# United States Patent [19]

**Ashton et al.**

[11] **3,870,622**

[45] **Mar. 11, 1975**


[54] **HYDROGENATION OF A HYDROCRACKED LUBRICATING OIL**


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[22] Filed: **June 25, 1973**

[21] Appl. No.: **373,332**

**Related U.S. Application Data**

[63] Continuation-in-part of Ser. No. 129,231, Sept. 9, 1971, abandoned.

[52] **U.S. Cl.** ..... **208/93,** 208/18, 208/58

[51] **Int. Cl.** ..... **C10g 37/06**

[58] **Field of Search** ..... 208/18, 58, 93



[56] **References Cited**

UNITED STATES PATENTS

| | | | |
|---|---|---|---|
| 2,787,582 | 4/1957 | Watkins et al. | 208/58 |
| 3,642,610 | 2/1972 | Divijak et al. | 208/58 |
| 3,666,657 | 5/1972 | Thompson et al. | 208/58 |
| 3,730,876 | 5/1973 | Sequeira | 208/18 |



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[57] **ABSTRACT**

The viscosity index of a hydrocracked lubricating oil stock boiling in the range of about 600°–1100° F. is increased by fractionating the stock into a light fraction boiling from 600° F. to about 750° F. and a bottoms fraction; mildly hydrogenating the light fraction and subsequently reblending the hydrogenated light fraction with the unhydrogenated fraction. Low boiling cracked hydrocarbons may be removed from the reblended lubricating oil to adjust the initial boiling point temperature to a desired value.


**10 Claims, No Drawings**

# HYDROGENATION OF A HYDROCRACKED LUBRICATING OIL

## RELATED APPLICATIONS

This application is a continuation-in-part of copending application Ser. No. 179,231, filed Sept. 9, 1971 now abandoned.

## BACKGROUND OF THE INVENTION

The present invention relates to an improved method for treating a hydrocracked lubricating oil stock to improve the temperature-viscosity characteristics and oxidation stability thereof. More particularly, the present invention relates to a treating method wherein a hydrocracked lubricating oil stock is fractionated into a light fraction with a maximum end point of 750° F. and a heavy fraction; the light fraction is subjected to a relatively mild hydrogenation treatment; and the hydrogenated light fraction and heavy fraction are reblended to produce a lubricating oil stock with improved temperature-viscosity characteristics and improved oxidation stability.

It is known in the prior art to subject a lubricating oil stock to a hydrocracking reaction, and subsequently hydrogenate all or part of the hydrocracked oil to improve color and oxidation stability, reduce impurities, neutralize the stock, and provide improvement in the lubricating oil stock temperature-viscosity characteristics. The benefits and advantages of such hydrocracking and hydrogenation of lubricating oil stocks are well known and understood by those familiar with the prior art. For example, Watkins et. al. (U.S. Pat. No. 2,787,582) discloses a process wherein a petroleum fraction (or crude) is fractionated into at least a 600°–950° F. virgin light lube stock and a 950° F. + residuum stock. The residuum stock is then hydrocracked. Hydrocracked effluent is subsequently fractionated into a light cracked hydrocarbon fraction, a 600°–950° F. hydrocracked lube fraction and a 950° F. + hydrocracked fraction. The 950° F. hydrocracked fraction is recycled to extinction within the hydrocracking process, or alternatively may be dewaxed and deresined to yield a heavy lubricating oil stock. The 600°–950° F. hydrocracked fraction and the 600°–950° F. virgin fraction are combined and treated in a very mild hydrogenation process, including reaction temperatures of from about 100° F. to about 500° F. This hydrogenated oil is then dewaxed and deresined to produce a light lubricating oil product. As desired, light lubricating oil and heavy lubricating oil may be combined to produce a desired lubricating oil product.

Other processes for treating a petroleum fraction to yield a lubricating oil are show in Divijak et al. (U.S. Pat. No. 3,642,610) and Thompson et al. (U.S. Pat. No. 3,666,657). A full boiling range lubricating oil stock is hydrocracked at relatively severe conditions and the hydrocracked oil, in the lubricating oil range, is hydrogenated at temperatures in the range of about 550° F. to 800° F. Subsequently, the hydrogenated hydrocarbon effluent is dewaxed and deresined to yield a full boiling range lubricating oil product.

In processes where a petroleum fraction is hydrocracked and subsequently hydrogenated to yield a lubricating oil stock, a substantial portion of the oil in the lubricating oil range may be converted by cracking reactions, into undesirable lighter fractions. As petroleum oils suitable for use in lubricating oils are in relatively short supply, it is desirable to minimize such losses. Also, hydrocracking and hydrogenating processes are expensive to construct and operate. Thus, it is desirable to have efficient operation of such processes to obtain the maximum benefit in improving lubricating oil quality.



The temperature-viscosity characteristic of importance in a lubricating oil stock is the viscosity decrease with an increase in temperature. Such relationship between viscosity of the oil and its temperature may be expressed in terms of a viscosity index number, wherein the viscosity index number is determined by employing ASTM method 2270. The viscosity index number for lubricating oils expresses the viscosity-temperature relationship such that lubricating oils with lower viscosity index numbers have relatively large changes in viscosity upon an incremental temperature change, and lubricating oils with higher viscosity index numbers have relatively smaller changes in viscosity upon an incremental change in temperature. Generally, lubricating oils with higher viscosity index numbers are more desirable as such oils will maintain their lubricating properties over a broader range of temperatures. In hydrocracking and hydrotreating reactions, viscosity decrease is a rough measure of the degree of cracking which a petroleum stock experiences. Excessive cracking results in a loss of lubricating oil range hydrocarbons to lighter hydrocarbons. An increase in viscosity index for a treated petroleum fraction improves the lubricating properties of the treated oil. Thus, processes for treating lubricating oil stocks which produce a larger increase in viscosity index with a minimum decrease in viscosity of the treated oil are preferred.

Methods for increasing the viscosity index number for a lubricating oil stock are known, such as solvent extraction employing solvents such as furfural, phenol, N-methylpyrrolidone and other solvents known to the art. Such solvent extraction methods improve the viscosity index number of a lubricating oil stock by extracting therefrom components, such as aromatics, which have a relatively low viscosity index number. By employing such a solvent extraction process, a substantial portion of the lubricating oil stock may be removed and the yield of finished lubricating oil is consequently decreased. Depending upon the nature of the lubricating oil stock subjected to a solvent extraction process, the yield of finished lubricating oil may be decreased by as much as 30% or more.

## SUMMARY OF THE INVENTION

Now according to the method of the present invention, we have discovered an improved method for increasing the viscosity index number of a hydrocracked lubricating oil stock which boils in the range of about 600° F. – 1,100° F. without substantially decreasing the yield of finished lubricating oil. The method of the present invention comprises fractionating the hydrocracked lubricating oil stock into a light fraction and a heavy fraction prior to hydrogenation. The light fraction boils in the range of about 600° F. to about 750° F. Generally, such a light fraction of a lubricating oil stock comprises from about 20% to about 30% by volume of the hydrocracked lubricating oil stock. The light fraction only is subjected to a mild hydrogenation reaction at a temperature of from about 600° F. to about 725° F., a pressure of from about 1,000 psig to

about 20,000 psig with hydrogen in the presence of a hydrogenation catalyst. The hydrogenated light fraction is then reblended with the heavy fraction to produce a lubricating oil of increased viscosity index number. If necessary, the reblended lubricating oil may be vacuumed stripped or otherwise treated to adjust the initial boiling point.

By following the method of the present invention, the viscosity index number of a hydrocracked lubricating oil stock may be substantially increased and the yield of hydrogenated lubricating oil stock will be about 89 volume percent of the hydrocracked stock or higher. Additionally, by following the method of the present invention, the ratio of viscosity index increase to viscosity decrease is greater than similar process of the prior art where broad boiling range hydrocracked lubricating oil stocks are hydrogenated. These and other advantages of the present invention will be more completely disclosed in the detailed description of the invention which follows.

## DETAILED DESCRIPTION OF THE INVENTION

Lubricating oil stock suitable for treatment according to the method of the present invention comprises hydrocracked stocks boiling in the range of from about 600° F. to about 1,100° F. and which have lubricating oil properties. For example, hydrocracked distillate fractions, hydrocracked deasphalted oils, and other oil stocks containing substantial concentrations of low molecular weight aromatic compounds boiling in the desired range may be employed. Such stocks generally contain substantial amounts of paraffinic hydrocarbons of high molecular weight which adversely effect the pour point temperature of such stocks. To produce finished lubricating oils, such stocks are generally subjected to a dewaxing process, such as solvent dewaxing, propane dewaxing, or other known dewaxing processes to adjust the lubricating oil stock pour point temperature to the desired value. Such dewaxing step may conveniently be performed prior to or subsequent to treatment according to the method of the present invention. Preferably dewaxing, which is an expensive process, is performed near the end of the process sequence required to produce a finished lubricating oil of desired properties. In this manner the dewaxing process may be performed on the minimum volume of oil, thereby reducing the cost of the process. The hydrocracked lubricating oil stocks contemplated for treatment according to the process of the present invention are those which contain substantial amounts of relatively low molecular weight aromatic hydrocarbons such as mono-, di-, and tri-nuclear aromatic compounds. The method of the present invention is particularly useful in treating a lubricating oil stock derived from a hydrocracked, deasphalted oil fraction boiling in the range of from about 600° F. to about 1,100° F. High molecular weight polynuclear aromatic compounds generally present in heavier fractions of petroleum oils may be partially saturated in a hydrocracking reaction and then tend to crack before the last one or two rings are saturated. Therefore, low molecular weight aromatic compounds having a low viscosity index number concentrate in the lighter fractions of hydrocracked lubricating oil stocks.

It has been observed that when lubricating oil stocks are subjected to a hydrogenation reaction, the first ring of a particular poly-nuclear aromatic will tend to saturate in preference to the aromatic rings of compounds of the same molecular weight range containing fewer aromatic rings. For example, one ring of a tri-nuclear aromatic compound tends to be saturated in a hydrogenation reaction before a ring of a di-nuclear aromatic compound or a mono-nuclear aromatic compound of the same molecular weight. Therefore, when a full boiling range lubricating oil stock comprising poly-nuclear aromatic compounds with a relatively large number of aromatic rings is treated in a hydrogenation reaction, the rings of the highly aromatic poly-nuclear aromatic compounds tend to partially saturate and the aromatic rings of less aromatic compounds, particularly mono- and di-nuclear compounds, tend to remain unsaturated. It has also been observed that such hydrogenation treatment of a high boiling range lubricating oil stock does not substantially improve the viscosity index number of such stocks. More severe hydrogenation treatment of a full boiling range lubricating oil stock, in an effort to saturate a significant number of the mono- and di-nuclear aromatic compounds, generally results in cracking a significant portion of the lubricating oil stock into compounds boiling below the lubricating oil range. Thus, a severe hydrogenation treatment of a hydrocracked lubricating oil stock may result in a significant yield loss of finished lubricating oil.

We have discovered that saturation of a significant portion of the aromatic rings of the lower molecular weight aromatic hydrocarbons contained in a lubricating oil stock will substantially increase the viscosity index number of the resulting lubricating oil.

According to the method of the present invention, the lower molecular weight aromatic compounds of a hydrocracked lubricating oil stock are preferentially saturated in a hydrogenation reaction and only a very small amount of the lubricating oil stock is cracked into hydrocarbons boiling below the desired lubricating oil range. A hydrocracked lubricating oil stock boiling in the desired lubricating oil boiling range of from about 600° F. to about 1,100° F., is fractionally distilled into a low boiling fraction and a high boiling fraction. The fractional distillation of the lubricating oil stock is controlled so that the aromatic compounds contained in the light fraction comprise essentially mono-, di-, and tri-nuclear aromatic compounds. To obtain a light fraction comprising mono-, di-, and tri-nuclear aromatic compounds, the end point of such light fraction is limited to about 750° F., and preferably is limited to about 725° F. That is, the light fraction boils in the range of about 600° F. – 750° F. Any convenient fractional distillation means capable of providing the desired separation may be employed.

The light fraction recovered from the fractional distillation step is treated in a relatively mild hydrogenation reaction under conditions which favor saturation of aromatic compounds. Catalyst which may be employed in the hydrogenation reaction comprise those catalyst which are suitable for hydrogenating aromatic compounds and which do not have a substantial cracking activity. Examples of such catalysts include chromium, tungsten, cobalt, molybdenum, nickel, their oxides and sulfides, and combinations thereof. Also, catalytically active noble metals such as platinum, palladium, rhodium, irridium, ruthenium, and combinations thereof may be employed. However, the noble metal catalysts tend to be poisioned by compounds commonly present in lubricating oil stocks, particularly sulfur and nitrogen compounds. Hydrogenation catalyst

are generally in a finely divided form and may be deposited upon a porous support such as precipitated alumina, silica alumina coprecipitate, or kieselguhr. For the present invention, it is preferred that the support material have very little or no cracking activity. A specific example of a catalyst which may be employed is a pelletized catalyst with a surface area of about 171 square meters per gram comprising about 5.9 weight percent nickel and about 18.3 weight percent tungsten supported upon an aluminum oxide base. A preferred catalyst which may be employed in the hydrogenation step of this invention is a pelletized catalyst having a surface area of about 287 square meters per gram comprising about 10.7 weight percent molybdenum and about 2.8 weight percent cobalt supported upon an alumina base. Preferably such catalysts are employed in their sulfide form which may be obtained by methods well known in the art such as treatment at elevated temperatures with hydrogen streams containing hydrogen sulfide or with oil streams containing small concentrations of carbon disulfide.

In the hydrogenation step of our invention, the optimum reaction temperature will vary somewhat depending on the catalyst employed. The desired reaction temperature is that at which a substantial portion of the aromatic components of the light fraction are saturated and at which only a very small portion of the light fraction is cracked into components boiling lower than the desired lubricating oil boiling range. Hydrogenation temperatures of from about 600° F. to about 725° F. are suitable and preferably temperatures are from about 650° F. to about 700° F. Lower temperatures may be employed when noble metal hydrogenation catalysts are employed. Other operating conditions in the hydrogenation step include a pressure of between about 1,000 and about 10,000 psig, and preferably from about 1500 to about 3000 psig, a liquid hourly space velocity from about 0.1 to about 3.0 and preferably from about 0.5 to about 1.5 volumes of hydrocarbon per volume of catalyst per hour, and a hydrogen feed rate from about 500 to about 30,000 standard cubic feet per barrel of lubricating oil stock or higher and preferably from about 5,000 to about 20,000 standard cubic feet per barrel. It is not necessary that the hydrogen employed in the hydrogenation step be 100% pure, and hydrogen rich streams of the type generally available in refinery type operations, e.g., of about 70% or higher hydrogen content, are acceptable. The particular operating conditions to be employed in the hydrogenation reaction in any specific operation will vary to a certain extent depending upon the properties of the light fraction being treated and upon the type of catalyst employed. The purpose of the hydrogenation step is to saturate a substantial portion of the lower molecular weight, i.e., mono- and di-nuclear aromatic, compounds present in the light fraction. Operating conditions may be adjusted by one skilled in the art to obtain the optimum saturation of such aromatic compounds.

A mixture of hydrogenated light fraction and noncondensed gas is recovered from the hydrogenation step. The noncondensed gas is separated from the light fraction by any convenient vapor liquid separation means such as for example a high pressure separator wherein the noncondensed gases are removed overhead and the hydrogenated light fraction liquid is withdrawn as a liquid stream. A portion of the noncondensed gases from the vapor liquid separation means may be returned to the hydrogenation reaction as a hydrogen recycle stream. A portion of such noncondensed gas may also be vented to remove from the system any small amount of low molecular weight hydrocarbon gases formed in the hydrogenation step. Fresh hydrogen is conveniently added to the recycle hydrogen stream as makeup for the hydrogen consumed in the hydrogenation step and for that vented to remove light hydrocarbons.

From the vapor liquid separation means, the hydrogenated light fraction is combined with the heavy fraction of the lubricating oil stock recovered from the fractionation step. The combined stock is then treated to adjust the initial boiling point to the desired value by removing any small amount of low boiling cracked products therefrom. For example, the combined stock may be heated to a temperature about 340° F. at a pressure of about 3 milimeters mercury absolute, where upon the low boiling cracked hydrocarbons will be vaporized and the initial boiling point of the combined stock may be adjusted to a desired value of about 600° F. Other means, such as fractional distillation, may also be employed to adjust the initial boiling point of the combined stock to the desired value.

Upon adjustment of the initial boiling point of the combined stock, a finished lubricating oil is produced having an increased viscosity index number and improved oxidation stability over the lubricating oil stock employed for treatment according to this invention.

In order to obtain the desired yield of finished lubricating oil of about 89 volume percent or more based upon the lubricating oil stock, it has been found that the hydrogenated light fraction must be combined with the heavy fraction before the low boiling cracked hydrocarbon is removed. Otherwise, if the hydrogenated light fraction is treated under conditions to vaporize the low boiling cracked hydrocarbon, a substantial amount of hydrocarbon boiling within the desired lubricating oil range will also be vaporized and thereby lost from the finished lubricating oil product. The addition of the heavy fraction to the hydrogenated light fraction tends to maintain the desirable components of the light fraction in the liquid phase during the treatment to remove undesirable, low boiling cracked compounds therefrom.

## EXAMPLE I

A deasphalted vacuum residuum oil was hydrocracked under hydrocracking conditions of about 1800 psig pressure, a liquid hourly space velocity of 1.0 volumes of oil per volume of catalyst per hour, 7,200 standard cubic feet of hydrogen per barrel of oil, at a temperature of about 825° F. in the presence of a catalyst comprising about 3% cobalt and about 11% molybdenum on an alumina-silica base having a surface area of about 287 square meters per gram, such catalyst being sold by American Cyanamid Company under the designation of Aero HDS 1441. From the hydrocracking reaction, a hydrocarbon product was recovered and fractionated to obtain a fraction boiling in the range of about 600° F. to about 1,100° F. This fraction was subjected to a solvent dewaxing step wherein the pour point was reduced to about 10° F. From the solvent dewaxing step, a lubricating oil stock having a pour point of 10° F., a kinematic viscosity at 100° F. of 18.81 centistokes and a viscosity index of 90 was obtained.

The dewaxed, hydrocracked oil was subjected to fractional distillation in a laboratory vacuum distillation column to yield a light fraction comprising 23.8 volume percent of the lubricating oil stock and having an end point of about 710° F. as an overhead product and a heavy fraction comprising 76.2 volume percent of the lubricating oil stock as a bottoms product. The light fraction was subjected to a hydrogenation reaction at a temperature of 700° F., a pressure of 1800 psig, a liquid hourly space velocity of 0.5 volumes of oil per volume of catalyst per hour, a hydrogen rate of 15,000 standard cubic feet of hydrogen per barrel of light fraction, in the presence of a catalyst comprising 3.5 weight percent nickel, 18.5 weight percent molybdenum supported upon an alumina base with a surface area of about 150 square meters per gram, such catalyst being sold by American Cyanamid Company under the tradename "Aero HDS-9A." From the hydrogenation reaction, a hydrogenated light fraction was recovered free of non-condensed gases in a yield of about 105 weight percent based upon the light fraction charge. The hydrogenated light fraction was then combined with the heavy fraction recovered from the fractional distillation step. The combined fractions were then heated in a vessel equipped with a water cooled reflux condenser at a pressure of about 3 millimeters mercury absolute to a liquid temperature in the vessel of 320° F. to remove low boiling cracked hydrocarbons formed in the hydrogenation reaction. The finished lubricating oil recovered as a liquid from the vessel comprised a 98 weight percent yield based upon the dewaxed lubricating oil stock charged to the fractional distillation step. The finished lubricating oil has a distillation range of about 600° F. to about 1,100° F., a pour point of about 10° F., a kinematic viscosity of about 19.53 centistokes at 100° F., and a viscosity index of 97. Thus, it can be seen that by following the method of the present invention a substantial improvement in the viscosity index, from 90 to 97, of the lubricating oil stock was obtained with only a minor loss in yield of finished lubricating oil. Also, the viscosity index increase was achieved without a concomitant decrease in oil viscosity.

## EXAMPLE II

The dewaxed, hydrocracked oil of Example 1, having a pour point of 10° F., kinematic viscosity of 18.81 centistokes at 100° F., and viscosity index of 90 was vacuum distilled to yield a light fraction overhead comprising 25 weight percent of the oil and a heavy fraction bottoms comprising 75 weight percent of the oil. The light fraction having an end point of about 725° F. was hydrogenated at a temperature of 700° F., a pressure of 1800 psig, a liquid hourly space velocity of 1.0 volume of oil per volume of catalyst per hour, at a hydrogen rate of 7,100 standard cubic feet per barrel of light fraction, in the presence of a catalyst comprising 5.9 weight percent nickel and about 18.3 weight percent tungsten upon an alumina support having a surface area of about 171 square meters per gram, such catalysts being sold by Harshaw Chemical Company under the designation Ni-4403E. From the hydrogenation reaction, a hydrogenated light fraction free of noncondensed gas was recovered in a yield of about 91 weight percent based upon light fraction charged. The hydrogenated light fraction was then combined with the heavy fraction recovered from the fractional distillation step and the mixture was charged to a vessel equipped with a water cooled reflux condenser. In the vessel the mixture was heated at a pressure of 3 millimeters mercury absolute to a liquid temperature in the vessel of 320° F. to remove low boiling cracked hydrocarbons.

A finished lubricating oil in a yield of 89.5 weight percent based upon the lubricating oil stock charged to the fractional distillation system, was recovered from the vessel. The finished lubricating oil had a boiling range of from about 600° F. to about 1,100° F., a kinematic viscosity of about 18.6 centistokes at 100° F., a pour point of 10° F. and a viscosity index of 100.

From Example 2, it is seen that, by following the fractionation and hydrogenation methods of the present invention, a substantial improvement in the viscosity index, from 90 to 100, was obtained for the hydrocracked oil with only minor decrease in viscosity. Also, the yield of lubrication oil, based upon hydrocracked oil is high (89.5%).

The finished lubricating oils of Examples 1 and 2 had good oxidation stability, and upon standing showed no tendency to form solid precipitates which commonly occur in unstablized hydrocracked oils in the lubricating oil range.

## EXAMPLE III

This comparative example is to show the advantages of the process of the present invention over methods of the prior art, such as shown in Watkins et. al. (U.S. Pat. No. 2,787,582).

A "wax distillate" petroleum fraction is obtained by fractionation of crude petroleum. The "wax distillate" has a viscosity of 96.1 centistokes at 100° F., viscoity index of 69 and pour point temperature of 100° F. The "wax distillate" is hydrocracked and the hydrocracked oil is then hydrogenated to yield lubricating oil stock of improved viscosity.

In the runs of this example, the "wax distillate" is hydrocracked and the hydrocracked oil is fractionated into a 600° F. – 950° F. boiling range oil stock. The oil stock is then separated into two portions for comparative hydrogenation runs to demonstrate the advantages of the present invention. A first portion of the 600° F. – 950° F. oil stock is hydrogenated at particular hydrogenation conditions and the hydrogenated oil is vacuum distilled to yield a first 600° F. – 950° F. lubricating oil stock.

Following the method of the present invention, the second portion of the 600° F. – 950° F. oil stock is fractionated into a 600° F. – 725° F. fraction and a 725° F. – 950° F. bottoms fraction. The 600°F. – 725° F. fraction is hydrogenated at the same conditions as the hydrocracked first portion described above. Effluent from this hydrogenation is combined with the 725° F. – 950° F. bottoms fraction and this mixture is vacuum distilled to yield a second 600° F. – 950° F. lubricating oil stock.

Tests are performed on the first and second lubricating oil stock to determine physical properties which relate to quality of lubricating oils. Comparisons are drawn between properties of the lubricating oil stocks to demonstrate the advantages of the method of the present invention over the prior art.

Table I shows results from high temperature, low space velocity hydrocracking and low temperature, low space velocity hydrogenation operations.

TABLE I

| | Hydrocracking | Hydrogenation | |
|---|---|---|---|
| | 600–950°F Fraction | 600–725°F Fraction | 600–950°F Fraction |
| Temperature (°F) | 775 | 700 | 775 |
| Pressure (psig) | 1500 | 1500 | 1500 |
| LHSV (vol oil/hr/ vol catalyst) | 0.25 | 0.25 | 0.25 |
| Hydrogen to oil SCF/B | 5000 | 5000 | 5000 |
| Catalyst | Harshaw Ni–4403E | | |
| Product Properties – For 600–950° F. Range Oils | | | |
| Kinematic Viscosity (centistokes at 100°F) | 28.55 | 29.00* | 27.75 |
| Viscosity Index | 118 | 125* | 121 |
| Yield – wt% (basis wax distillate) | 68 | 67* | 55.9 |
| Pour point temp. (°F) | 100 | 100* | 100 |

*hydrogenation effluent recombined with 725–950°F. fraction and mixture vacuum stripped to yield 600–950°F. range oil.

From Table I, the advantages of employing the method of the present invention over the prior art method is clearly seen. The viscosity index of the hydrocracked oil is substantially increased by hydrogenating the 600°–725° F. fraction, without a concomitant decrease in viscosity. Also, the yield of 600°–950° F. lubricating oil stock is substantially increased over the yield obtained by hydrogenating the 600°–950° F. range hydrocracked stock.

Table II shows results from high temperature, low space velocity hydrocracking and hydrogenation operations.

TABLE II

| | Hydrocracking | Hydrogenation | |
|---|---|---|---|
| | 600–950°F Fraction | 600–725°F Fraction | 600–950°F Fraction |
| Temperature (°F) | 775 | 775 | 775 |
| Pressure (psig) | 1500 | 1500 | 1500 |
| LHSV (vol oil/hr/ vol catalyst) | 0.25 | 0.25 | 0.25 |
| Hydrogen to oil SCF/B | 5000 | 5000 | 5000 |
| Catalyst | Harshaw Ni–4403E | | |
| Product Properties – For 600–950° F. Range Oils | | | |
| Kinematic Viscosity (centistokes at 100°F) | 28.55 | 26.00* | 17.98 |
| Viscosity Index | 118 | 129* | 131 |
| Yield – wt% (basis wax distillate) | 68 | 65* | 42 |
| Pour point temp. (°F) | 100 | 100* | 100 |

* hydrogenation effluent recombined with 725–950°F. fraction and mixture vacuum stripped to yield 600–950°F. range oil.

Table II demonstrates the advantages of employing the method of the present invention over the prior art method. The viscosity index of the hydrocracked oil is substantially increased by hydrogenating the 600–725° F. fraction without a concomitant large decrease in viscosity. The hydrogenated 600°–950° F. fraction shows a substantial viscosity decrease for a similar viscosity index increase. Yield of lubricating oil stock from the process of the present invention is substantially higher (65% of wax distillate) over yield (42% of wax distillate) obtained by the prior art method.

By following the method of the present invention the viscosity index of a lubricating oil stock may be substantially improved without the concomitant loss in yield of finished lubricating oil which is generally experienced when methods of the prior art are employed.

To one skilled in the art it will be evident that many variations and modifications of this invention can be practiced in view of the foregoing disclosure that will come within the spirit and scope of the invention.

We claim:

1. A method of treating a hydrocracked lubricating oil stock having an initial boiling point of about 600°F, and having an end point in the range of from about 950°F to about 1,100°F, and containing a substantial portion of mononuclear and di-nuclear aromatic compounds, for increasing, the viscosity index thereof, which method comprises:

a. fractionating the hydrocracked lubricating oil stock into a light fraction boiling in the range of about 600°F to about 750°F, and a heavy fraction having an initial boiling point of about 750°F;

b. hydrogenating the light fraction at a temperature of from about 600°F to about 725°F, a pressure of from about 1,000 to about 10,000 psig, a liquid hourly space velocity of from about 0.1 to about 3.0 volumes light fraction per hour per volume of

catalyst with from about 500 to about 30,000 standard cubic feet of hydrogen per barrel of light fraction in the presence of a hydrogenation catalyst for saturation of mono-nuclear and di-nuclear aromatics hydrocarbons;

c. reblending the hydrogenated light fraction and the heavy fraction; and

d. separating low boiling cracked hydrocarbon from the reblended lubricating oil of step (c) for adjustment of the initial boiling point to about 600°F.

**2.** The method of claim **1** wherein the catalyst is selected from the group consisting of chromium, tungsten, cobalt, molybdenum, nickel, their oxides, their sulfides, platinum, palladium, rhodium, irridium, ruthenium and combinations thereof.

**3.** The method of claim **2** wherein the hydrogenation catalyst is supported upon a porous, noncracking inorganic oxide base.

**4.** The method of claim **3** wherein the base is selected from the group consisting of silica-alumina, alumina, and kieselguhr.

**5.** The method of claim **4** wherein the hydrogenation catalyst comprises nickel and tungsten supported upon alumnina.

**6.** The method of claim **4** wherein the hydrogenation catalyst comprises cobalt and molybdenum supported upon alumina.

**7.** The method of claim **2** wherein the light fraction is hydrogenated at a temperature of from about 650°F to about 700°F, a pressure of from about 1,500 psig to about 3,000 psig, a liquid hourly space velocity of from about 0.25 to about 1.5 volumes of oil per volume of catalyst per hour, and a hydrogen rate of from about 5,000 to about 20,000 standard cubic feet of hydrogen per barrel of light fraction.

**8.** The method of claim **7** wherein the hydrocracked lubricating oil stock is separated into a light fraction having an initial boiling point of about 600°F and an end point of about 725°F and a heavy fraction having an initial boiling point of about 725°F by fractional distillation.

**9.** The method of claim **8** wherein the initial boiling point temperature of the reblended oil is adjusted to about 600°F by vaporizing low boiling cracked hydrocarbons from the liquid reblended oil at an elevated temperature of about 340°F and a subatmospheric pressure of about 3 millimeters mercury, absolute.

**10.** The method of claim **9** including a dewaxing step to reduce the pour point temperature of the reblended oil to about 10° F. or less.

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