a lubricating oil and a petroleum wax which comprises charging a hydrocarbon oil containing constituents in part distilling in the lubricating oil boiling range into a catalytic cracking unit operating at a temperature of from about 900 to 1050° F. and at a pressure from about 10 to 50 p.s.i.g. wherein the hydrocarbon oil is severely catalytically cracked; subjecting the vaporous hydrocarbon products from said catalytic cracking operation to fractionation, withdrawing from said fractionation a highly aromatic decant oil fraction having a gravity of 0 to 20 API, and boiling in the lubricating oil distillation range with approximately 90% boiling above 550° F. and having a viscosity at 100° F. in excess of 200 Saybolt Universal Seconds; contacting said decant oil fraction with a selective solvent for aromatic and olefinic compounds to remove aromatic and olefinic compounds therefrom, stripping with steam the raffinate and extract resulting

from the solvent extraction, dewaxing the steam stripped raffinate with a solvent capable of securing dissolution of the wax therein when cooled, recovering a solvent extracted dewaxed lubricating oil and wax separated in said dewaxing step, condensing the overheads from said steam stripping operations, permitting a phase separation to occur between the components of said overheads and then separating each of the components substantially free of the other components present therein.

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