

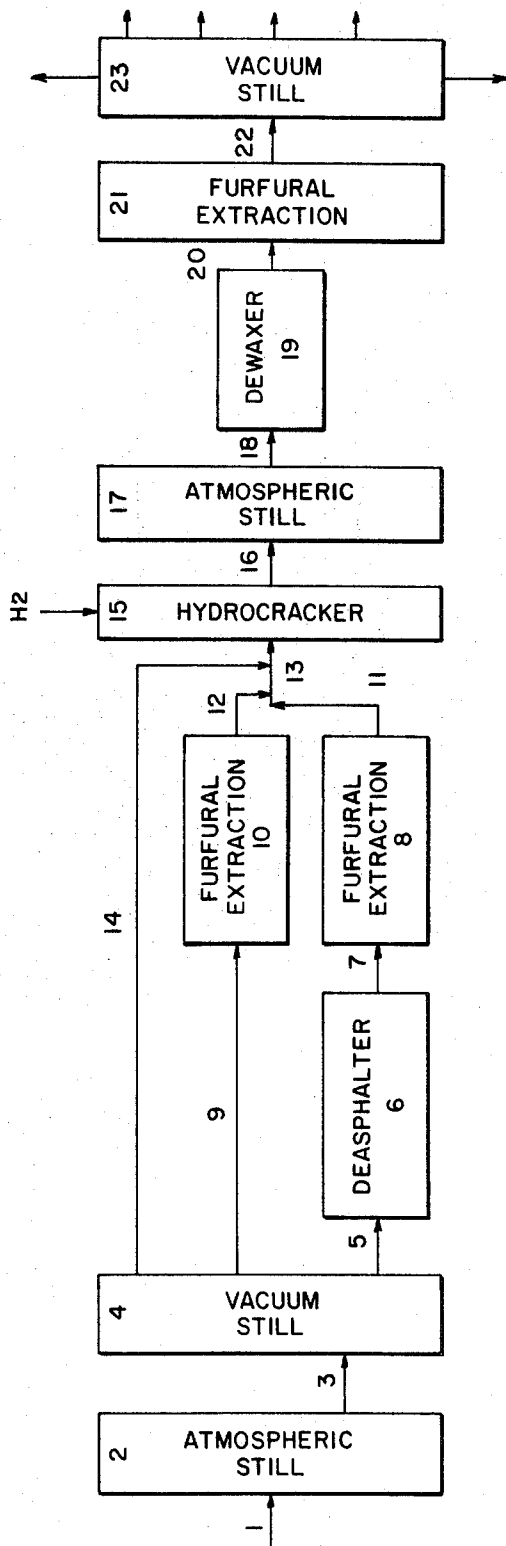
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HYDROCRACKING PRODUCTION OF LUBES

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FIGURE

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3,723,295

HYDROCRACKING PRODUCTION OF LUBES

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18 Claims

ABSTRACT OF THE DISCLOSURE

A process for preparing high V.I. lube oils of improved quality comprising solvent extracting at least part of the lube oil hydrocracker charge stock with a solvent having preferential solubility for aromatics, for example, furfural; hydrocracking the raffinate from said extraction under conditions providing for an increased V.I. of said raffinate.

Quality is further enhanced by serially extracting the hydrocracked products with a solvent having preferential solubility for aromatics, such as furfural, under conditions providing for highly selective removal of color bodies, color body precursors, U.V. adsorbing compounds and sludge precursors.

Alternatively, the quality of the hydrocracked product may be further enhanced by selectively hydrogenating same at relatively severe lube hydrogenation conditions whereby color bodies, color body precursors, U.V. adsorbing compounds and sludge precursors are mitigated.

CROSS REFERENCE TO RELATED APPLICATION

This application is a continuation-in-part of U.S. application Ser. No. 743,915 filed on July 3, 1968, by Rene F. Kress, and now abandoned.

BACKGROUND OF THE INVENTION

Various processes have been used from time to time for upgrading lubricating oil stocks and other petroleum fractions to lubricating oil stocks. These have generally involved either solvent extraction or hydrogenation including hydrocracking or hydrotreating treatment. Briefly, hydrocracking has involved treating the charge material over a catalyst at a temperature on the order of about 650° F. and above at high partial pressures of hydrogen. In more recent times, there has been an increased demand for lubricating oils having a high viscosity index. Recent developments, particularly in hydrocracking techniques, or hydrotreating techniques as some prefer to call it, has given birth to an increased interest in commercial utilization of such hydrogenation processes as a lubricating oil stock upgrading method in order to obtain lubricating oils with an increased viscosity index. This has been so in part at least because of the decline in availability of natural sources from which high V.I. lubes can be obtained by conventional techniques such as solvent extraction. The difficulty of supplying this market is aggravated by the continuous demand for high V.I. lubes with still higher V.I. numbers.

Many petroleum refining streams comprising by-products such as residuums have restricted utility, for example, as a low-grade fuel, and accordingly have a very low value. With the high degree of competitiveness in the petroleum industry, any substantial economic benefits to be realized by making it possible to upgrade low-value materials to highly desired and more valuable products is to be highly commended. This is especially so where the desired product so produced is one which otherwise comes from relatively limited and declining natural sources.

Accordingly, objects in hydrocracking are to obtain V.I.'s which are higher than can be obtained by solvent extraction, or yields at the same V.I. which are higher than solvent extraction, and as always product flexibility.

The foregoing objects and others which become apparent from a reading of the present disclosure in entirety are accomplished by the present invention.

The figure is a diagrammatic representation of a flow scheme showing the major processing steps and their sequence in a preferred embodiment of this invention.

SUMMARY OF THE INVENTION

It has now been found that if at least part of a lube oil hydrocracking charge is first solvent extracted with a solvent having preferential solubility for aromatics and then hydrocracked at a temperature in the range of about 650° to 825° F., a hydrogen partial pressure of at least about 1500 p.s.i. in the presence of a hydrocracking catalyst, at a space velocity in the range of about 0.2 to 4.0, at least one of the objects described herein are obtained. At the same time, the extract material, which is removed by the extraction and which would otherwise have an adverse effect in the hydrocracking reaction, is an excellent specialty oil.

DETAILED DISCUSSION

Typically, lube oil hydrocracking processes use a relatively heavy charge stock containing a large amount of cyclic compounds such as the naphthenics, aromatics, and in most cases, multiring aromatic compounds, or alternatively poly(fused-ring) compounds or polycyclic compounds. Typical charge stocks are the unpressable distillates, deasphalted crudes (i.e., which are naturally limited essentially to the suitable boiling range), and pressed and unpressed deasphalted residuums, all usually boiling above about 650° F.

While not wishing to be bound by any theories set forth herein, it is believed that those theories advanced heretofore by others are correct as to the mechanism involved in hydrocracking enhancement of the V.I. of such lube oil fractions. These theories postulate that the V.I. increase has been in large part due to saturation, ring-scission, and isomerization of the polycyclic compounds in said materials, but with minimal cleavage of said compounds into lower molecular weight materials. Notwithstanding the fact that hydrogenation, ring-scission, and isomerization play an important part in the accomplishment of V.I. enhancement, experimental data suggests that some type(s) of aromatic ring compounds have an apparent adverse effect on the overall hydrocracking reaction. Furthermore, contrary to the teachings by skilled artisans in this field, enhanced yields of high V.I. lube product can be obtained with some crudes by selectively removing some of the aromatic compounds from the hydrocracker charge. It is believed that important bad actors include poly(fused-ring) aromatic compounds, although certainly other materials also exert an adverse effect in a hydrocracking reaction unless the charge is pretreated to remove or transform them. The conclusion that poly(fused-ring) aromatics are serious bad actors in a conventional hydrocracking operation is based in part on the observation that by taking a heavy lube fraction like those typically employed in a hydrocracker and fractionating same, the top or light fraction, although containing substantially the same percentage of aromatics, contains less fused-ring aromatics than the heavier fractions, and this produces a very good hydrocracked lube oil product. As the fractions become progressively heavier with the progressing increase in molecular weight, boiling point, and amount of the poly(fused-ring) aromatics content therein, unless any of the fractions boiling above about 100° F. are first de-

asphalted, the hydrocracked product therefrom becomes progressively worse in terms of yields as well as quality.

This can be explained as follows: The hydrocracker feed stock is invariably a complex mixture of compounds as indeed any petroleum fraction is, and the heavier fractions invariably comprise a mixture of poly(fused-ring) compounds of various types. Certain of these poly(fused-ring) compounds are easier to break than are others. Hydrocracking operating conditions are quite naturally adjusted to the particular feed and are based on the overall results obtained therewith. The greater the amount of hydrocracking refractory materials present, the more operating conditions tend to be adjusted upward, particularly the temperature, in order to increase the yield of high V.I. product. Of course, the foregoing broad statement is to be understood to be qualified in that there is a temperature limit beyond which the adjustment in LHSV (liquid hourly space velocity) is in fact the controlling variable for "good" and "bad" feeds. In making such adjustments in operating conditions, certainly more of the refractory materials are caused to break and open up into aliphatic substituents on a remaining ring(s). However, at the same time that this occurs, some of the material that is more easily hydrocracked in the feed is overcracked at the more strenuous conditions required and employed to open up greater amounts of the materials more resistant to hydrocracking in admixture therewith. This overcracked material is poor in quality as a lubricating oil (usually because the viscosity is too low) and accordingly, offsets the increased amount of good V.I. material produced by the additional ring-scission of more refractory components at the more severe conditions. Generally, the amount of overcracking of the easier-to-crack or less resistant materials exceeds the amount of ring opening of the more resistant materials, thereby decreasing the overall yield of desired high V.I. lube product.

Deasphalting brings about substantial improvement in the performance of the heavier fractions particularly those boiling above 1000° F. in a hydrocracker for reasons in addition to other materials which exhibit an adverse effect of an entirely different nature, such as metals which poison the catalyst and carbonaceous matter which produces significant amounts of coke in this reaction as well as other conventional catalytic reactions at high temperatures.

Now, however, if the heavy hydrocracker charge stock is not only deasphalted but additionally solvent extracted with a solvent having preferential solubility for aromatics, additional amounts of the more hydrocracking resistant components are selectively removed. Lube fractions which are lighter than a conventional deasphalter charge are likewise improved by the present solvent extraction, although fractions boiling in the range of about 650° to 850° F. are normally not so treated. As a result of the removal of substantial amounts of the hydrocracking resistant materials from the hydrocracker charges, at least one of several unexpected but highly desirable consequences flow therefrom. Among these are that hydrocracking at overall less severe conditions becomes possible, and increased yields of good quality high V.I. product are obtained with some crudes; and in all cases, increased product distribution flexibility is obtained. In addition, there are substantial economies of significant commercial impact in both capital investment and operating costs. To illustrate the magnitude of economies involved, consider that a temperature increase differential of about 25° F. is equivalent to a doubling of the space rate. In a commercial-size operation, the savings on reactor cost and catalyst load alone, which is brought about by operating at a space rate of about 0.5 as compared to a space rate of about 0.25 to 0.30 or a space rate of about 1.0 as compared to a space rate of about 0.5, etc., is several million dollars. While reduced cost in hydrocracker construction is at least partially offset by the cost of solvent extraction facilities, most refiners have such on hand or need for some

solvent extraction capacity in other processing steps. Also, through solvent extraction of a hydrocracking charge, the catalyst life is lengthened and the hydrogen consumption is lowered; and of very great importance to a refiner, there is greater flexibility in product distribution by a variation in the amount of material treated in each process and the conditions employed therein. Those skilled in the art can appreciate the importance of the features discussed in addition to others inherently involved which have not been discussed.

Whether increased yield of high V.I. product is obtained, or whether instead a higher V.I. is obtained, or whether still another advantage, namely, more flexible and desirable product distribution in lieu of or in addition thereto, is obtained by the solvent extraction of the hydrocracker charge depends in large part on the aromatic content of the crude. In the case of crudes having an aromatic content of, for example, about 50%, if they are solvent extracted first they generally will not experience an increase in yields and the product may not have a higher V.I. than if hydrocracked without the extraction. However, the advantages of less severe operating conditions, with a hydrocracker and catalyst load only about one-half as large, plus greatly improved product distribution are of material importance to the refiner. On the other hand, if a crude having a lower aromatic content, for example, about 30%, is extracted before hydrocracking, an increased yield of high V.I. product is obtained in addition to the advantages experienced with the high aromatic charge above.

The particular extraction technique is capable of considerable variation as is the particular solvent or solvents employed therein. This is relatively well known in the art since there is extensive solvent extraction technology, both research and commercial in character, although so far as I am aware a raffinate of a residuum or similar material has not been hydrocracked to produce a high V.I. lube as herein described. For fullness of disclosure, however, the extraction procedure, equipment, and solvents will now be discussed.

Illustrative but nonlimiting examples of the solvents that can be employed in the present invention are furfural, acetophenone, phenol, acetonitrile, nitrobenzene, aniline, 2,2-dichlorodiethyl ether, and dimethyl sulfoxide and mixtures thereof. The particular solvent selected is often dependent on several considerations, not the least of which is economics; but, generally speaking, furfural and phenol are the more preferred solvents. With the exception of a low asphalt lube or fraction, the material boiling above about 1000° F. is to be deasphalted before the aromatic extraction. In the case of the low asphalt stocks, the well-known Duo-Sol extraction procedure wherein deasphalting and aromatics extraction are carried out simultaneously is quite satisfactory. Known techniques for increasing selectivity for aromatics can be advantageously employed on occasion here. Examples of these are: providing for the presence of a small amount of water during the extraction with furfural, operating in the lower portion of the suitable temperature range for the particular solvent, and carrying out several extractions with a low ratio of solvent to oil and combinations of the foregoing.

The temperature of the extraction and solvent dosage is interdependent, and both the extraction and solvent dosage are in turn dependent upon the composition of the particular fraction being extracted. Accordingly, the following comments are to be understood as so qualified.

The temperature of all the extractions must be carried out below the temperature miscibility of the oil and the solvent in order to have any extractive separation. Usually the extraction temperature should not be more than about 50° F. below the temperature of miscibility for a highly efficient operation. If the charge has not been dewaxed, then the minimum temperature of the extraction is controlled by the point at which solids appear. However, in

addition if the extraction temperature is too low, the extraction will be too selective and require application of compensating features such as additional extraction stages or else the benefits may be too limited. The temperature range encompassing all of the suitable operating temperatures for all of the solvents is, generally speaking, about 0° to 350° F. In the case of furfural, however, a temperature in the more restricted range of about 125° to 325° F. is preferably employed.

Much of the same comments above in regard to temperature are equally applicable to the ratio of solvent to oil employed. That is, the temperature and solvent ratios are interdependent on each other, and each is in turn dependent on the charge stock and principally its boiling range of molecular weight range. High ratios of solvent to oil like high temperatures tend to reduce the efficiencies of the operation, producing lower yields of raffinate as a hydrocracker charge, and are to be avoided. For the most part, at the suitable temperatures, solvent to oil ratios in the range of about 6/1 to about 0.25/1 will be found suitable. However, ratios of solvent to oil on the order of about 4 to 0.8/1 will be found most preferred. It is believed that any further discussion of these variables will be better understood by reference to an example. Thus, a Lagomedio crude fraction boiling in the range of about 850° to 950° F. is preferably solvent extracted at a temperature of about 200° to 250° F. at a solvent dosage in the range of about 1 to 2 parts by volume of furfural per volume of treated oil. The fraction boiling above 950° F. from the same crude which has been desphalated with propane is preferably solvent extracted at a temperature of about 225° to 275° F. at a solvent dosage of about 2 to 3 volumes of furfural per volume of treated oil. Fractions from other crudes would require some modification of the foregoing.

The equipment that may be employed is not critical as any conventional solvent extraction equipment can be employed. For example, rotating disc contactors, Podbielniak reactors, and countercurrent packed bed extraction columns may be named as illustrative. As will be apparent from the foregoing, the extraction can be carried out in either a batch-wise operation or a continuous one, although the latter is generally found more convenient, economic, and preferred.

The residuum and distillates which have been extracted are then charged to a conventional lube oil hydrocracker and hydrocracked but nonlimiting examples of the hydrocracking procedure and modifications are U.S. Pats. 2,779,711, 2,917,448, 2,960,458, 3,046,218, 3,078,238, and 3,078,221. It is to be fully appreciated, however, that in the foregoing patents several clearly teach away from the present invention, indicating that the charge stock is not to be extracted with a solvent having preferential solubility for aromatics and that, in contradistinction to those teachings, an improved result can be obtained by such an extraction at milder hydrocracking conditions in combination with said extraction pretreatment. It has thus been discovered that those teachings are in error to the extent that they purport to apply to the procedure of this present invention as a whole. It is also desired to point out that such teachings are in error as to the requisite minimum viscosity of suitable charge stocks. In the present invention, charge stocks as low as about 45 to 50 SUS at 210° F. can be employed. However, as the prior art indicates, the hydrocracker charge should generally have a V.I. of at least about 60 preferably at least about 75.

In brief, the preferred hydrocracking procedure comprises hydrocracking the solvent extracted material at about 650° to 825° F., but preferably between 700° and 800° F. at a pressure above about 1500 p.s.i., but more usually and preferably above about 2000 p.s.i., and at a liquid hourly space velocity between about 0.2 and 4.0, but more usually between about 0.4 and 1.5. The hydrocracking treatment is, of course, carried out in the

presence of hydrogen over a hydrocracking catalyst, i.e., a catalyst having both aromatic saturation and ring-scission activity. Preferably, a sulfactive catalyst is employed. Sulfactive catalysts broadly comprise a sulfide of any metal of Group VI, left-hand column, of the periodic system or a sulfide of an iron group metal but preferably a sulfide of the Group VI metals mixed with a sulfide of an iron group metal; for example, a nickel sulfide and tungsten sulfide catalyst, in about a 1/1 to 4/1 metal ratio respectively, is excellent on an alumina, silica, or alumina-silica base. Hydrocracking catalysts of free metals such as palladium on a mole-sieve base, etc., can be used but are less preferred.

To obtain the high V.I. lube oil product, the hydrocracker effluent is dewaxed (when necessary) and then is distilled into various blending stocks and typically into No. 1, No. 2, and No. 4 distillates, all of which have V.I. of about 100 or above.

A very important varying embodiment of the present invention comprises the broad three-step combination of (1) solvent extracting the hydrocracker charge stock, (2) hydrocracking the raffinate, followed by (3) a second solvent extraction of the hydrocrackate. Solvent extraction following hydrocracking is disclosed in commonly assigned copending application Ser. No. 530,580 filed Feb. 28, 1966, now abandoned entitled "Stable Lubricating Oil" under the inventorship of Sheldon L. Thompson. The entire teachings of that application in regard to the hydrocracking and solvent extraction treatment following the hydrocracking are incorporated herein. However, for convenience and for purposes of fullness of disclosure, the teachings will be briefly summarized. According to application Ser. No. 530,580, the hydrocracked lube oil product which has been hydrocracked at a temperature above about 650° F. is serially extracted with a selective solvent having preferential solubility for aromatic compounds at a temperature broadly in the range of about 0° to 300° F. Preferably, the extraction is carried out at a relatively low temperature within the respective suitable range. With furfural the temperature range is preferably about 80° to 130° F. using a furfural to oil ratio in the range of about 1.25/1 to 0.5/1 and employing a minimum of two and preferably three to seven extraction stages. The effect of the foregoing extraction is to improve the quality of the oil in respect to color, color stability, U.V. adsorptivity, and sludge formation.

Alternatively, but usually less preferred, in lieu of the second stabilizing selective solvent extraction, the hydrocracked product can be hydrogenated in accordance with the procedure disclosed in commonly assigned copending application Ser. No. 694,096, filed Dec. 28, 1967, now abandoned, under the joint inventorship of Thompson et al. The teachings of Ser. No. 694,096 are incorporated herein in entirety with such modifications as are necessitated by the difference in the two inventions, which modifications will be readily apparent. In brief, however, that process involves hydrogenating hydrocracked lube oil products over a sulfactive hydrogenation catalyst such as sulfide of the Group IV-B metals and the Group VIII metals, and preferably combinations thereof, for example, nickel sulfide and molybdenum sulfide on an alumina carrier. The hydrogenation temperatures are in the range of about 450° to 640° F. but preferably from about 575° to 625° F., and hydrogen partial pressures are at least about 1500 p.s.i. and preferably about 2500 to 3000 p.s.i.

The hydrocracked product, of course, can be solvent extracted in bulk prior to any separation; or the extractions can be carried out separately on separated fractions of the hydrocracked product, for example, a fraction comparable to a 100 Neutral Oil, a 200 Neutral Oil, a 500 Neutral Oil, and a Bright Stock. Likewise, the prehydrocracking solvent extraction can be carried out on the hydrocracker charger in bulk before separation into the respective charge fractions, or the extractions can be carried out on each fraction separately. Of course, any combination of extractions in bulk or on separated lube frac-

tions before and after hydrocracking can be employed. A preferred embodiment involves an extraction on separated lube fractions before hydrocracking, followed by extraction of the hydrocracked product in bulk. This latter embodiment constitutes an especially preferred version of this invention and will be discussed in reference to the figure for purposes of clarity.

Referring now to the figure, a crude is charged through line 1 to a conventional atmospheric still 2 and topped to about 700° F. The reduced crude is charged via line 3 to a conventional vacuum still 4 and fractionated into three fractions. The three fractions boil in the ranges of about 700° to 850° F., about 850° to 1000° F., and finally the residuum containing all the material boiling above about 1000° F.

If the residuum is to be used in the remainder of this process, it is charged through line 5 to deasphalter 6 and is propane deasphalted there. Alternatively the residuum may be used elsewhere such as for a residual fuel, delayed coker charge stock etc., the deasphalted oil is then charged via line 7 to a furfural extracting stage 8 wherein material which is relatively more refractory is removed. The intermediate fraction is charged via line 9 to a similar furfural extracting stage 10 wherein material which is relatively more refractory is removed. In lieu of duplicate extracting equipment, both of the foregoing extractions can be carried out in the same equipment. However, preferably the feeds are alternately charged to the equipment and the raffinates are combined, if they are to be, for further processing after the extractions have been carried out separately.

Referring again to the figure, the raffinate from 8 if it is to be used is charged via line 11 to line 13 wherein it is mixed there with the raffinate from 10 which is charged to line 13 through line 12, and both raffinates are mixed in line 13 with the unextracted distillate boiling in the range of about 700° to 850° F., which is

charged via line 14. The combined and mixed feeds are charged to hydrocracker 15 where they are hydrocracked at conditions falling within conventional hydrocracking conditions (e.g., a temperature in the range of about 700° to 800° F., a hydrogen pressure of about 2000 to 3000 p.s.i., a space velocity in liquid volumes of feed per volume of catalyst per hour of about 0.4 to 1.5 over a catalyst of nickel sulfide-tungsten sulfide in a metals ratio of about 4 to 1 respectively on an alumina-silica carrier) but adjusted so that overall they are milder than such would be for the feed if not solvent extracted. The hydrocrackate is charged via line 16 to an atmospheric still 17 where it is topped to about 650° F. and then charged via line 18 to dewaxer 19. The dewaxed product is charged via line 20 to furfural extraction equipment 21. In the furfural extraction carried out in 21, the overall conditions are materially different than that in 8 and 10. This extraction is carried out so as to be very shallow and selective whereby components removed are substantially limited to those necessary to obtain quality stability (i.e., primarily as to U.V. stability, stability in the presence of oxygen, and stability with respect to sludge formation) with a minimal loss of oil to the extraction, for example, on the order of about 2%. The preferred conditions are those discussed in reference to copending application Ser. No. 530,580 hereinabove. The stabilized raffinate oil is passed via line 22 to the final vacuum still 23 where the light materials have viscosities (if not a gas) below that for lube oils. The distillation is carried

out so as to recover lube blending stocks that are desired, for example, a 70 Neutral, a 100 Neutral, a 200 Neutral, a 500 Neutral, and a Bright Stock.

Of course, other conventional processing techniques can be employed with this invention such as recycle of materials to further upgrade them where desired (with the usual reduction in yield due to the upgrading).

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Example I

		Crude properties
Gravity, API°	-----	32.9
Sulfur, wt. percent	-----	1.26
SUS/100° F.	-----	52.7
Pour point, ° F.	-----	-30.0
O.D. Color	-----	22,270

The foregoing charge was vacuum distilled and the heaviest fraction (comprising about 23% of the crude) was propane deasphalted (yield of oil about 50%) to produce the following fractions:

		Boiling range
Light vacuum distillate	-----	About 775° to 855° F.
Heavy vacuum distillate	-----	About 855° to 955° F.
Deasphalted oil	-----	About 955° and above.

A portion of the heavy distillate and deasphalted oil were extracted with furfural at the following conditions:

	Solvent dosage, percent	Temperature, ° F.	Raffinate Yield
Heavy vacuum distillate	150	220	About 60%.
Deasphalted oil	300	220	About 80%.

These fractions had the following properties:

	Unextracted			Extracted	
	Weight percent aromatics	API gravity, 60° F.	Conradson carbon No.	Weight percent aromatics	API gravity, 60° F.
Heavy vacuum distillate	50.4	21.9	-----	37.0	29.0
Deasphalted oil	52.4-52.8	22.0-22.3	1.8-1.98	-----	25.6

The foregoing materials were blended as follows to prepare comparative feeds for hydrocracking:

Run number	1	2
Light vacuum distillate, percent	23.8	29.2
Heavy vacuum distillate, percent	28.7	-----
Deasphalted oil, percent	47.5	-----
Extracted heavy vacuum distillate, percent	-----	24.2
Extracted deasphalted oil, percent	-----	46.6

The properties of the above blends were as follows:

Run number	1	2
API gravity, 60° F.	23.3	27.7
IBP	694	706
5%	755	762
10%	784	791
50%	917	940
E.P.	1,030	1,030
Recovery, percent	75	67
Conradson carbon, wt. percent	1.0	-----
Viscosity/100° F.	41.13	35.47
Viscosity/210° F.	16.14	14.74

The blended charges were hydrocracked as follows:

Run number	1	2
Catalyst composition	(1)	(1)
Catalyst temperature (avg.)	755	755
Space velocity (v./hr./v.)	0.5	1.0
Hydrogen pressure	2,500	2,500
Hydrogen consumption (100% purity) s.c.f./bbl	1,000	800

¹ Nickel sulfide-tungsten sulfide in about a 1 to 1 metals ratio on a silica alumina base.

The results on a dewaxed basis were as follows:

Run number	1	2
Yield, based on vol. percent of charge	39.4	45.7
Yield, based on vol. percent of original crude	9.6	19.1
V.I. range	105-115	102-110

¹ This made proportionately less material approximating a 100 Neutral and accordingly a greater proportion of the crude could be hydrocracked, such as the light vacuum distillate which was not charged to the hydrocracker to make additional 100 Neutral if desired.

Example II

This example compares partially extracted and unextracted distillate feed hydrocracking using a Lagomedio crude. The light vacuum distillate as used herein boils below 855° F. and the heavy vacuum distillate above 855° F.

	Unextracted distillate	Partially extracted distillate
Chargestock composition, vol. percent hydrocracker charge:		
Unextracted lt. vac. dist.	66.6	73.7
Unextracted heavy vac. dist.	33.4	
Heavy vac. dist. raffinate		26.2
Total	100.0	100.0
Blended feed stock analysis:		
API gravity	25.2	27.5
Vacuum boiling range, ° F. at atm.:		
IBP	688	685
5%	728	735
10%	761	760
30%	807	798
50%	851	877
70%	893	877
90%	922	927
95%	944	951
E. P./recovery, percent	952/98	987/98
Viscosity:		
Cst. at 100° F.	65.8	41.0
Cst. at 210° F.	6.81	6.17
Sulfur, wt. percent	1.3	1.09
Nitrogen, wt. percent	.139	.08
Gel aromatics, wt. percent	39.6	36.9
Rams bottom carbon, wt. percent	.34	0.16
Operating conditions:		
Avg. catalyst temperature, ° F.	779	747
Peak catalyst temperature, ° F.	795	756
Space velocity, vol./hr./vol.	0.98	1.02
H ₂ partial pressure, p.s.i.a.	2,550	2,586
H ₂ chemical consumption, s.c.f./bbl.	850	700
Product yields:		
100 neutral plus lube yield, vol. percent charge	39.2	43.0
100 neutral plus lube yield, vol. percent crude	7.6	7.75
V.I. range of lubes	102-112	101-109

Component properties	Unextracted		Heavy dist. raffinate
	Lt. vac. dist.	Heavy vac. dist.	
API at 60° F.	262	232	29.6
Vacuum boiling range, ° F. at 1 atm.:			
IBP	713	717	699
5%	748	824	812
10%	763	854	862
30%	785	896	906
50%	814	908	923
70%	844	917	943
90%	880	936	960
95%	889	943	989
E. P./recovery	899/98	947/98	1002/98
Viscosity:			
Cst. at 100° F.	33	130	70
Cst. at 210° F.	5.38	11.97	9.39
Sulfur, wt. percent	1.25	1.44	0.56
Gel aromatics, wt. percent	38.0	43.7	28.7

This example illustrates an improvement in yield through the use of the present invention along with the use of a lower hydrocracking temperature and a reduction in hydrogen consumption.

I claim:

1. A process of preparing lubricating oils comprising:
 - (a) fractionating a charge stock into a plurality of fractions boiling above 650° F., including a heavy vacuum distillate boiling above about 850° F.,
 - (b) solvent extracting said heavy vacuum distillate with a solvent having preferential solubility for aromatics, said extraction being carried out at a tem-

perature of from 0° F. to 250° F. and a solvent to oil ratio of from about 6:1 to 0.25:1 to produce a raffinate,

- (c) combining said raffinate with at least a substantial portion of the lower boiling portion of said charge stock which has not been solvent extracted to form a hydrocracker charge stock,
- (d) hydrocracking said hydrocracker charge stock at from about 650° F. to about 825° F., a hydrogen partial pressure of from about 2000 p.s.i. to about 3000 p.s.i. in the presence of a hydrocracking catalyst at a liquid hourly space velocity in the range of from about 0.2 to about 4.0, whereby a lube oil having a substantially improved viscosity index is produced,
- (e) solvent extracting at least a portion of said hydrocrackate in at least two stages with a solvent having preferential solubility for aromatics to provide for a loss of oil on the order of about 2%, and
- (f) recovering a lubricating oil.

2. The process of claim 1 wherein solvent extraction step (c) is performed on all of the hydrocrackate.

3. The process of claim 2 wherein the hydrocracking step (b) is carried out using a sulfactive hydrogenation catalyst.

4. The process of claim 3 wherein the charge stock before step (a) is fractionated into a fraction boiling at from about 700 to 850° F., a fraction boiling at from about 850 to 1000° F., and a residuum boiling above about 1000° F. wherein only the fraction boiling at from about 850 to 1000° F. is solvent extracted in step (b) and wherein only the fraction boiling at from about 700 to 850° F. and the extracted fraction boiling at from about 850 to 1000° F. are combined to form the hydrocracker charge stock.

5. The process of claim 4 wherein the solvent used in steps (a) and (c) is furfural.

6. The process of claim 3 wherein the charge stock before step (a) is fractionated into a fraction boiling at from about 700 to 850° F., a fraction boiling at from about 850 to 1000° F., and a residuum boiling above about 1000° F., wherein the residuum is deasphalted and both the fraction boiling at from about 850 to 1000° F. and the residuum are solvent extracted with a solvent having preferential solubility for aromatics, and all three fractions are recombined in step (b).

7. The process of claim 6 wherein the solvent used in steps (a) and (c) is furfural.

8. A process of preparing lubricating oils comprising:

- (a) fractionating a charge stock into a plurality of fractions boiling above about 650° F., including a heavy vacuum distillate boiling in the range of from about 850° F. to about 1000° F.,

- (b) solvent extracting at least a major portion of the fraction boiling in the range of from about 850° F. to about 1000° F. with a solvent having preferential solubility for aromatics, said extraction being carried out at a temperature of from 0° F. to 350° F. and a solvent to oil ratio of from about 6:1 to 0.25:1 to produce a raffinate,

- (c) combining said raffinate with at least a substantial portion of the lower boiling portion of said charge stock which has not been solvent extracted to form a hydrocracker charge stock,

- (d) hydrocracking said hydrocracker charge stock at from about 650° F. to about 825° F., a hydrogen partial pressure of from about 2000 p.s.i. to about 3000 p.s.i. in the presence of a hydrocracking catalyst at a liquid hourly space velocity in the range of from about 0.2 to about 4.0, whereby a lube oil having a substantially improved viscosity index is produced, and
- (e) recovering a lubricating oil.

9. The process of claim 8 wherein the charge stock in step (a) is fractionated into three fractions—the light-

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est of which fractions boils in the range of from the initial boiling point of the charge stock up to about 850° F., the heavy vacuum distillate, and a residuum boiling above about 1000° F., wherein a substantial portion of the lightest fraction is combined with the heavy vacuum distillate in step (c) and the residuum is not combined in step (c).

10. The process of claim 9 wherein the hydrocracking in step (d) is carried out using a sulfactive hydrocracking catalyst.

11. The process of claim 10 wherein the sulfactive hydrocracking catalyst is a supported mixture of nickel sulfide and tungsten sulfide.

12. The process of claim 10 wherein the solvent used in step (b) is furfural.

13. The process of claim 12 wherein the temperature used in step (b) is from about 125° F. to about 350° F.

14. The process of claim 8 wherein the charge stock in step (a) is fractionated into three fractions—the lightest of which fractions boils in the range of from the initial boiling point of the charge stock up to about 850° F., the heavy vacuum distillate, and a residuum boiling above about 1000° F., wherein the residuum is deasphalted, both the heavy vacuum distillate and the residuum are separately solvent extracted with a solvent having preferential solubility for aromatics at a temperature of from 0° F. to 350° F. and a solvent to oil ratio of from about 6:1 to 0.25:1 and a substantial portion of all three fractions are combined in step (c).

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15. The process of claim 14 wherein the hydrocracking in step (d) is carried out using a sulfactive hydrocracking catalyst.

16. The process of claim 15 wherein the sulfactive hydrocracking catalyst is a supported mixture of nickel sulfide and tungsten sulfide.

17. The process of claim 15 wherein the solvent used in step (b) is furfural.

18. The process of claim 17 wherein the temperature in step (b) is from 125° F. to 350° F.

References Cited

UNITED STATES PATENTS

	2,917,448	12/1959	Beuther et al.	208—86
15	3,308,055	3/1967	Kozlowski	208—18
	3,463,724	8/1969	Langlois et al.	208—18
	3,562,145	2/1971	Franz et al.	208—96
	3,403,092	9/1968	Rausch	208—87
	3,481,863	12/1969	Donaldson et al.	208—18
20	3,414,506	12/1968	Campagne	208—18
	3,242,068	3/1966	Paterson	208—18
	3,520,796	7/1970	Murphy et al.	208—18

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208—18, 93, 96