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PRODUCTION OF LUBRICATING OIL

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This invention relates to the production of lubricating oil by hydrocracking. More particularly, the invention is directed to the problem of converting high-boiling hydrocarbon oils into lower-boiling lubricating oils characterized by high viscosity index and low pour point.

It has previously been proposed to prepare high viscosity index lubricating oils by hydrocracking heavy oils such as residuum. Severe conditions of temperature and pressure are used, with catalysts such as supported nickel and tungsten sulfides, to crack ring compounds to materials suitable for lubricating oil. The product requires dewaxing because normal paraffins in the feed are not converted, or if converted are only cracked to lower-boiling normal paraffins, which cause high pour points and are therefore not suitable for lubricating oils. In an alternate approach, it has been proposed to isomerize wax to isoparaffins by treating at elevated temperature with supported platinum hydroisomerization catalysts. Isoparaffins of appropriate boiling range would be ideally suited for high viscosity index specialty lubricants. However, such isomerization processes require the use of deoiling to prepare a clean feed free of oily hydrocarbons, and the product must be dewaxed to separate unconverted normal paraffins from the isomerized product. The necessity for dewaxing is a serious drawback in the known processes because dewaxing is itself an expensive operation added on to the already expensive catalytic treating processes, which are so costly that their use can only be justified over presently-used chemical and physical lubricating oil production methods when the refiner cannot obtain suitable crude oils. Consequently, it is still the usual practice to prepare lubricating oils by combinations of solvent extraction, solvent dewaxing, acid treating, mild hydrofinishing, and clay contacting of appropriate fractions of select crude oils, and then to use various additives to improve the performance characteristics such as viscosity, viscosity index, and oxidation stability. These methods are becoming inadequate to meet the increasing demand for the lighter grades of special lubricants, such as multigrade or multiviscosity oils, wherein there is desired the unique combination of high viscosity index and low pour point. One of the specifications for the base stock for multiviscosity grade oil is that it should have a viscosity index of above 100, about 130 for the SAE 10–30 grade. Also a pour point of below 0° F. is desired, below about —25° F. for the lighter grades, say —75° F. for SAE 10.

It has now been found that waxy oils can be converted to low pour point, isoparaffinic, high viscosity index lubricating oils with concomitant production of valuable lower boiling products, by selecting or preparing a hydrocarbon oil feed of particular properties, hydrocracking said feed in a controlled manner, and recovering a lower boiling product lubricating oil from the hydrocracked materials. Not only is it unnecessary to exclude normal paraffins from the feed or to dewax the product, but the use of a predominantly paraffinic feed is essential to the success of the process. However, the process is not like wax isomerization, as the feed must contain some non-waxy constituents, the product lubricating oil must boil entirely below the initial boiling point of the feed, and substantial amounts of lower boiling valuble products are concomitantly produced.

In accordance with one embodiment of the invention, a predominantly paraffinic hydrocarbon oil feed having

an initial boiling point of at least 750° F., boiling over a range of at least 50° F., and containing less than 10 p.p.m. nitrogen present as nitrogen compounds, is selected or prepared. The feed and at least 2000 standard cubic feet of hydrogen per barrel of feed are passed into contact in a hydrocracking zone with an acidic hydrocracking catalyst having hydrocracking and isomerizing activity in the substantial absence of nitrogen compounds at 400–750° F., 500–2500 p.s.i.g., and 0.3–5 LHSV. The effluent from the hydrocracking zone is separated by distillation into fractions including at least one normally liquid oil fraction boiling above the initial boiling point of the feed, at least one normally liquid lubricating oil product fraction boiling between 650° F. and the initial boiling point of the feed, at least one additional normally liquid product fraction boiling below the initial boiling point of the feed, and at least one normally gaseous product fraction. The normally liquid lubricating oil product fraction is recovered as the net desired product, without dewaxing. In a preferred embodiment, the product lubricating oil contains above 80% isoparaffins, especially between 85 and 95% isoparaffins.

The limitation that the feed boils entirely above 750° F. is intended to exclude unconverted portions of the feed from appearing in the lube oil product which boils above 650° F. Obviously, materials boiling below 650° F. could be present in the feed wtihout contaminating the product boiling above 650° F. Such a situation is not likely to occur naturally, but could be created by mixing a lower-boiling feed with the high-boiling paraffinic feed. Hence, the possibility of hydrocracking simultaneously two feeds of different boiling range is not excluded from the process of this invention, provided that the resulting feed charge does not contain any substantial product-contaminating amount of components boiling in the range of the desired lubricating oil, defined by an initial boiling point of at least 650° F. and an end boiling point of not over 1050° F. In the invention, a hydrocarbon charge is prepared which contains less than 10 p.p.m. nitrogen present as nitrogen compounds, which is free of components boiling in the range of the desired lube oil, and which contains as the essential feed component a predominantly paraffinic oil boiling over a substantial range of at least 50° F. and entirely above the boiling range of the desired lubricating oil product. The charge is hydrocracked at the controlled conditions, and there is obtained directly by fractionation of the effluent at least one isoparaffinic lube oil product boiling between 650° F. and the initial boiling point of the paraffinic oil.

The process of the present invention differs from the previously proposed hydrocracking and isomerizing processes in several respects, including one or more of the following:

(1) The nature and preparation of the feed,

(2) Control of the hydrocracking to promote a special type of conversion reaction,

(3) Direct recovery of the product lubricating oil, and

(4) The nature of the products.

The feed stock to the process of this invention is a hydrocarbon oil derived from crude petroleum or similar hydrocarbonaceous sources and having the aforementioned properties. For example, a suitable raw feed stock is a waxy straight-run distillate of paraffinic crude petroleum boiling entirely above about 850° F. Or, the feed may be a paraffinic heavy catalytically cracked cycle oil boiling, for example, from about 850° F. to about 950° F. Preferably, the heavy catalytic cycle oil is first extracted with a selective solvent, such as phenol, sulfur dioxide, furfural, or the like, to give a raffinate substantially free of aromatics and of enhanced paraffinicity. Again, the feed may be a deasphalted short residuum from a paraffinic base crude oil, obtained by vacuum or like distillation

of petroleum or a residual fraction thereof to obtain an oil which has a viscosity at 210° F. of 55–270 SSU after deasphalting and deresining, preferably with a low boiling hydrocarbon, such as propane, propylene, isobutane, and normal butane, or mixtures thereof.

The preferred feed stocks are of "predominantly paraffinic nature," by which is meant that a major portion of the hydrocarbon species in the feed is straight chain or branched saturated hydrocarbons. In general, this characteristic of paraffinicity is associated with the property of high viscosity index; hence the feed will have a viscosity index of above about 60. However, it is not to be inferred that the high viscosity index of the feed stock is entirely due to the content of straight chain paraffins which are solid at room temperature and are usually referred to as paraffin wax content. For example, an East Indian crude was topped to give a 760° F. plus residuum, which, after deasphalting, had a viscosity index of 100 and a paraffin wax content of 45 weight percent. After dewaxing with a selective solvent (methylethylketone) to give a dewaxed oil of ASTM pour point of +10° F., the resulting oil had a viscosity index of 50. By contrast, a Brazilian crude, topped in the same manner to give a 760° F.+ residuum, after deasphalting had a viscosity index of 110 and a paraffin wax content of 40 weight percent. After dewaxing with selective solvents to an ASTM pour point of +10° F., the resulting oil had a viscosity index of 102. Thus, even with the high normal paraffin content of the Brazilian residuum, the dewaxed oil still had a high content of branched chain paraffins and is therefore a preferred feed, whereas the East Indian residuum is less suitable. As applied to the present invention, the preferred feed stocks have an initial boiling point of at least 750° F., a pour point of at least 100° F., a viscosity index after dewaxing to +25° F. pour point of 60–100, and a viscosity at 210° F. of 55–270 SSU. The test of dewaxing to +25° F. pour point and then measuring the viscosity index is a means of determining whether the nonwaxy constituents are also largely saturated and, if so, that the undewaxed oil is a suitable feed.

The concentration of aromatic hydrocarbons in the feed stock should not exceed about 20 volume percent. Likewise, the content of naphthenes should not be greater than about 40 volume percent. In the process of the present invention, aromatics are converted to naphthenes, but it is desired to minimize the naphthene content of the product lubricating oil. Similarly, naphthenes are converted to lower boiling branched and cyclic hydrocarbons; but these are generally lower boiling than the product lubricating oils. If the feed stock selected is too highly naphthenic, however, naphthenes will appear in the product lubricating oil.

For the production of specialty lubricants by the process of the invention, it is advantageous to select a feed stock of rather narrow boiling range. For example, a feed stock having an initial boiling point of 750° F. and an end point of 850° F., or another feed stock having an initial boiling point of 850° F. and an end point of 950° F., may be processed individually to prepare narrow boiling range lubricating oil products, boiling, respectively, from 650° F. to 750° F., and from 750° F. to 850° F. These products are especially useful in preparing specialty oils, such as transformer oils, ice machine oils, automotive transmission oils, and lighter grades of turbine oils. However, the feed may be a broader range material of high initial boiling point, for example 1000° F., such as a deasphalted short residuum or bright stock, and this may be processed and then fractionated to give low boiling range lubricating oils, such as the ranges 750–750° F. and 850–950° F., which are highly desirable as components for multi-viscosity automotive oils and turbine oils. One of the properties of these high quality narrow cuts is a low evaporation rate in service, resulting in reduced consumption in automotive and other uses.

The hydrocarbon oil feed is passed along with hydrogen at the rate of from 2000 to 15,000 standard cubic feet of hydrogen per barrel of oil, at elevated pressures of 500 to 5,000 p.s.i.g., into contact in a hydrocracking zone with a hydrocracking catalyst at a liquid hourly space velocity based on the feed of from 0.2 to 15 volumes of oil per volume of catalyst per hour (LHSV). At these conditions, the selected feed is converted to products including the desired lubricating oil by hydrocracking in a controlled manner. To obtain the desired highly isoparaffinic lubricating oil product, the hydrocracking is carried out at relatively low temperatures in the range of 400 to 750° F. Higher yields of the desired isoparaffins are obtained at low hydrocracking temperatures. Hence, it is especially preferred that the temperature not exceed about 710° F.

The catalyst employed must exhibit both hydrocracking and isomerizing activity at these low temperatures. Suitable hydrocracking catalysts include combinations of a hydrogenating component, such as a compound or a metal of Group VIII of the Periodic Table, with a cracking component, such as a compound or a metal of Group VI and/or a refractory oxide carrier. In the process of this invention, the hydrocracking catalyst comprises preferably a hydrogenating-dehydrogenating component on an active acid support; exemplary materials being compounds of nickel and cobalt, especially the sulfides. The preferred support is essentially an active cracking catalyst comprising acidic silica-alumina, but silica-magnesia or similar mixed oxides may be used to lesser advantage in some cases.

In most cases, it will be desirable to pretreat the feed to the hydrocracking zone to remove nitrogen compounds, and in many cases such treatment is essential. The most preferred hydrocracking catalysts are sensitive to nitrogen poisoning in that higher operating temperatures are required for satisfactory rates of conversion when significant amounts of nitrogen compounds are present. Thus, the desired low temperature operation cannot be maintained for long operating periods unless the nitrogen content of the feed selected is relatively low. Preferably, the nitrogen content should be below 10 p.p.m. and it is particularly advantageous to reduce the nitrogen content to below 1 p.p.m., for example, 0.5 p.p.m. or less.

Operating schemes which may be used to denitrify the hydrocarbon oil feed can have many variations. Although physical or chemical extraction can be used, such methods are usually more expensive and wasteful of oil and achieve less complete removal than conversion techniques, such as catalytic hydrogenation of the nitrogen compounds to ammonia. In the catalytic process, the feed is contacted with a suitable catalyst in the presence of hydrogen at conditions including temperatures of 500–850° F., pressures of 200–5000 p.s.i.g., space velocities of 0.2–10 LHSV, and hydrogen flow rates of 1000–15,000 s.c.f per barrel of oil. The catalyst employed is any denitrification catalyst which is active for the hydrogenation of nitrogen compounds, and which is not permanently poisoned by sulfur (sulfactive), since the feeds treated usually contain sulfur. Typical catalysts comprise the oxides and/or sulfides or other compounds of Group VI–B metals and of Group VIII metals, and combinations thereof, unsupported or supported on a carrier; for example, a cobalt-molybdate on alumina. Hydrocracking may be achieved along with denitrification by using an acidic carrier such as silica-alumina, silica-magnesia, silica-zirconia, and the like, or by using higher temperatures with a nonacidic carrier such as alumina. A catalyst particularly preferred because of its high activity for denitrification by hydrogenation of nitrogen compounds without excessive cracking is a sulfided, nickel-molybdenum-alumina, catalyst containing over 3% nickel and over 12% molybdenum. The nitrogen which was initially present in the oil as contaminating

organic nitrogen compounds is coverted to ammonia by contacting with such a catalyst at 600–800° F., 1000–2500 p.s.i.g., 0.4–2 LHSV, and 2000–10,000 s.c.f. H_2/barrel, and the ammonia is then removed to yield the nitrogen-free oil.

In the hydrocracking zone, paraffins in the nitrogen-free hydrocarbon oil feed are converted in several ways, including cracking to lower-boiling paraffins and isomerizing to isoparaffins, some of which are also lower boiling than the feed. This is in contrast to previously known processes, wherein the oil was either hydrocracked without isomerization, or isomerized without hydrocracking, but never both to any substantial extent. In the new process, using the preferred hydrocracking catalysts comprising cobalt or nickel sulfides on silica-alumina, the paraffins are predominantly both cracked and isomerized. Thus, there is produced a wide spectrum of isoparaffins, part of which still boil within the initial boiling range of the feed, part of which boil just below the initial boiling point of the feed, and some of which are much lower boiling. In accordance with this invention, there is recovered as the desired lubricating oil from the effluent of the hydrocracking zone a normally liquid fraction comprising only those isoparaffins which boil above about 650° F. but below the initial boiling point of the feed. Thus, the product lubricating oil is an entirely synthetic material containing no material boiling within the boiling range of the original feed.

Condensed ring aromatic hydrocarbons in the feed predominantly split into multiple aromatic rings which usually boil below 650° F. Some of the aromatics are also hydrogenated to naphthenes, but again mostly of lower boiling point. Similarly, naphthenes in the hydrocarbon oil feed are split into ring structures boiling below 650° F. and isoparaffins. Most of these isoparaffins also boil below about 650° F., a characteristic feature of the hydrocracking being in the production of substantial amounts of isobutane. Nevertheless, if the feed contains excessive amounts of naphthenes and/or aromatics, some of the products of hydrocracking these materials will appear in the boiling range of the desired lubricating oil, thereby producing an inferior product.

The desired isoparaffinic lubricating oil product is derived primarily from the paraffins in the hydrocarbon oil feed. Hence, it is important to employ a feed which is predominantly paraffinic. On the other hand, a purified wax is not a preferred feed in the present invention because the normal paraffins are more resistant to hydrocracking than other saturated hydrocarbon types. This is another respect in which the present invention differs from previously known isomerization processes which treated wax, and wherein the boiling point lowering due to isomerization was not sufficient to permit direct recovery of a lubricating oil product by distillation without dewaxing. The present invention is economically attractive because there are produced concomitantly, by hydrocracking, lower-boiling valuable products including gasoline, kerosene or jet fuel, and furnace oil or diesel oil. The feed may, however, contain up to about 50% wax, in which case the conversion per pass may be relatively low, and it is therefore preferred to recycle unconverted portions of the feed for continuing contacting with the hydrocracking catalyst.

The effluent of the hydrocracking zone is separated by fractionation into fractions including at least one normally gaseous stream, at least one normally liquid product stream boiling at least partly below 650° F., at least one normally liquid lubricating oil product stream boiling between 650° F. and the initial boiling point of the feed, and at least one normally liquid stream boiling at least partly above the initial boiling point of the feed. The material boiling above the initial boiling point of the feed may be recycled to extinction for maximum production of the lubricating oil product. The initial boiling point of this recycle material may be below the initial boiling point of the feed, corresponding to the end boiling point of a lubricating oil product boiling above 650° F., the initial boiling point of the recycle material being referred to herein as the recycle cut point. In certain cases, it will be desirable to withdraw a portion of the higher-boiling recycle bottoms as a separate product stream to obtain greater process efficiency. In other cases, it may be desirable to hydrocrack all or a portion of the recycle bottoms by contacting with a less selective hydrocracking catalyst or at a higher hydrocracking temperature to prevent a buildup of normal paraffins in the system by hydrocracking said normal paraffins to materials which can then be converted to the isoparaffinic lubricating oil when repassed through the hydrocracking-isomerizing zone employing the preferred hydrocracking catalyst at temperatures of below 710° F. In a special embodiment, the material in the effluent of the hydrocracking zone which boils above the initial boiling point of the feed is recycled back to the inlet of the nitrogen removal zone, wherein conditions are controlled with a selected catalyst to effect partial hydrocracking of the material and thereby improve denitrification of the bottoms, whereby the hydrocracking zone is made to operate at a lower temperature, thus favoring isomerization.

The following example is indicative of a flow scheme and operating conditions to be used and the results which are to be expected in the practice of a specific embodiment of the invention.

Example No. 1

A Mid-Continent cylinder stock prepared by vacuum reduction of a 36.0° API Burbank, Oklahoma, crude oil followed by two-stage propane deasphalting and deresining has the following characteristics:

Gravity, ° API	23.7
Pour point, ° F.	110
Viscosity, SSU at 100° F.	1736
Viscosity, SSU at 210° F.	123
Viscosity index	98
Total nitrogen, p.p.m.	1200
Conradson carbon residue, wt. percent	1.0
ASTM D–1160 initial, ° F.	1025

The deasphalted and deresined oil contains approximately 12 volume percent aromatics. After removing about 12 weight percent wax from a sample of this cylinder stock by dewaxing with a mixture of methylethylketone and benzene, the dewaxed oil has a pour point of +20° F. and a viscosity index of 85, indicating that the oil in terms of the definition described previously is substantially paraffinic. It is to be understood that the feed employed in the invention is the deasphalted-deresined stock that has not been dewaxed. However, the deasphalted deresined oil must be purified to remove the nitrogen. In this example, denitrification is accomplished in two stages by first passing the oil and 6000 s.c.f. H_2 per barrel into contact with a hydrocracking-denitrification catalyst comprising nickel and tungsten sulfides supported on silica-magnesia at 750° F., 2500 p.s.i.g., and 0.7 LHSV. Hydrocracked products are removed from the effluent, and the portion which still boils above 1000° F. is passed with 6000 s.c.f. H_2 per barrel into contact with a hydrogenating-denitrification catalyst comprising nickel and molybdenum sulfides on alumina at 700° F., 2000 p.s.i.g., and 0.5 LHSV for final nitrogen removal without hydrocracking. Hydrogenated products are removed from the effluent, and the portion which still boils above 1000° F. is found to contain only about 0.5 p.p.m. nitrogen, is predominantly paraffinic, and amounts to about 80–85% of the original deasphalted oil, the other 15–20% having been converted to gasoline and clean middle distillates and heating oils in the denitrification stages. The paraffinic oil is passed with 8000 s.c.f. H_2 per barrel and two volumes of recycle oil having an initial boiling point of 985° F. into contact with a hydrocracking-isomerizing

catalyst comprising 6% nickel sulfide on silica-alumina at 600° F., 1500 p.s.i.g., and 0.7 LHSV based on fresh paraffinic oil. The hydrocracking zone effluent is cooled and separated at about 1500 p.s.i.g. into a liquid oil phase and a hydrogen-rich gas phase, which is recycled. There is a net consumption of about 750 s.c.f. H_2 per barrel of fresh feed, makeup for which is added to the recycle hydrogen. The liquid oil is fractionated at reduced pressure to recover desired products. In this example a normally gaseous fraction comprising hydrogen through propane vapors is first separated by flashing the oil at about 200 p.s.i.g. and 150° F. The remaining oil is then split into a light portion boiling below 650° F. and a heavy portion boiling above 650° F. The light portion is further fractionated to obtain gasoline, kerosene, and diesel products. The heavy portion is fractionated under vacuum, to avoid prolonged overheating which may lead to discoloration and instability, to obtain product lubricating oil fractions boiling below 985° F. and the aforementioned recycle oil having an initial boiling point of 985° F. All boiling points in this example and elsewhere in this specification are corrected to atmospheric pressure. A typical net product breakdown is as follows:

	Viscosity at 100° F. (SSU)	Yield, vol. percent of paraffinic oil feed	Viscosity Index	ASTM Pour Point, ° F.
Propane and lighter		[1] 2.5		
Butanes		3		
C_5, 350° F. gasoline		15		
350-500° F., kerosene		25		
500-650° F., diesel		20		
650-700° F	60	10	135	−80
700-820° F	150	20	133	−20
820-950° F	400	30	131	−5

[1] Weight percent.

In addition to their high viscosity indices and low pour points the neutral oils boiling between 650° F. and 950° F. are characterized by light color of +25 to 0 Saybolt and isoparaffin content of 85–95%. The oils are stable, do not require dewaxing or other finishing treatment, and have excellent additive response.

In the above example all material in the hydrocracking zone effluent boiling above 985° F. is recycled back to the hydrocracking zone inlet and reprocessed to extinction. Alternately, all or a portion of the bottoms boiling above the initial boiling point of the feed can be withdrawn to storage or recycled back to the inlet line to the hydrocracking-denitrification zone. The latter operation is employed if the bottoms boiling above feed initial become too refractory for conversion at low temperatures due to excessive buildup of normal paraffins. Also, if desired, pluralities of cuts of various boiling ranges and viscosities may be taken as side streams from the vacuum distillation or, alternately, the yield of one cut may be maximized. For example, in the above illustration of the invention it was desired to produce three grades of neutral oils: a so-called 50 Neutral boiling between 650° F. and 700° F., a 150 Neutral boiling between 700° F. and 820° F., and a 400 Neutral boiling between 820° F. and about 975° F. In this case three side streams would be provided. If it were desired to maximize the production of 150 Neutral, it would be possible to take one or two side streams which on blending would give the desired viscosity. On the other hand, it is within the scope of this invention to produce a narrow, highly fractionated cut of 150 Neutral from a high boiling feed in order to obtain a fraction that would have a higher flash point and exhibit lower oil consumption in automotive use. In this case the distillation is operated to produce only fractions boiling below about 820° F., and two side streams are provided: (1) to draw a so-called 50 Neutral boiling between 650° F. and 700° F., and (2) the desired narrow cut 150 Neutral boiling between 700° F. and 820° F. In this case the recycle to the hydrocracking zone contains the unconverted feed boiling above the feed initial along with synthetic material boiling between 820° F. and the feed initial. Thus by manipulation of the temperatures on the fratcionation column it is possible to produce various grades of neutral oils boiling below the feed initial; or if desired, by manipulation of the so-called recycle cut point it is possible to maximize production of a single grade of narrow cut neutral oil. The lightest grade of neutral oil recovered may have an initial boiling point well above 650° F. in some cases, for example when only a narrow cut of 750–850° F. boiling range is desired.

The following example is indicative of the inferior results obtained when the paraffinic feed does not boil entirely above the boiling range of the desired lube oil.

Example No. 2

When a paraffinic, low aromatic content, long residuum from the same Burbank, Oklahoma, crude oil as in Example 1, but having an initial boiling point of about 670° F., and a 50% point of about 950° F., is denitrified to 0.5 p.p.m. nitrogen and hydrocracked in substantially the same manner with the nickel sulfide on silica-alumina catalyst at a recycle cut point of 985° F., the neutral oils produced have the following characteristics:

	Viscosity, SSU at 100° F.	Viscosity Index	ASTM Pour Point, ° F.
50 Neutral 650-700° F	60	105	−10
150 Neutral 700-820° F	150	95	+60
400 Neutral 820-950° F	400	92	+75

The neutral oils in this case are of inferior quality and would require dewaxing, due to the fact the initial boiling point of the feed was too low and the products were a mixture of synthetic and unconverted overlap material from the long residuum. In addition to the high pour points from inclusion of overlap material, unconverted naphthenes and aromatics remained in the product by virtue of this overlap, thus affecting the viscosity indices of the neutral oils. These oils, to be suitable for multiviscosity oil blending, would require solvent extraction, clay contacting, and solvent dewaxing.

The following example of an embodiment of the present invention describes the production of high viscosity index, low pour point, highly isoparaffinic lubricating oil stock from heavy catalytic cycle oil.

Example No. 3

The feed to the hydrocracking unit of the present invention comprises 1000 b.p.d. of a raffinate prepared from heavy catalytic cycle oil in the following manner: The heavy cycle oil is obtained by catalytic cracking, at 45% conversion, of a mixture of heavy vacuum gas oil and propane deasphalted residuum from a combination of California and Arabian crudes. The 850–950° F. straight-run fraction from this crude mixture contains a relatively small quantity of liquid paraffins of lubricating oil viscosity and larger quantities of naphthenes and aromatics. By catalytically cracking the mixture of vacuum gas oil and deasphalted residuum at low conversion, 40–50%, the naphthenes are converted to gasoline and to aromatics which boil in the gasoline and light cycle oil boiling range. In addition, some of the highly aromatic components will appear as catalytic coke. Thus, the concentration of nonparaffinic components is reduced by processing in the catalytic cracker. The heavy catalytic cycle oil boiling between 850° F. and 950° F. is subjected to a 200 volume percent solvent treat at 150° F. with phenol (95% phenol plus 5% water). This solvent extraction is employed to further remove the nonparaffinic components from the cycle oil, particularly to reduce the aromatic concentration to about 5 volume percent. The raffinate from the solvent extraction step which

amounts to about 60% yield of the cycle oil feed has a viscosity index of 75 without dewaxing and a viscosity SSU at 210° F. of 55. If the raffinate is dewaxed to give a +25° F. pour point material, the viscosity index of the dewaxed oil is 65. Thus, the feed in this case to the process of the invention is predominantly paraffinic in nature, as defined previously. The heavy cycle oil raffinate prepared as outlined above contains about 5% aromatics and 200 p.p.m. nitrogen. The total nitrogen content is reduced to less than 0.5 p.p.m. by processing in a first-stage denitrification zone using a conventional denitrification catalyst and operating conditions which avoid substantial cracking. From the denitrification zone the denitrified stock along with about 400 barrels of recycle oil, also having an initial boiling point of 850° F., is fed to the hydrocracking zone containing a hydrocracking catalyst of about 6% nickel sulfide on silica-alumina. Conditions in the hydrocracking zone are temperatures of 550–650° F. and a total system pressure of 1500 to 2000 p.s.i.g. The LHSV is about 0.7, and there is a net hydrogen consumption in this zone of about 600 standard cubic feet per barrel of fresh feed. After removing the light gases, gasoline, kerosene, and diesel fuel stocks by distillation up to 650° F., two fractions of desired lubricating oil product are recovered including a 50 Neutral boiling from 650–700° F. and a 150 Neutral boiling from 700–820° F. These fractions are removed under vacuum to avoid overheating of the lubricating oil product. Thus, from 1650 b.p.d. of heavy catalytic cycle oil 850–950° F. boiling range there is obtained by solvent extraction 1000 b.p.d. of raffinate of similar boiling range, and from this raffinate feed there is obtained in the hydrocracking zone of the present invention the following yields:

	Volume percent of fresh feed	Viscosity at 100° F. (SSU)	Viscosity Index	ASTM Pour Point, ° F.
C_3 and lighter	[1] 2.5			
Butanes	3.5			
C_5, 350° F. gasoline	17.0			
350° F.–500° F. kerosene	27.0			
500–650° F. diesel	25.0			
50 Neutral 650–700° F	15.0	61	134	−100
150 Neutral 700–820° F	35.0	150	135	−25

[1] Weight percent.

Both neutral oils are of light color, +25 to +5 Saybolt, and comprise 80–95% isoparaffins. The oils are stable and do not require dewaxing or any finishing treatment.

The raffinate feed described above contains about 5% aromatics. If the extraction step were eliminated, the cycle oil feed, which contains over 20% aromatics, would give inferior products and product distribution on hydrocracking. Thus, the overall reaction would be characterized by excessive splitting with high yields of naphtha and middle distillate products and low yields of the desired lubricating oil product. In addition, the lubricating oil product would be below 100 viscosity index. Likewise, if the feed to the hydrocracking zone contained a high percentage of naphthenes, the products from the hydrocracking zone would be predominantly lower boiling than desired for lubricating oil; and the lubricating oil fraction would be too naphthenic and below 100 viscosity index. When the boiling range of the product overlaps the feed, as mentioned, the product contains normal paraffins and must be dewaxed. When the heavy catalytic cycle oil raffinate of the preceding example is converted by destructive hydrogenation, i.e., by contacting with a nickel-tungsten sulfide catalyst at 800° F. and 3500 p.s.i.g., the hydrocracked product boiling between 650° F. and 825° F. is highly naphthenic, and the paraffins are not isomerized. Hence, under those conditions the isoparaffinic lubricating oil is not obtained.

Thus, the important features in obtaining the high product qualities desired include the specification of high initial boiling point of the feed stock and its highly paraffinic nature. In addition, if almost complete denitrification of the feed is practiced to permit hydrocracking at low temperatures where isomerization is favored, the desired lubricating oil product as outlined above in the preceding example will be predominantly isoparaffinic. Another specification outlined in the process of the invention is that the product contains only material boiling above 650° F., and that the product end point is not permitted to overlap the initial boiling point of the feed.

The lubricating oils produced by the process of the invention are narrow cut, lower-boiling, stocks including prime base stocks for SAE 10–30 grade multipurpose lubricating oils. The light gasoline, C_5 to 180° F., produced in the process is isoparaffinic with high research and motor leaded octanes. The heavy gasoline, 180–350° F., is predominantly a mixture of isoparaffins and naphthenes, and as such is an excellent catalytic reformer feed stock. The kerosene boiling between 350° F. and 500° F. is characterized by high smoke point and below —100° F. freeze point. The diesel stock boiling between 500° F. and 650° F. is characterized by cetane numbers of over 60 and low pour points of —90° F. Thus, there is produced an isoparaffinic lubricating oil of high viscosity index and low pour point and concomitantly high grade, lighter fuel products. The fact that the principal product is a high grade lubricating oil does not preclude its use as a source of narrow boiling range isoparaffins for chemical synthesis.

I claim:

1. A process for the production of lubricating oil which comprises preparing a hydrofined predominantly paraffinic hydrocarbon oil feed having an initial boiling point of at least 750° F., boiling over a range of at least 50° F. and containing less than 10 p.p.m. nitrogen, passing said feed and at least 2000 standard cubic feet of hydrogen per barrel of said feed into contact in a hydrocracking zone with a hydrocracking catalyst having hydrocracking and isomerizing activity and comprising a hydrogenating-dehydrogenating component selected from the group consisting of nickel sulfide and cobalt sulfide, and an active acidic refractory oxide cracking component, at 0.2 to 15.0 LHSV, 400° to 710° F., and 500 to 5000 p.s.i.g. whereby paraffins are hydrocracked and isomerized, separating the effluent from said hydrocracking zone into fractions including (1) at least one normally liquid oil fraction boiling above the initial boiling point of said feed, (2) at least one normally liquid lubricating oil product fraction boiling between 650° F. and the initial boiling point of said feed, (3) at least one additional normally liquid fraction boiling below the initial boiling point of said feed, and (4) at least one normally gaseous fraction, and recovering said normally liquid lubricating oil product fraction as a net product having a pour point below 0° F. without dewaxing.

2. The process of claim 1 wherein said hydrocarbon oil feed boils between about 750° and 950° F.

3. The process of claim 1 wherein said hydrocarbon oil feed boils from about 850° to about 950° F.

4. The process of claim 1 wherein said hydrocarbon oil feed contains less than about 40% naphthenes and less than about 20% aromatics.

5. The process of claim 1 wherein said hydrocarbon oil feed is a waxy raffinate of heavy cracked cycle oil.

6. The process of claim 1 wherein said hydrocarbon oil feed is a deasphalted residuum which has been denitrified by catalytic hydrogenation.

7. A process for the production of a highly isoparaffinic, low pour point, high viscosity index lubricating oil which comprises preparing a hydrofined hydrocarbon oil feed having an initial boiling point of at least 850° F., boiling over a range of at least 50° F., and containing less than 10 p.p.m. nitrogen, less than about 40% naphthenes

and less than about 20% aromatics, passing said feed and from 2000 to 30,000 s.c.f. of hydrogen per barrel of said feed into contact in a hydrocracking zone with a hydrocracking catalyst having hydrocracking and isomerizing activity and comprising a hydrogenating-dehydrogenating component selected from the group consisting of nickel sulfide and cobalt sulfide on an active acid refractory oxide cracking support at 0.2 to 15 LHSV, 400 to 710° F., and 500 to 5000 p.s.ig., and recovering as the desired lubricating oil product by fractionating the effluent from said hydrocracking zone a normally liquid fraction boiling between 650° F. and the initial boiling point of said feed and having a pour point below 0° F. without dewaxing.

8. The process of claim **7**, wherein said hydrocarbon oil feed is a waxy raffinate of heavy cracked cycle oil.

9. The process as in claim **7**, wherein said hydrocarbon oil feed is a deasphalted residuum.

10. A process for producing isoparaffinic lube oil having a boiling range defined by an initial boiling point of at least 650° F. and an end boiling point of not over 1050° F. from waxy oil without dewaxing, which comprises preparing a hydrocarbon charge which is free of product-contaminating amounts of components boiling in the boiling range of the desired lube oil product, which charge contains less than 10 p.p.m. nitrogen present as nitrogen compounds and which charge contains as the essential feed component a hydrofined predominantly paraffinic hydrocarbon oil boiling over a substantial range of at least 50° F. and entirely above the boiling range of the desired lubricating oil product, passing said charge and at least 2000 s.c.f. of H_2 per barrel of paraffinic oil into contact in a hydrocracking zone with an acidic hydrocracking catalyst having hydrocracking and isomerizing activity and comprising a hydrogenating-dehydrogenating component selected from the group consisting of nickel sulfide and cobalt sulfide, and an active acidic refractory oxide cracking component, at conditions including a temperature of 400 to 710° F., pressure of 500 to 5000 p.s.i.g., and space velocity based on paraffinic oil of 0.2 to 15 LHSV, whereby paraffins in said paraffinic oil are both cracked and isomerized, and fractionating the effluent from said hydrocracking zone to thereby obtain directly fractions including as the desired isoparaffinic lube oil at least one normally liquid product fraction boiling between 650° F. and the initial boiling point of said paraffinic oil.

11. The process of claim **10** further characterized by fractionating said effluent to obtain additional fractions including (1) at least one normally liquid oil fraction containing components boiling in the range of said paraffinic oil, (2) at least one additional normally liquid oil fraction boiling below the initial boiling point of said paraffinic oil, and (3) at least one normally gaseous fraction.

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