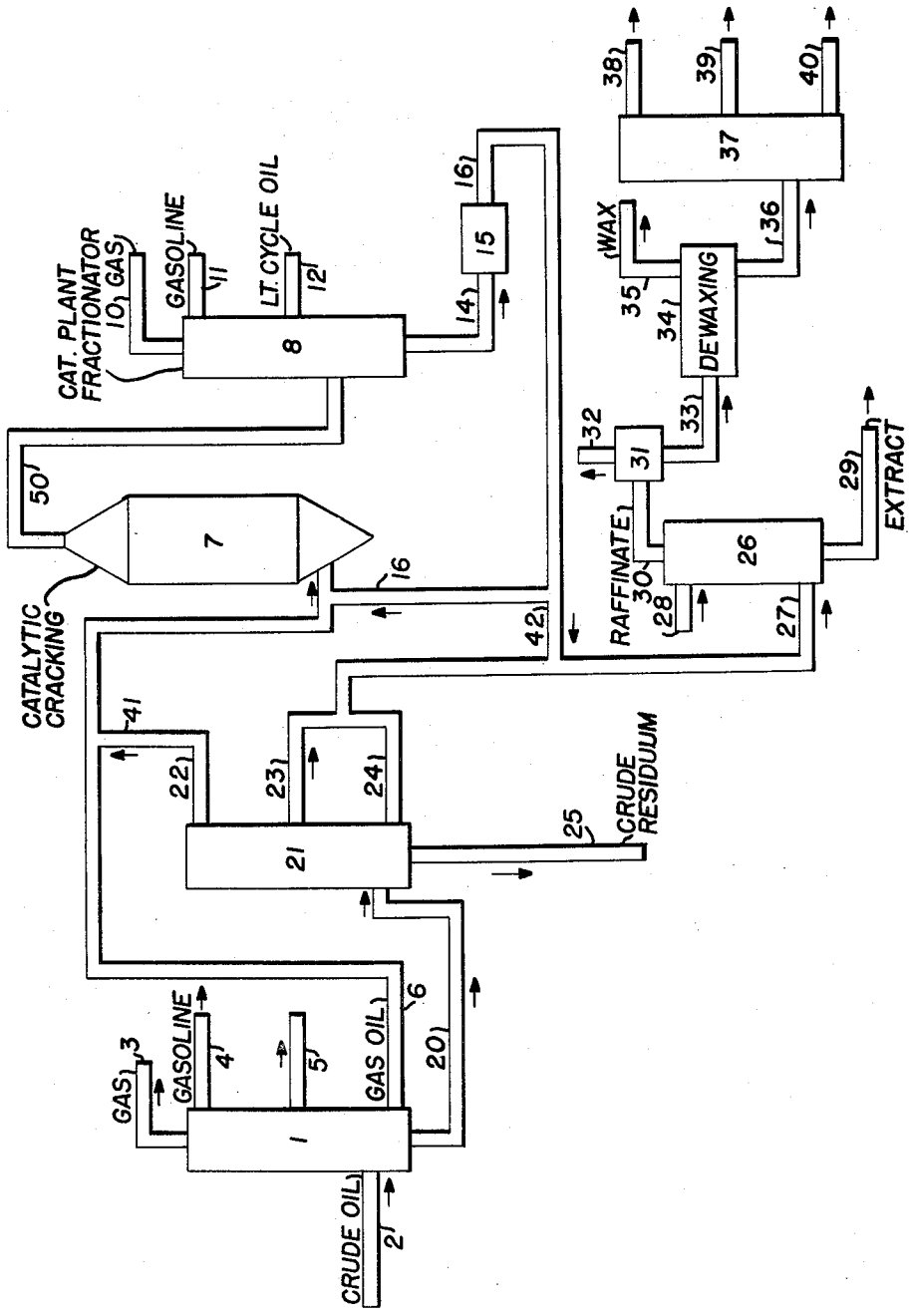
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PRODUCING LUBRICATING OILS BY SOLVENT EXTRACTION

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PRODUCING LUBRICATING OILS BY SOLVENT EXTRACTION

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The present invention is concerned with an improved process for the production of high quality lubricating oils. The invention is more particularly concerned with high quality lubricating oil blends comprising virgin streams in combination with a stream secured from a catalytic cracking operation. In accordance with the present invention, the lighter or lower boiling constituents of wide virgin distillate fraction are removed and are preferably passed through a catalytic cracking operation. These constituents are replaced by streams secured from the catalytic cracking operation to produce high viscosity index lubricating oil having other beneficial qualities.

It is well known in the art to produce lubricating oils by various processes comprising distillation operations and the like. One criterion utilized to determine the quality of a lubricating oil is the viscosity characteristics of the oil. In many operations the temperatures at which a lubricant is employed vary hundreds of degrees. Thus, it is essential to provide lubricating oils which have proper viscosities over the entire range of operating temperatures at which they are used. The relative change in viscosity of an oil as it is heated is generally referred to as the "viscosity index" of the oil. Thus, the viscosity index of an oil provides information as to the change in viscosity of the oil over the temperature range of 100° F. to 210° F. It is apparent that for many uses it is very desirable to employ lubricating oils having the highest possible viscosity indices.

In general, three types of hydrocarbons are to be found in the lubricating oil fraction of a crude petroleum, namely paraffinic, aromatic, and naphthenic hydrocarbons. It is known that the paraffinic type hydrocarbons have by far the highest viscosity indices, as for example, in the range of about 125 to 180. Naphthenic and aromatic type hydrocarbons have materially lower viscosity indices. If these type materials are rich in ring structures, the viscosity indices are below 0. Because of this, paraffinic type crude oils have long been considered to be the best source of lubricating oil. However, truly paraffinic crude oils are unusual, and more often, crude oils are of the mixed base type, containing a combination of paraffinic, naphthenic and aromatic type hydrocarbons, all of which are present in substantial proportions. Examples of such crude oils are Panhandle, Louisiana, Mississippi, East Texas and Middle East crude oils.

Many efforts have been made to provide suitable processing methods for producing high quality, high viscosity index lubricating oils from such mixed base crude oils. In particular, it has been found that by employing solvent extraction processes, lubricating oils may be made more paraffinic by the selective removal of aromatic type compounds. However, the solvents are employed for the removal of the aromatic type compounds are less selective for removing naphthenic constituents and the one or two ring non-condensed aromatic constituents. As a result, lubricating oils obtained by solvent extraction processing are characterized by containing relatively large proportions of naphthenic compounds and the one or two ring

aromatic compounds having long side chains. These constituents lower the potential viscosity index of the oil.

When manufacturing lubricating oils of various viscosity grades, it is economically attractive to process the corresponding fractions from the crude in admixture as a wide boiling feed stock. This saves considerable tankage and lines compared to separate processing of individual fractions. While this is an attractive method practically, there have been found to be process advantages that arise when processing the wide boiling stock. This occurs in the extraction step in that there is a tendency to "over-extract" the light part of the wide boiling stock and "under-extract" the heavy portion. This is because of the tendency of the solvent to dissolve low molecular weight components in preference to high molecular weight components of the same or equivalent molecular structure.

This "over-extraction" leads to a low viscosity fraction of very high viscosity index, which fraction is often unstable in engine performance. This also occurs when narrow boiling oils are too severely extracted and is due to the removal of natural oxidation inhibitors. These results are measured by the Sligh test and the Conradson carbon value. It is one purpose of this invention to overcome this inherent disadvantage of wide cut extraction. It has been found that if the light virgin fraction is replaced by a cycle stock, the low viscosity finished lube oil will have much better oxidation stability. In this manner, the wide boiling lube stock processing becomes very attractive since the oxidation instability of the low viscosity lube is avoided.

In accordance with the present invention, a high quality, high viscosity index lubricating oil is secured by removing the lower boiling constituents from a wide cut lubricating oil fraction. These low boiling virgin lubricating oil constituents are replaced with cracked hydrocarbon constituents of substantially the same boiling range and viscosity.

The process of the present invention may be more fully understood by reference to the drawing illustrating one embodiment of the same.

Referring specifically to the drawing, a crude oil, as for example, a Middle East crude, is introduced into distillation zone **1** by means of feed line **2**. Temperature and pressure conditions in zone **1** are adjusted to remove overhead by means of line **3** normally gaseous hydrocarbon constituents. Hydrocarbon constituents boiling in the motor fuel boiling range are removed from distillation zone **1** by means of line **4** while constituents boiling in the light distillate range, as for example, kerosene, diesel fuel and heating oil, are removed from zone **1** by means of line **5**. A fraction boiling in the gas oil boiling range, about 450° F. to 700° F., is removed from distillation zone **1** by means of line **6** and passed to a catalytic cracking zone **7**. The cracking operation conducted in zone **7** may be any desired type employing a catalyst such as modified natural or synthetic clay or gel type catalysts. Examples of these catalysts are montmorillonite clays, silica-alumina, silica-magnesia composites and other conventional cracking catalysts. The process may comprise a continuous or batch operation employing fixed beds, moving beds, fluidized, or suspensoid systems. The heat required for cracking may be supplied as preheat of processed materials and/or as the sensible heat of exothermically regenerated catalyst or may be supplied in any other conventional manner. The cracking is carried out at temperatures of about 800° F. to 1000° F., and pressures of about atmospheric to 25 p. s. i. g. or higher in a conventional manner. The total cracked products are removed from cracking zone **7** by means of line **50** and are passed to a product fractionator **8**. Fractionator zone **8** is operated to remove relatively low boiling constituents overhead by means of line **10**. Side

streams of intermediate boiling ranges are removed by means of lines 11 and 12. A bottoms product is segregated from fractionator 8 and removed through line 14. If the cracking operation conducted in zone 7 is a fluidized one, the product material withdrawn through line 14 will contain a small percentage of catalyst particles carried over from zone 7. Thus, it is necessary to pass the product stream of line 14 to a settler 15 or otherwise to permit separation of the liquid hydrocarbon product from the catalyst. A clarified hydrocarbon stream boiling in the range of about 650° F. to 1020° F., is removed from zone 15 through line 16, and handled as hereinafter described.

A bottoms fraction boiling above about 750° F., and up to about 1300° F. is removed from atmospheric crude pipe still 1 by means of line 20. This stream is introduced into vacuum crude pipe still 21 which is operated at a bottoms temperature of about 700° F., and at a pressure of about 20 mm. Hg. In accordance with conventional procedures, temperature and pressure conditions are adjusted to segregate a lubricating oil fraction having a viscosity of about 40 to 45 S. S. U. at 210° F., and boiling in the range from about 700° to 900° F., by means of line 22. An intermediate fraction boiling in the lubricating oil boiling range and having a viscosity of about 48 to 55 S. S. U. at 210° F., and boiling in the range from about 800° to 1050° F. is segregated by means of line 23 while a heavier fraction having a viscosity in the range from about 80 to 100 S. S. U. at 210° F., and boiling in the range from about 850° to 1150° F., is removed by means of line 24. A heavier crude residuum fraction comprising about 25% of the feed to zone 21 is segregated as a bottoms stream by means of line 25. This stream may be further refined as desired.

In accordance with conventional procedures, portions of the respective side streams segregated by means of lines 22, 23 and 24 are combined as a wide distillate cut and passed to solvent treating zone 26 by means of line 27. The balance of these side streams are passed to catalytic cracking. The composition of the wide distillate made by combining the various side streams is adjusted to correspond to the market demands for the various lube viscosity grades.

In solvent extraction zone 26 the wide distillate fraction is contacted with a solvent having a preferential selectivity for the relatively more aromatic type constituents as compared to the relatively more paraffinic type constituents. Solvents of this type are, for example, phenol, furfural, and the like. Usually from about ½ to 4 volumes of solvent are utilized per volume of oil. The temperatures employed in the zone 26 are in the range from about 120° F. to 250° F. while pressures are in the range from about atmospheric to 50 lbs. per square inch. The solvent is introduced into solvent contacting zone 26 by means of line 28. The solvent flows downwardly in zone 26 and countercurrently contacts the upflowing oil under conditions wherein the more aromatic type constituents are dissolved in the solvent. A solvent extract phase is removed from zone 26 by means of line 29 and is processed to segregate the solvent such as phenol from the aromatic type hydrocarbon constituents. The solvent is recycled to the treating zone 26.

A raffinate phase comprising the more paraffinic type constituents and the solvent such as phenol is removed by means of line 30 and passed into a solvent distillation zone 31 wherein temperature and pressure conditions are adjusted so as to segregate the solvent from the paraffinic type constituents. The solvent is removed by means of line 32 while the highly paraffinic oil phase is removed from zone 31 by means of line 33. This phase is then passed to a dewaxing zone 34. In zone 34 the oil is contacted with a suitable dewaxing solvent such as liquid propane, methyl ethyl ketone, mixed ketones, and the like. Zone 34 comprises the necessary chilling and filtering stages for the segregation of the dewaxing solvent, the wax and the oil and for the recycling of the solvent to the dewaxing operation. A wax phase is segregated from zone 34 by means of line 35 while the dewaxed oil also free of solvent is removed from zone 34 by means of line 36. This dewaxed oil phase is usually passed to a vacuum pipe still operated at a pressure of about 20 mm. to 50 mm. and at a bottoms temperature of about 650° F. to 700° F. The pressure conditions in zone 37 are adjusted to segregate a light lubricating oil fraction as, for example, one boiling in the range from about 700° F. to 900° F., and having a viscosity Saybolt Universal of about 43 seconds at 210° F. This low boiling fraction is removed from distillation zone 37 by means of line 38. An intermediate boiling lubricating oil fraction as, for example, one boiling in the range from about 800° F. to 1050° F., and having a viscosity Saybolt Universal of 56 seconds at 210° F., is removed from zone 37 by means of line 39. A high boiling fraction such as one boiling in the range from about 850° F. to 1150° F., and having a viscosity of 150 seconds Saybolt Universal at 210° F. is removed from distillation zone 37 by means of line 40.

In accordance with the present invention, the low boiling lubricating oil fraction segregated from crude pipe still 21 by means of line 22 is not blended with the intermediate and higher boiling virgin constituents, but is passed to catalytic cracking zone 7 by means of line 41. In accordance with the present invention, the entire quantity of heavy cycle oil is segregated in distillation zone 8 by means of line 16 is not recycled to catalytic cracking zone 7; but at least an amount equivalent to that diverted by means of line 41 is blended with the intermediate and high boiling virgin constituents by means of line 42. The amount of cycle oil so blended will be such as to constitute from about 5% to about 40% by volume of the blend.

By operating as described, that is, by substituting equivalent boiling cycle oil constituents for the low boiling virgin constituents, a higher quality product is secured. Furthermore, a higher yield for the same feed is secured upon solvent extraction. Still another advantage in the extraction process is that the introduction of the catalytic cycle stock gives better phase separation in the contacting stages. Hence, higher capacity can be run in the solvent extraction tower.

In order to further illustrate the present invention, the following example is given:

EXAMPLE I

Three solvent treating operations were conducted for the manufacture of high quality lubricating oils as follows:

Operation A.—In this operation the feed comprised a blend of viscosities (S. S. U. (Saybolt Seconds, Universal)) of 42, 51, and 81 @ 210° F. These streams were secured by a vacuum pipe still operation and were blended as follows:

	Vol. percent	Vis. S. S. U.
#1 Side Stream	6.8	42
#2 Side Stream	35.2	51
#3 Side Stream	58.0	81

Operation B.—The feed stock was identical to the feed stock in Operation A except #1 side stream was replaced with 6.8% by volume of a cycle oil secured as hereinbefore described. This cycle oil had a viscosity in the range from about 40 to 44 S. S. U. at 210° F., and boiled in the range from about 700° F. to 975° F.

Operation C.—This operation was conducted on the same feed stock as Operation B in order to produce an equivalent quality product as secured by Operation A. The net result of the operation was to secure a consider-

ably higher yield of equivalent quality product with less phenol treat.

The results of the three operations are shown below:

Table I

Operation			A	B	C
Operating Conditions:					
Temperature, Top ° F			204	204	204
Temperature, Bottom ° F			186	185	184
Phenol Treat Percent on Oil			238	228	153
Water in Phenol, Percent on Phenol			3.3	3.8	3.8
Water injected, Percent on Phenol			3.1	3.4	4.6
Raffinate Yield, Vol. Percent on Oil Feed			43.3	47.5	57.1
Phenol in Raffinate, Vol. Percent			17.8	14.0	15.0
Oil in Extract, Vol. Percent			19.3	19.6	19.8
Dephenolized Raffinate:	Feed A	Feed B and C			
Gravity, API @ 60° F	20.7	20.0	31.5	31.5	30.0
Pour, ° F	+105		+115	+120	+120
Viscosty @ 210° F	62.8	63.4	52.1	52.3	53.7
R. I. @ 75° C	1.4964	1.5019	1.4574	1.4580	1.4621
Dephenolized Extract:					
Gravity, API @ 60° F			13.8	10.9	8.4
R. I. @ 75° C			1.5261	1.5410	1.5535
Dewaxed Raffinate:					
Gravity, API @ 60° F	19.1	18.5	30.3	30.7	29.1
R. I. @ 75° C	1.5021	1.5060	1.4639	1.4600	1.4660
Pour, ° F	+15	40	+20	+45	+40
Viscosity @ 100° F	806	780	324	309	349
Viscosty @ 210° F	68.3	67.1	55.2	58.8	55.8
Viscosity Index	57	55	107½	129	106

From the above it is apparent that when substituting cycle oil constituents for low boiling virgin constituents, a yield of 47.5% is secured as compared to a yield of 43.3%. It is to be noted that the viscosity index of Operation B is 129, as compared to 107½ of Operation A. In Operation C, where conditions were adjusted to secure approximately the same viscosity index, a yield of 57.1% was secured as compared to a yield of 43.3%.

The dewaxed raffinates from the respective operations were then distilled into two corresponding viscosity fractions with the results as follows:

Table II

Operation	A		B		C	
Viscosity Grade—SSU @ 210° F	43	56	43	56	43	56
Cut range on raffinate, Vol. Percent	3-18	18-56	0-22	22-53	0-22	22-36
Finished Products Inspections:						
Gravity, API @ 60° F	32.8	29.6	32.6	------	28.6	------
Viscosity @ 100° F	151	407	155	407	153	359
Viscosity @ 210° F	43.9	59.5	44.5	59.1	44.0	58.1
Viscosity Index	114	103	118	105	112	98
Conradson Carbon, Wt. Percent	.05	.05	0.0	------	.02	------
Sligh No., mg. sludge/10 gms. of oil in 24 hours	26	1.8	9.7	1.4	4.9	0.5

It is apparent from the above that when cracked cycle constituents are substituted for low boiling virgin constituents, the oxidation stability characteristics are improved. This is shown by the Sligh value of 26 on the 43 viscosity grade as compared to values of 5 to 10 secured in Operations B and C. It is to be noted that Operations B and C also gave lower Conradson carbon values, thus indicating superior engine performance.

In the current operations the feed stock blend containing cycle oil constituents settled in about 2½ minutes to clear phases, as compared to 3½ minutes when the oil feed blend comprised entirely virgin distillates. This indicates substantially increased throughputs for commercial plants processing blends whose lower boiling constituents comprise cracked constituents.

What is claimed is:

1. A process for producing lubricating oil by solvent extraction of a virgin lubricating oil distillate normally boiling in the range of about 700° to 1150° F., which comprises: segregating a higher boiling fraction of said distillate boiling in the range of about 800° to 1150° F., thereby excluding the lowest boiling fraction from said distillate, blending with said higher boiling fraction a catalytic cycle oil constituting catalytically cracked constituents boiling in the range of about 650° to 1020° F., in an amount such that said catalytic cycle oil will constitute from about 5% to about 40% of the volume of the blend, and thereafter treating said blend with a solvent having a preferential selectivity for aromatic type constituents, and segregating a raffinate product.

2. The process defined by claim 1 in which the said solvent is selected from the group consisting of phenol and furfural.

3. The process defined by claim 1 in which the said solvent is phenol.

4. The process defined by claim 1 wherein the said catalytic cycle oil has substantially the same viscosity as the said excluded lowest boiling fraction of the said virgin lubricating oil distillate.

5. The process defined by claim 1 wherein the quantity of said catalytic cycle oil in said blend is substantially the same as the quantity of the said excluded lowest boiling fraction of the said virgin lubricating oil distillate.

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