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Stauffer et al.

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[54] **LUBE OIL HYDROTREATING PROCESS**

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[58] **Field of Search** 208/78, 18

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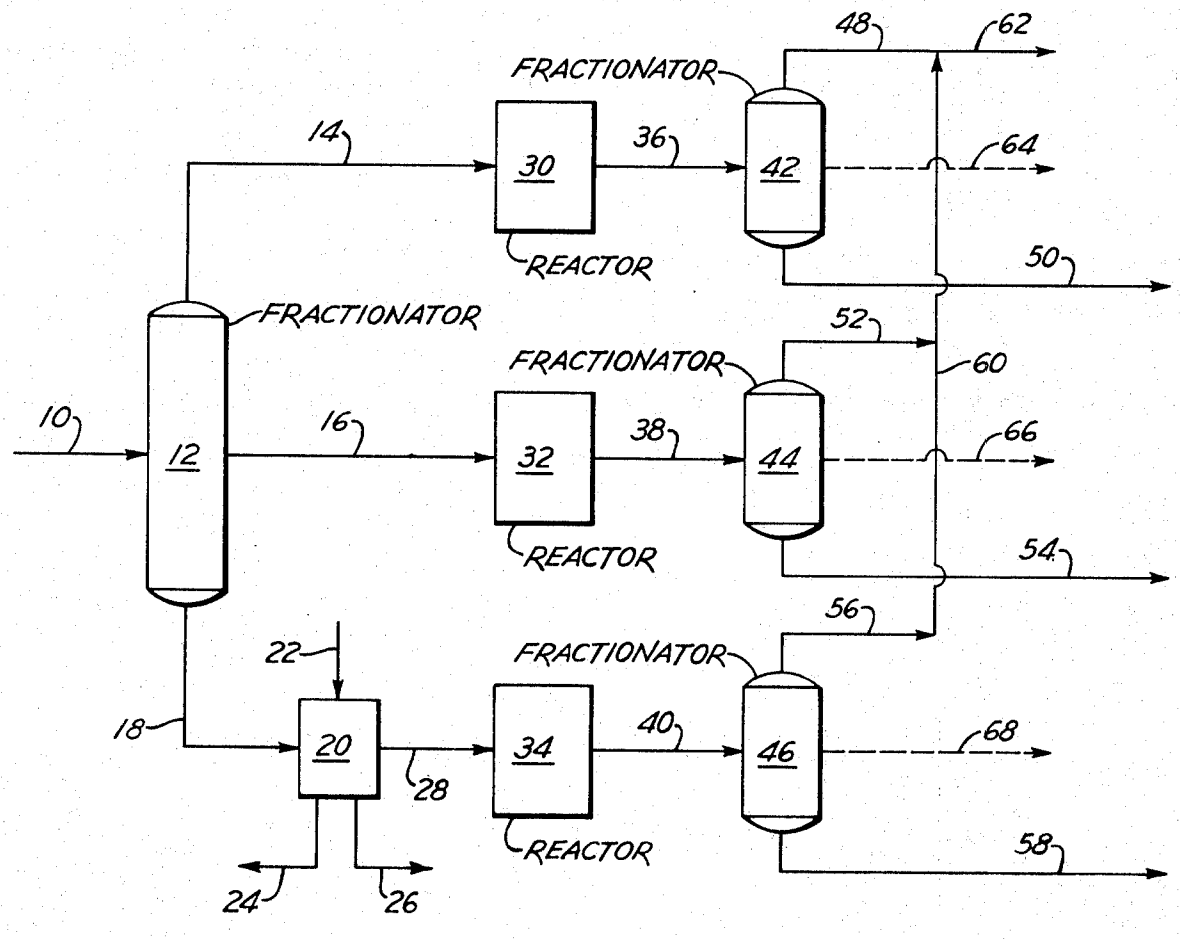
[57] **ABSTRACT**

A process for producing lubricating oils in order to obtain lubricating oils of enhanced viscosity index by hydrotreating various crude lubricating oil fractions separately.

3 Claims, 2 Drawing Figures



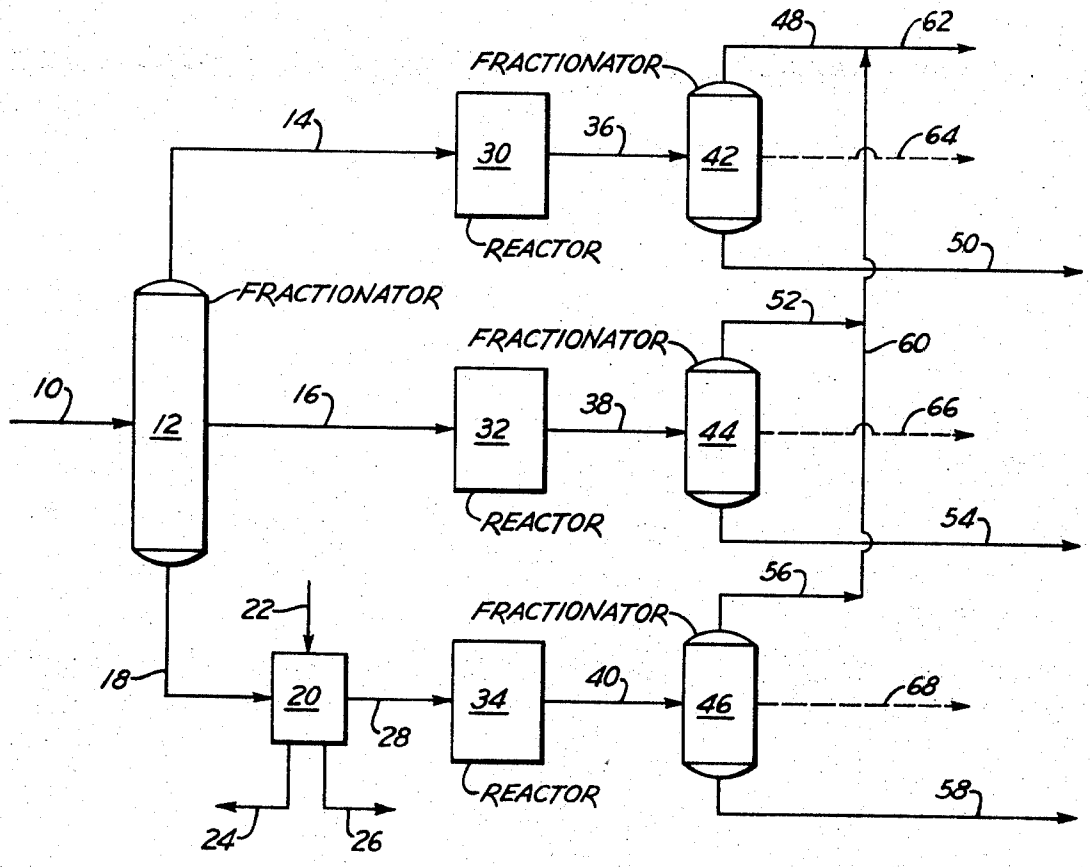

48
62
FRACTIONATOR
14
30
36
42
64
REACTOR
50
FRACTIONATOR
52
FRACTIONATOR
60
10
12
16
32
38
44
66
REACTOR
54
56
22
FRACTIONATOR
18
20
34
40
46
68
28
REACTOR
58
24
26

Fig. 1

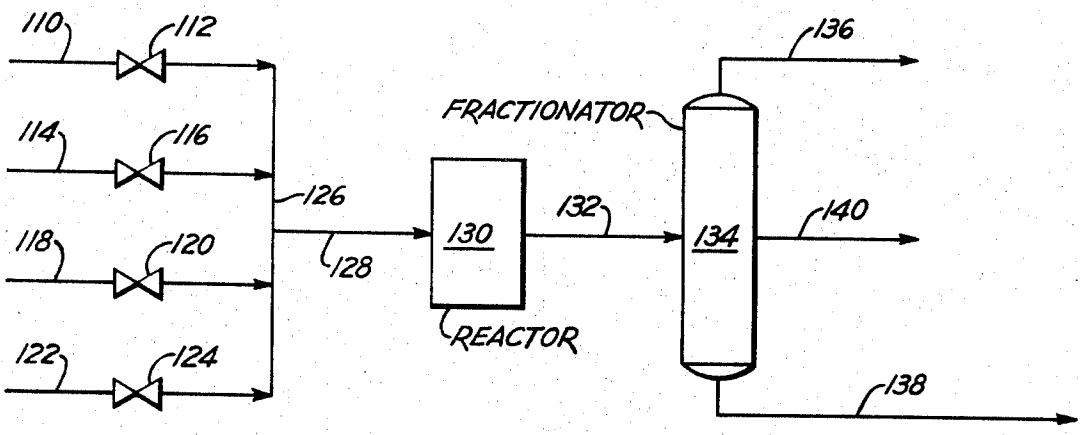

110
112
136
FRACTIONATOR
114
116
126
130
132
134
140
118
120
128
REACTOR
122
124
138

Fig. 2

LUBE OIL HYDROTREATING PROCESS

Our invention relates to the production of lubricating oils by hydrotreating. More particularly, our invention relates to the production of lubricating oils by separately subjecting various crude lubricating oil fractions to hydrotreating and then fractionating the effluents. More particularly, our invention relates to the hydrotreating of various crude lubricating oil fractions under the optimum conditions required to provide the desired product slate.

It has previously been suggested in the art to subject hydrocarbon fractions boiling in the lubricating oil range to various treatments with hydrogen in order to provide lubricating oil base stocks meeting desired specifications, such as, for example, viscosity, viscosity index (VI), pour point and acceptable contaminant levels. These hydrogen treatment techniques are designated by a variety of terms whose definitions tend to overlap depending upon the individual employing such terms. Regardless of the inadequacy of nomenclature in this area, these hydrogen treatment processes can be categorized into four different groups. We chose to term these categories as hydrocracking, hydrotreating, hydrogenation and hydrofinishing.

As employed herein the term "hydrocracking" is meant to describe an extremely severe hydrogen treatment, usually conducted at comparatively high temperatures and requiring the employment of a catalyst having substantial cracking activity, e.g., an activity index (AI) greater than 40 and generally greater than 60. This type of process is conducted to effect extensive and somewhat random severing of carbon to carbon bonds resulting in a substantial overall reduction in molecular weight and boiling point of treated material. Thus, for example, hydrocracking processes are generally employed to effect an extremely high conversion, e.g., 90 percent by volume, to materials boiling below the boiling range of the feed stock or below a designated boiling point. Usually a hydrocracking process is employed to produce a product boiling predominantly, if not completely, below about 600° to 650° F. Most frequently this type of process is employed to convert higher boiling hydrocarbons into products boiling in the furnace oil and naphtha range. When applied in connection with lubricating oils, hydrocracking processes produce only a minor quantity of materials boiling in the lubricating oil range, i.e., 625° to 650° F.+, to the extent that, at times, the production of a lubricating oil is merely incidental to the production of naphtha and furnace oil. Hydrocracking is the most sever of the four types of processes mentioned above.

On the other end of the spectrum, "hydrofinishing" is an extremely mild hydrogen treatment process employing a catalyst having substantially no cracking activity. This process effects removal of contaminants such as color forming bodies and a reduction of minor quantities of sulfur, oxygen and nitrogen compounds, but effects substantially no saturation of unsaturated compounds such as aromatics. This process, of course, effects no cracking. As a general rule, hydrofinishing is employed in lieu of the older techniques of acid and clay contacting.

A third type of hydrogen treatment process is "hydrogenation" which as employed herein, describes another comparatively mild process. Hydrogenation, although being comparatively mild, is more severe than hydrofinishing and generally effects saturation of unsaturated materials such as aromatics. A hydrogenation process is also capable of removing somewhat larger quantities of contaminants such as sulfur. A hydrogenation process is conducted with a catalyst having substantially no cracking activity and accordingly does not produce any significant reduction in boiling point of the material treated over and above that which might be effected from sulfur removal alone. Accordingly, therefore, a hydrogenation process is employed, albeit infrequently, in the area of lubricating oil production in order to effect saturation of aromatics and removal of sulfur from a charge stock already boiling within the lubricating oil range without the production of any lower boiling materials.

As distinguished from hydrocracking, hydrofinishing and hydrogenation, the term "hydrotreating" is employed herein to describe a processing technique significantly more severe than hydrogenation although substantially less severe than hydrocracking. The catalyst required in a hydrotreating process must possess cracking activity and generally possess a particular type of activity termed "ring scission activity." The degree of cracking and ring scission activity is dependent upon foodstock and product desired. Thus, a hydrotreating process effects a substantial molecular rearrangement as compared to hydrogenation or hydrofinishing but does not effect the extensive and somewhat random breakdown of molecules effected in hydrocracking. Accordingly, this type of process effects substantially complete saturation of aromatics and the reactions are believed to follow the course of converting condensed aromatics to condensed naphthenes followed by selective cracking of the condensed naphthenes to form single ring alkylnaphthenes. Thus, polynuclear cyclic compounds are attacked and the rings are opened, while monouclear cyclic compounds are not substantially affected. The alkyl side chains formed by opening the rings are not further reacted to sever the alkyl side chains. Hydrotreating processes are also effective for the isomerization of paraffins. As with the less severe hydrogenation process and the more severe hydrocracking process, hydrotreating is also effective to remove contaminants such as sulfur, nitrogen and oxygen. Thus, a hydrotreating process removes contaminants, reduces the quantity of aromatics and polynuclear cyclic compounds and increases the quantity of paraffins, thereby enhancing the quality of the material treated, reducing its iodine number and increasing its VI.

A hydrotreating process can also be identified by the fact that the particular combination of operating conditions and catalyst selected to accomplish the above-mentioned results produces a product wherein there is a general decrease in VI from the highest viscosity fraction to the lowest viscosity fraction of the lubricating oil. While at times the rate of decrease in VI with decreasing viscosity may be extremely slight or even appear to be non-existent among extremely high viscosity fractions, the rate of decrease in VI tends to become greater as the viscosity of the lubricating oil fraction decreases. Usually, this decrease in VI with decreasing viscosity is particularly pronounced among the lighter lubricating oils having the lowest viscosities, such as, for example, materials whose viscosity is usually measured in Saybolt Universal Seconds (SUS) at 100° F. Additionally, this phenomenon is evidenced quite drastically in hydrotreated lubricating oil products having

viscosities of less than about 300 SUS at 100° F. and obtained from distillate charge stocks. This is not to say, however, that the decrease in VI with decreasing viscosity cannot be seen quite clearly in the hydrotreated products of residual stocks whose viscosities, at times, are more conveniently measured in SUS at 210° F.

The particular operation involved in the process of our invention is hydrotreating as distinguished from hydrofinishing, hydrogenation and hydrocracking. The material normally charged to a hydrotreating operation can be termed a "crude lubricating oil stock" and is generally obtained from crude petroleum by distillation so as to provide a material boiling at least above about 600° F. and preferably above about 625° to 650° F. Depending upon the crude petroleum from which the crude lubricating oil stock is obtained, such material may be subjected to a pretreatment such as solvent extraction prior to being charged to a hydrotreating operation. Within the overall boiling range of crude lubricating oils, we term materials boiling up to about 950° to 1,000° F. as "distillates" or "distillate crude lubricating oil stocks" while we term the portions boiling above about 950° to 1,000° F. "residuals" or "residual crude lubricating oil stocks." In connection with residual crude lubricating oils, it may be desirable, depending upon the source of the crude, to subject such material to deasphalting such as, for example, propane deasphalting, prior to charging it to a hydrotreating process. The products from hydrotreating operations can be fractionated and blended with each other to produce desired lubricating oil products and in some instances, depending upon specific end uses of the lubricating oils, such materials can be subjected to finishing operations, such as acid and clay contacting or the hydrofinishing treatment described previously.

In the petroleum refinery field generally, and particularly with processes effecting any substantial molecular rearrangement of the material being treated, it is usually anticipated that the heavier or higher boiling feed stocks must be treated at more severe conditions than those employed for the treatment of a lighter or lower boiling feed stock. From this it follows that the severity of the operation is in many instances determined by the severity required to effect molecular rearrangement of the heavier components in the feed stock. We have found, however, that in the area of hydrotreating a wide boiling crude lubricating oil that such is not necessarily so. Rather we have found that in hydrotreating such stock containing both residual and distillate the severity of the operation is limited by the tendency of the higher boiling components, e.g., materials boiling above 950° to 1,000° F., to crack into extremely low boiling, e.g., less than 650° or 600° F., less valuable non-lubricating oil materials at conditions of high severity. Consequently, the severity of a hydrotreating operation must be adjusted to avoid such cracking or hydrocracking. This restriction on severity limits the possible increase in VI for the lower viscosity, lower boiling, e.g., boiling below 950° to 1,000° F., portions of the charge stock thereby producing lower viscosity lubricating oils of undesirably low VI. In many instances the VI of such low viscosity lubricating oil base stocks is too low to meet even minimum specifications for given lubricating oils.

This phenomenon presents a serious dilemma to the refinery operator in that selection of operating conditions of proper severity to retain the higher boiling product fraction, i.e., bright stock, while achieving desired VI for the bright stock results in the lighter fractions having an unacceptably low VI. On the other hand, however, if operating conditions are selected so as to provide adequate severity for the desired enhancement of the VI of the distillate products, the disadvantages are two-fold. First, as mentioned above, there is not only an overall loss in lubricating oil product obtained but such loss is substained in the bright stock product which is probably the most important product from the viewpoint of economics and flexibility, since a heavier fraction can always be blended with a lighter fraction to produce a blended base stock of lower viscosity but once a heavier material has been destroyed, it cannot be reconstituted. Further, employment of a severity sufficient to provide adequate VI enhancement for the lighter fractions not only decreases the yield of bright stock but also produces a bright stock product having an unnecessarily high VI. This is termed "VI giveaway."

We have further found that in the treatment of distillate crude lubricating oils, i.e., boiling up to about 950° or 1,000° F., it is generally advantageous to treat the highest boiling distillate fraction, the so called heavy distillate, under more severe conditions than employed in treating a lower boiling distillate fraction, e.g., a middle distillate fraction. This relationship in the severity of hydrotreating, for example, a heavy distillate fraction boiling from about 900° to about 1,000° F. and a medium distillate fraction boiling from about 850° to about 950° F. prevails even though both distillate fractions are hydrotreated under conditions more severe than employed in hydrotreating a residual fraction.

Our invention provides a process for producing lubricating oils with an improved viscosity-VI distribution. In accordance with our invention a residual crude lubricating oil fraction and a plurality of distillate crude lubricating oil fractions are separately subjected to hydrotreating under conditions of differing severity. The particular operating conditions are selected so that the severity of conditions employed in hydrotreating the distillate crude lubricating oils decreases with decreasing boiling range of the distillate crude lubricating oil fractions and so that the conditions employed in hydrotreating the heaviest distillate fraction are more severe than the conditions employed in hydrotreating the residual crude lubricating oil fraction. After hydrotreating, each of the hydrotreated effluents is separately fractionated so as to separate a lubricating oil boiling range fraction from a lower boiling fraction. The lower boiling materials are removed from the system and the lubricating oil boiling range fractions are recovered as product. These separate fractionations can be conducted so that the lower boiling fractions are comprised solely of materials boiling below the lubricating oil boiling range, i.e., below about 650° F., or they can be conducted so that the lower boiling fraction also comprises a minor portion of the lubricating oil boiling range materials contained in an individual hydrotreater effluent. Alternatively, the separate fractionations can be conducted so as to separate the lower boiling lubricating oil boiling range materials as separate fractions which are removed from the system for separate recovery or treatment. The selection of particular cut points and number of fractions obtained is, of course, very

much determined by selection of feed stocks, operating conditions and desired products.

The feed stock suitable for employment in our invention can be a wide boiling crude lubricating oil or several individual crude lubricating oil fractions. Generally, an individual lubricating oil base stock fraction, i.e., the product of hydrotreating, and the corresponding individual crude lubricating oil fraction, i.e., the charge to hydrotreating, boil over a nominal range of about 100° F. At times, the actual spread from initial boiling point (IBP) to end point (EP) of the fraction may be somewhat greater or lesser than the nominal 100° F. but the spread from 10 to 90 percent point rarely exceeds 100° F. and is usually well within the 100° F. range, e.g., about 80° F. The charge stock to the present invention, however, is termed a wide boiling crude lubrication oil which is meant to define a crude lubricating oil boiling over a range of at least about 150° and frequently boiling over a range of at least 200° F. Such a wide boiling crude lubricating oil will also have a spread between 10 percent point and 90 percent point of at least about 125° F. and usually at least about 170° F. Similarly, several individual crude lubricating oil fractions whose spectrum of boiling ranges encompasses at least about 150° F. and preferably at least about 200° F. constitute suitable feed stocks. As will be understood, the individual crude lubricating oil fractions can be charged directly to the process of our invention, while a wide boiling crude lubricating oil would have to be fractionated so as to obtain individual crude lubricating oil fractions to be separately hydrotreated.

Additionally, the charge stock to our invention, whether a wide boiling crude lubricating oil or a plurality of individual crude lubricating oil fractions considered as an entity, will contain a significant quantity of both distillate components and residual components. Thus, a total charge stock containing from about 10 to about 90 percent by volume distillate components and containing from about 90 to about 10 percent by volume residual components can be treated advantageously in accordance with our invention. Usually, the total feed stock to the process of our invention will be comprised of at least about 25 percent by volume each of distillate and residual components.

The catalyst employed in the process of our invention is a dual functional catalyst comprised of a hydrogenating component on a cracking carrier. Suitable catalysts include metalliferous hydrogenating components selected from the group consisting of Group VI and Group VIII metals, their oxides and sulfides supported on a carrier having cracking activity. Suitable cracking carriers include those having an Activity Index of at least about 15. Carriers having an Activity Index which is comparatively high, e.g., greater than about 60, are also quite satisfactory. Conversely, we have found that in some employments carriers having an Activity Index of less than about 20 and even less than about 18 can be utilized satisfactorily. Illustrative of these catalysts are those containing a plurality of hydrogenating components such as combinations of nickel, cobalt and molybdenum; nickel and tungsten; cobalt and molybdenum, etc. supported on refractory metal oxide carriers. Suitable carriers can be comprised of a single oxide or a plurality of such oxides, e.g., alumina, silica-alumina, silica-magnesia, silica-zirconia, silica-aluminamagnesia, etc. We have found a catalyst comprised of nickel and tungsten hydrogenating components supported on a silica-alumina carrier to be quite satisfactory. Additionally, all of these catalysts can be promoted by the addition thereto of a small quantity of halogen in the range from about 0.1 to about 10 percent by weight based on the total catalyst, and preferably from about 1 to about 4 percent by weight based upon the total catalyst. We prefer to employ a catalyst containing from about 1 to 3 percent by weight of fluorine based on the total catalyst.

The operating conditions employed generally in the hydrotreating operations in accordance with our invention include a temperature in the range from about 600° to about 900° F., preferably from about 700° to about 850° F. and particularly from about 725° to about 825° F; a hydrogen partial pressure in the range from about 2,000 to about 10,000 PSI and preferably in the range from about 2,500 to about 5,000 PSI; a liquid hourly space velocity (LHSV) in the range from about 0.1 to about 10 and preferably from about 0.5 to about 5.0 volumes of crude lubricating oil feed stock per volume of catalyst per hour; and a hydrogen feed rate in the range from about 2,000 to about 10,000 standard cubic feet per barrel (SCF/B) and preferably in the range from about 3,000 to about 6,000 SCF/B. It is not necessary to employ pure hydrogen gas in the hydrotreating operations but it is desirable to maintain a hydrogen purity of at least about 50 percent by volume. Thus, impure hydrogen streams of the type generally found in a refinery, such as, for example, reformer off-gas, containing from about 70 to about 90 percent by volume hydrogen are quite satisfactory.

Within the above ranges of operating conditions, the particular operating conditions employed in the treatment of an individual crude lubricating oil fraction are selected so as to provide the desired degree of severity of treatment for the particular stock and to maintain the required relative severities in the treatment of the plurality of crude lubricating oil fractions. The particular techniques of altering the severity of treatment are well-known to those skilled in the art and include, for example, increasing or decreasing the temperature and increasing or decreasing the space velocity. It will be understood that variation in the severity of the hydrotreating can be affected by employing anyone of the well-known techniques alone or in combination with other known techniques. Thus, for example, the severity of the hydrotreating operation can be increased by increasing the operating temperature, decreasing the space velocity or both increasing the temperature and decreasing the space velocity. As will also be understood by those skilled in the art, the space velocity employed can be varied by altering the charge rate to a fixed quantity of catalyst, by altering the effective catalyst inventory while maintaining a constant charge rate or both. The severity of the hydrotreating operation can also be affected by the operating pressure employed, however, the overall effect of varying pressure is comparatively minor relative to the resulting variation in severity obtainable with smaller and more readily achieved variations in temperature and space velocity.

As mentioned previously, it is a requirement of our invention that the heaviest distillate crude lubricating oil fraction be hydrotreated under conditions more severe than those employed in hydrotreating a residual crude lubricating oil fraction. When this variation in

severity is accompanied solely by a variation in operating temperature while maintaining a constant space velocity, the temperature selected for treatment of the heaviest distillate crude lubricating oil fraction is at least about 10° F. and preferably is at least about 15° F. greater than the temperature employed in hydrotreating the residual crude lubricating oil fraction.

Further, it is a requirement of our invention that the severity of the operating conditions employed in hydrotreating the various distillate fractions decreases with decreasing boiling range of the crude distillate fractions. Thus, for example, among the crude distillate fractions, the heavy distillate will be treated most severely, the medium distillate less severely and the light distillate will be treated under conditions of the lowest severity. Generally, the variation in severity of hydrotreating conditions between two adjacent distillate crude lubricating oil fractions will be substantially less than the difference in severity of operating conditions employed when treating the heaviest crude distillate fraction as compared to the severity of conditions employed when treating a residual distillate crude lubricating oil fraction. It should be noted that in some instances, depending upon the particular feed stock employed and the slate of products desired, the operating conditions employed in hydrotreating the lowest boiling or lightest distillate crude lubricating oil fraction can be at a severity less than that employed in the hydrotreatment of a residual crude lubricating oil fraction. Generally, however, all of the crude distillate fractions will be treated at a severity greater than that employed in the treatment of the residual crude lubricating oil fraction.

Further, we prefer to employ operating conditions in our hydrotreating operations selected from the above-described ranges so as to obtain a yield of at least 50 percent by volume based upon total reactor charge stock of 625° F.+ material. Accordingly, the operating conditions are selected so that at reactor outlet conditions the 625° F.+ material comprises at least 22 mol percent of the product which is normally liquid at 60° F. and one atmosphere. Furthermore, operating conditions are selected so that the actual hydrogen consumption (measured as standard cubic feet per barrel of fresh feed) is less than the product of 30 multiplied by volume percent (measured at 60° F. and one atmosphere) of 625° F.+ material in the total C_5+ reactor effluent.

In order to describe our invention in greater detail, reference is made to the attached drawings wherein FIGS. **1** and **2** are flow schemes showing different methods of operating the process of our invention.

In FIG. **1**, a residual-containing crude lubricating oil boiling above about 650° F. is introduced by means of line **10** into fractionator **12** operated so as to separate the crude lubricating oil into an overhead fraction boiling from about 650° to 850° F., an intermediate fraction boiling from about 850° to about 1,000° F., and a bottoms fraction (containing the residual components) boiling above about 1,000° F. These fractions are removed from fractionator **12** by means of lines **14, 16** and **18,** respectively. The residual fraction of line **18** is subjected to solvent deasphalting by conventional means, such as, for example, propane deasphalting. The deasphalting unit is schematically represented by block **20** showing solvent being introduced via line **22,** solvent being removed via line **24** and asphaltic materials being removed via line **26.** Deasphalted oil is removed from deasphalting unit **20** by means of line **28.** The 650° to 850° F. fraction of line **14,** the 850° to 1,000° F. fraction of line **16** and the deasphalted oil of line **28** are then introduced into hydrotreating reactors **30, 32** and **34,** respectively, wherein these fractions are separately subjected to hydrotreating.

Each of the reactors **30, 32** and **34** contains a fixed bed of a suitable catalyst, such as, for example, nickel-tungsten-fluorine on a silica alumina carrier having an AI of about 75. In each of the reactors, the respective fraction is contacted with the catalyst in the presence of hydrogen under hydrotreating conditions of temperature, pressure and space velocity. The particular operating conditions employed in the three reactors **30, 32** and **34,** however, differ substantially in their severity with the most severe conditions being employed in reactor **32** and the least severe conditions being employed in reactor **34.** Illustrative of the variation in the difference in severity of operating conditions employed would be the employment of a liquid hourly space velocity in reactor **34** at least 30 to 50 percent higher than that employed in reactor **32.** Additionally, the operating temperature employed in reactor **32** would be 5° F. or more greater than the temperature employed in reactor **34.** The relative difference in severity of operating conditions employed in reactors **30** and **32,** however, would not be as great as the difference in severities between reactors **32** and **34.** Thus, reactors **30** and **32** can be operated at about the same space velocity with reactors **30** being operated at a temperature somewhat lower than that employed in reactor **32,** for example, about 5° or 10° F. lower.

The hydrotreated materials from reactors **30, 32** and **34** are removed via lines **36, 38** and **40,** respectively, and passed to fractionators **42, 44** and **46,** respectively, wherein each of the hydrotreated materials is fractionated to separate lubricating oil boiling range product from lower boiling materials.

In fractionator **42,** the hydrotreated material is separated into furnace oil and lighter materials boiling below 650° F., which fraction is removed overhead via line **48,** and a bottoms lubricating oil product fraction, such as, a light neutral base oil, which fraction is removed via line **50.** Similarly, in fractionator **44,** the hydrotreated material is separated into a furnace oil and lighter fraction removed via line **52** and a bottoms lubricating base oil product such as a heavy neutral oil, which fraction is removed via line **54.** Again, in fractionator **46,** the hydrotreated material is separated into a furnace oil of lighter fraction which is removed overhead via line **56** and a bottoms lubricating oil base stock product such as a bright stock, which is removed via line **58.** The furnace oil and lighter components from each of the fractionators **42, 44** and **46** can be combined via line **60** and **62** as shown in the drawing and removed from the system for recovery or further processing. The lubricating base oil products of lines **50, 54** and **58** are also removed from the system for use individually as base oils or for blending operations.

Alternatively, each of the fractionators **42, 44** and **46** can be operated so as to separate an intermediate lubricating oil boiling range material which is lighter or lower boiling than the base oil product recovered as bottoms from each of the fractionators **42, 44** and **46.** These intermediate lubricating oil boiling range fractions are shown being taken from fractionators **42, 44**

and **46** by dotted lines **64, 66** and **68,** respectively. The intermediate lubricating oil boiling range materials of lines **64, 66** and **68** are removed from the system for separate recovery or for further treatment, such as, for example, acid and clay contacting, outside of the operating scheme of FIG. **1,** i.e., they are not returned to the present system for reprocessing.

FIG. **2** shows a schematic diagram illustrating employment of so-called "blocked" operation rather than the parallel operation of FIG. **1.** In FIG. **2,** four separate crude lubricating oil fractions are employed. A light distillate fraction boiling in the range from about 650° to 750° F. is introduced via line **110** containing valve **112.** A medium distillate fraction boiling in the range from about 750° to 850° F. is introduced via line **114** containing valve **116.** A heavy distillate fraction boiling in the range from about 850° to 950° F. is introduced via line **118** containing valve **120** while a deasphalted oil boiling 950° F.+ is introduced via line **122** containing valve **124.** Each of the lines **110, 114, 118** and **122** are connected to a manifold **126** having a single inlet line **128.**

In operation, three of the valves **112, 116, 120** and **124** are maintained in the closed position while one of such valves is maintained in the open position thereby permitting introduction of but one of the four crude lubricating oils into manifold **126** and from thence into reactor **130** via inlet line **128.** Thus, for example, by maintaining valve **112** in the open position and valves **116, 120** and **124** in the closed position, the light distillate crude lubricating oil fraction of line **110** is passed via manifold **126** and inlet line **128** into line **130.**

In reactor **130,** the particular crude lubricating oil fraction being charged at the particular time is contacted with hydrogen and a suitable hydrotreating catalyst, such as, for example, a nickel-molybdenum catalyst supported on an alumina carrier having an AI of about **18.** The material hydrotreated in reactor **130** is removed therefrom and passed via line **132** to fractionator **134** wherein the hydrotreated material is separated into a light fraction boiling below the lubricating oil boiling range, an intermediate lubricating oil boiling range fraction boiling lower than the desired lubricating oil boiling range product fraction and the desired lubricating oil fraction. The fraction boiling below the lubricating oil boiling range is taken overhead from fractionator **134** by means of line **136** and removed from the system. The desired lubricating oil fraction is removed from the bottom of fractionator **134** by means of line **138** and passed to product recovery means (not shown). The intermediate lubricating oil boiling range fraction is taken from fractionator **134** by means of line **140** and is removed from the system for recovery or further treatment.

As can be seen, each of the crude lubricating oil fractions of line **110, 114, 118** and **122** can in turn be treated separately in reactor **130** simply by opening the valve in the appropriate line and closing the valve in the remaining lines. Thus, to shift from treatment of the light distillate crude lubricating oil of line **110** to treatment of the medium distillate crude lubricating oil fraction of line **114** is merely necessary to close valve **112** in line **110** and open valve **116** in line **114.** As operation is shifted from the treatment of one crude lubricating oil fraction to another, the severity of the operating conditions can be altered by increasing or decreasing the temperature in reactor **130,** such as, for example, increasing the temperature in reactor **130** by about 5° F. when shifting from the treatment of the light distillate fraction of line **10** to the treatment of the medium distillate fraction of line **114.** Similarly, the severity of the operating conditions in reactor **130** can be varied by altering the feed rate of the different crude lubricating oil fractions thereby altering the liquid hourly space velocity through reactor **130.**

Reference is now made to the following example in order to illustrate our invention in more detail.

EXAMPLE

In this example, the operating technique of our invention is compared to the more traditional technique of processing a wide boiling range crude lubricating oil as a single entity. In accordance with our invention, the deasphalted oil obtained by solvent deasphalting a residual boiling range crude lubricating oil, a heavy distillate crude lubricating oil fraction and a medium distillate crude lubricating oil fraction were separately subjected to hydrotreating and the effluents from each of the three separate hydrotreating operations were separately fractionated for the recovery of lubricating base oil products. To provide a basis of comparison, an aliquot blend of these three crude lubricating oil fractions were subjected to hydrotreating under the operating conditions dictated by the residual components of the blend. In all hydrotreating operations of this example, the catalyst employed was a nickel-tungsten-fluorine catalyst supported on a silica alumina carrier having an AI of about 75.

The inspections of the three crude lubricating oil fractions together with the operating conditions employed in treating each of the three fractions and the aliquot blend are set forth in Table I below.

TABLE I

FEED	DAO	Hvy. Dist.	Med. Dist.	
B/D	337	228	435	
Inspections				
°API	20.2	17.8	20.1	
SUS/100°F.			582.0	
SUS/150°		416.0		
SUS/210°	210	113.4	61.1	
Pour, °F.	+115	+105	+95	
S, wt.%	2.85	3.47	3.03	
C. R., Rams, wt.%	1.50	0.94	0.20	
Dist., D1160 °F. at				
5%	933			
10	983	928	836	
30		953	859	
50		969	875	
70		989	895	
90		1017	928	
				Aliquot Blend
Operating Conditions				
Press., psig	3000	3000	3000	3000
Avg. Cat. Temp., °F.	735	743	735	735
LHSV	1.5	1.0	1.0	1.5
H_2 consump.; SCF/B feed	550	800	920	760
Yield 625°F.+				
vol % feed	98	91	81	
vol % liq. product	94.2	85.8	76.4	
mol % liq. product	86.4	71.5	55.7	
Factor (30 × vol % liq. product)	2826	2574	2292	

From an examination of the operating conditions shown in Table I, it will be seen that the crude lubricating oil fractions were subjected to hydrotreating as required by our invention. Each of the hydrotreating effluents, i.e., from hydrotreating the three distillate fractions separately and from hydrotreating the aliquot blend were fractionated so as to obtain the same type

base oil products, i.e., bright stock, heavy neutral and light neutral. Inspection data for these products obtained from hydrotreating the separate fraction as well as hydrotreating the aliquot blend are set forth in Table II below.

TABLE II

	Bright Stock	Heavy Neutral	Light Neutral
Product Inspections		Separate Fractions	
SUS at 100°F.	2510	425	170
SUS at 210°F.	150	58.5	44.8
VI	95	92	105
		Aliquot Blend	
SUS at 100°F.	2510	520	150
SUS at 210°F.	150	61.8	41.8
VI	95	84	57

Examination of the data in Table II clearly demonstrated that the technique of our invention produces products, particularly distillate fractions, of substantially higher quality than obtained in accordance with the prior art technique. Specifically, it will be noted that the VI of the products obtained from the aliquot blend suffer from the traditional disadvantage of hydrotreating wherein there is a sharp decline in VI with decreasing viscosity to the point that the lower viscosity products have VI's which are totally unacceptable. As distinguished from this, it will be seen that the process of our invention is capable of producing not only a bright stock having a viscosity in the desired range of about 95 but that such is accomplished while simultaneously producing distillate stocks of greatly enhanced viscosity index. Finally, it will be noted that in accordance with the process of our invention, the lowest viscosity product, i.e., the light neutral oil has a VI substantially greater than the VI of the bright stock.

We claim:

1. An improved process for the production of lubricating oils which comprises separately hydrotreating a residual crude lubricating oil fraction and a plurality of distillate crude lubricating oil fractions under conditions of differing severity to provide hydrotreated effluents, wherein the severity of conditions employed in hydrotreating the distillate fractions decreases with decreasing temperature of the boiling range of the crude distillate fraction , the conditions employed in hydrotreating the heaviest distillate fraction are more severe than the conditions employed in hydrotreating the residual fraction and the hydrotreating of the residual fraction and the distillate fractions is conducted at a temperature in the range from about 600° to about 900° F. and a hydrogen partial pressure in the range from about 2,000 to about 10,000 PSI, separately fractionating each hydrotreated effluent so as to separate materials boiling below the lubricating oil boiling range from lubricating oil boiling range materials, removing the lower boiling materials from the process and recovering lubricating oil boiling range materials as product.

2. The process of claim **1** wherein the fractionations are conducted so as to separate a fraction comprising the lowest boiling lubricating oil boiling range components from the higher boiling lubricating oil boiling range components and the higher boiling lubricating oil components are recovered as product.

3. The process of claim **1** wherein the hydrotreating conditions are selected so as to maintain a yield from each hydrotreating operation of at least about 50 percent by volume of hydrotreated material boiling above about 625° F. based upon charge to the hydrotreating operation, to maintain at least 22 mol percent of the normally liquid effluent from each hydrotreating operation in the form of materials boiling above about 625° F. and to maintain a hydrogen consumption, measured as standard cubic feet per barrel of charge stock, in each hydrotreating operation at less than about the product of 30 multiplied by the volume percent of 625° F.+ material in the normally liquid effluent.

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