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[54] **PROCESS FOR HYDRODESULFURIZING AND HYDROTREATING LUBRICATING OILS FROM SULFUR-CONTAINING STOCK**

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[51] **Int. Cl.²** **C10G 23/02**
[58] **Field of Search** 208/210, 89

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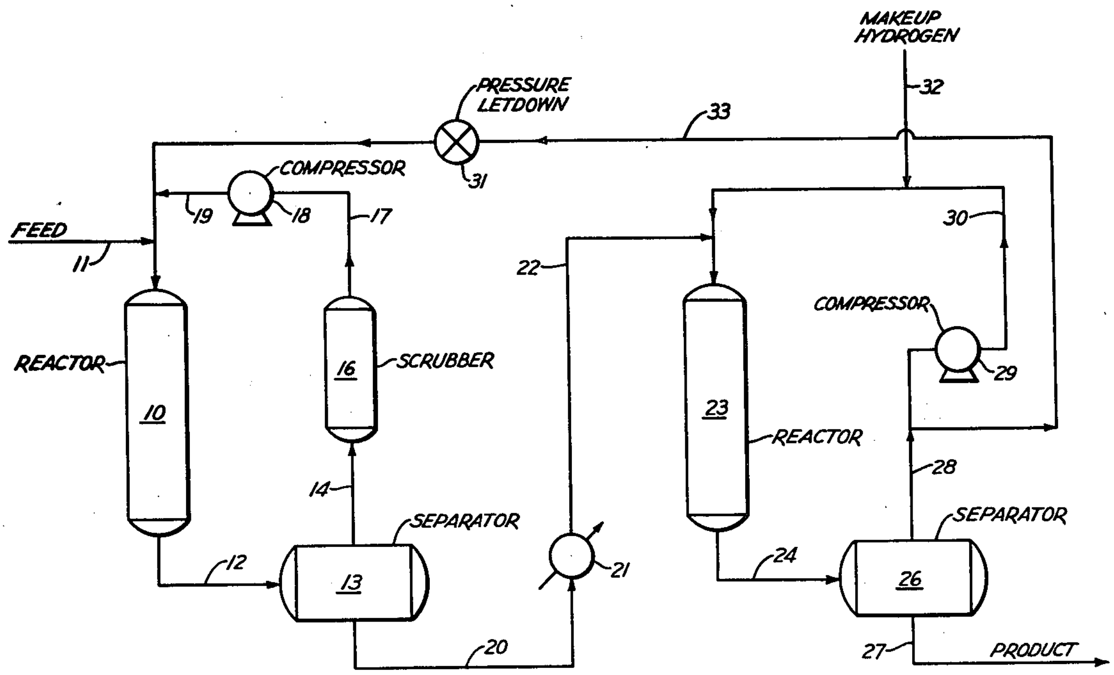
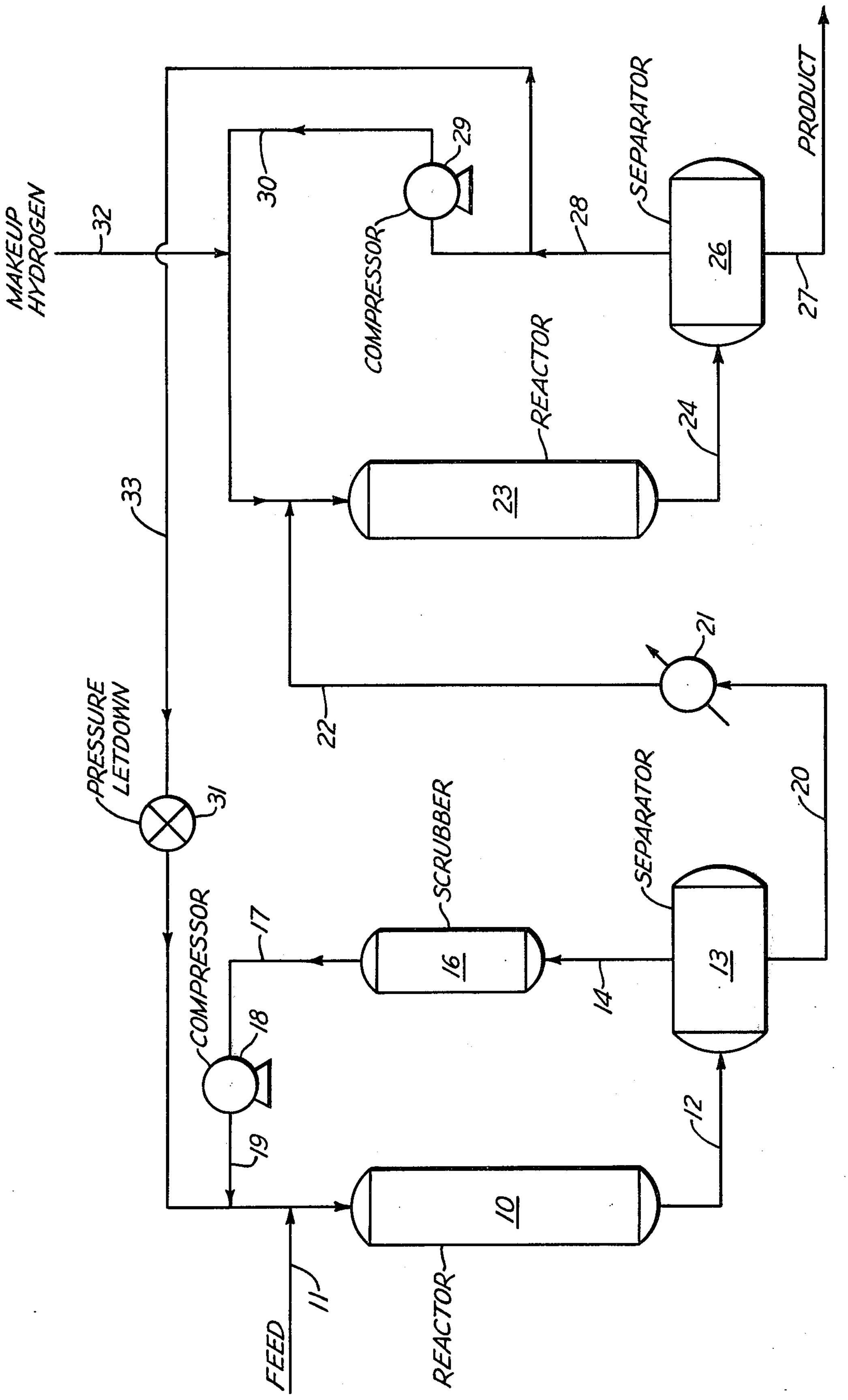
[57] **ABSTRACT**

An improved process for producing lubricating oils from a lubricating oil stock containing at least 2.0 weight percent sulfur by subjecting such stock to hydrodesulfurization so as to obtain a product containing a maximum of 1.0 weight percent sulfur. The desulfurized effluent is then subjected to hydrotreating.

8 Claims, 1 Drawing Figure

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PROCESS FOR HYDRODESULFURIZING AND HYDROTREATING LUBRICATING OILS FROM SULFUR-CONTAINING STOCK

BACKGROUND OF THE INVENTION

Our invention relates to an improved process for the production of lubricating oil from sulfur-containing lubricating oil base stocks. More particularly, it is directed to an improved process for producing lubricating oils from a sulfur-containing stock employing the techniques of hydrodesulfurization and hydrotreating.

Due to the variety of terms applied to hydrogen treatment techniques, particularly in the field of lubricating oil production, and due to the fact that the definition of such terms tend to overlap depending upon the individual employing such terms, it is believed necessary to set forth particular definitions of the terms we will employ in our specification and claims. We term the three most common hydrogen treatment techniques associated with lubricating oil production "hydrocracking," "hydrofinishing" and "hydrotreating."

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. (316° to 343° C.) 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.+ (329° to 343° C.), 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 severe of the three 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.

As distinguished from hydrocracking and hydrofinishing, the term "hydrotreating" is employed herein to describe a processing technique significantly more severe than hydrofinishing 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 feedstock and product desired. Thus, a hydrotreating process effects a substantial molecular rearrangement as compared to hydrofinishing but does not effect the extensive and somewhat random breakdown of molecules effected in hydrocracking. Accordingly, this type of process effects substantial 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 compounds are attacked and the rings are opened, while mononuclear 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 hydrofinishing 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 viscosity index.

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 amont 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. (38° C.). Additionally, this phenomenon is evidenced quite drastically in hydrotreated lubricating oil products having viscosities of less than about 300 SUS at 100° F. (38° C.) 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. (99° C.).

Catalyst compositions employed in hydrotreating processes normally comprise an alumina or silica-alumina support containing at least 20 percent by weight of one or more hydrogenating metals. In the hydrotreating of lubricating oil base stocks, hydrogen partial pressures in the range of about 2000 to about 10,000 lbs. per square inch (141 to 704 kg/sq.cm.) and hydrogen feed rates in the range of about 2000 to about 10,000 standard cubic foot/barrel (56,500 to 283,200 liters/159 liters) are utilized. Hydrogen consumption (measured as standard cubic feet per barrel of fresh feed) is normally 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 the catalytic hydrotreating of sulfur-containing lubricating oil base stocks it has been discovered that a substantial upstream portion of the fixed catalyst bed is employed to desulfurize the feed and that the hydrotreating reaction occurs in only a downstream portion of the catalyst bed. As a result, the space velocity of the feed flow through the hydrotreating zone must be substantially reduced. Therefore, the conventional hydrotreating process employing catalyst compositions containing high concentrations of metals and requiring high hydrogen pressures is very inefficient for the hydrotreating of lubricating oil base stocks containing a significant concentration of sulfur. Lubricating oil base stocks containing at least 2.0 weight percent sulfur are considered to contain a significant concentration of sulfur.

Accordingly, an object of this invention is to provide an improved process for hydrotreating a lubricating oil base stock containing at least 2.0 weight percent sulfur.

Another object of the invention is to provide a process for hydrotreating a lubricating oil base stock containing at least 2.0 weight percent sulfur wherein higher space velocities are obtained.

Yet another object of the invention is to provide an improved process for the hydrotreating of lubricating oil base stocks containing at least 2.0 weight percent sulfur whereby catalyst compositions containing substantially reduced hydrogenation metal concentrations and substantially lower hydrogen partial pressures are employed.

Other objects, advantages and features of this invention will be readily apparent to those skilled in the art from the following description and appended claims.

SUMMARY OF THE INVENTION

By the invention, a two-stage hydrogenation process is provided whereby a lubricating oil base stock containing at least 2.0 weight percent sulfur is initially hydrodesulfurized in the presence of a catalyst composite containing a low concentration of metals under a substantially reduced hydrogen partial pressure and the substantially desulfurized lubricating oil base stock containing from 0.15 to 1.0 weight percent sulfur is thereafter hydrotreated in the presence of a catalyst composition containing a relatively high concentration of metals and under a substantially increased hydrogen partial pressure.

DESCRIPTION OF THE DRAWING

The drawing is a schematic representation of one embodiment of the invention.

DESCRIPTION OF THE INVENTION

The feed stock charge to the initial hydrogenation stage or hydrodesulfurization step is a substantially asphaltic-free lubricating oil base stock boiling completely above about 650° F. (343° C.). Depending upon the source of the crude oil from which the lubricating oil base stock is obtained, it may be necessary to suject the 650° F.+ boiling fraction to a pretreatment step such as propane deasphalting to provide a lubricating oil base stock feed to the inventive two-stage hydrogenation process which is substantially asphaltic-free.

Generally, the operating conditions employed in the initial hydrogenation or hydrodesulfurization stage include a temperature in the range of about 600° to about 900° F. (316° to about 482° C.), a pressure in the range of about 300 to about 2500 psi (14.1 to 176 kgs/sq.cm.) and a space velocity in the range of about 0.1 to about 10 volumes of charge stock per volume of catalyst per hour. A hydrogen partial pressure in the range of 200 to 2000 psi (14.1 to 141 kgs/sq.cm.) is maintained in the hydrodesulfurization zone. The hydrogen feed rate to the initial stage is maintained in the range from about 1000 to about 5000 standard cubic feet per barrel (28,320 to 141,500 liters/159 liters) of charge stock. It is not necessary to employ a pure hydrogen stream in the hydrodesulfurization step and, preferably, the hydrogen stream from the second hydrogenation or hydrotreating stage can be employed as a hydrogen source in the initial stage. The hydrogen content of the gas stream should be at least about 50 percent by volume.

The catalyst composition employed in the hydrodesulfurization step comprises a combination of at least one hydrogenation component selected from each of Groups VI-B and VIII metals, their oxides and sulfides or mixtures thereof, and a refractory metal oxide. The total concentration of the hydrogenation metals employed in the hydrodesulfurization stage will range from 5.0 to 15.0 weight percent. It is within the scope of the invention to employ a combination of metalliferous components, such as cobalt-molybdenum, nickel-molybdenum, nickel-cobalt-molybdenum, nickel-tungsten, etc. Preferably, the hydrogenation component is dispersed on a refractory oxide carrier of high surface area, such as, for example, alumina, silica-alumina, silica-magnesia, etc.

Generally, in the hydrodesulfurization step, it will be found that the hydrogen consumption is in the range of about 1 to about 5 and preferably at about 2 to about 4 molecular weights of hydrogen per atomic weight of sulfur removed. As distinguished from hydrodesulfurization, it will generally be found that in the hydrotreating step the range of hydrogen consumption is in excess of about 6 mols of hydrogen per atomic weight of sulfur removed from the feed stock.

The operating conditions and catalysts employed in the hydrodesulfurization step are selected so as to reduce the concentration of sulfur to the range of 0.15 to 1.0 weight percent of the lubricating oil base stock effluent withdrawn from the hydrodesulfurization step. As it is desired to maintain a sulfided catalyst composition in the second hydrogenation stage, the sulfur concentration in the effluent withdrawn from the hydrodesulfurization stage and passed as feed to the hydrotreating stage is maintained at a level of at least 0.15 weight percent.

The substantially desulfurized lubricating oil base stock withdrawn from the hydrodesulfurization stage is then subjected to a second treatment process step so as to hydrotreat the lubricating oil base stock. It is within the scope of the invention to employ a single vessel for the novel two-stage process of this invention with the effluent from the hydrodesulfurization catalyst bed being passed directly to the hydrotreating zone containing the hydrotreating catalyst composition. It is also within the scope of this invention to employ separate vessels for the hydrodesulfurization and hydrotreating process steps as illustrated by the attached drawing and hereafter discussed.

The operating conditions employed in the hydrotreating stage of the invention include a temperature in the range of about 600° to about 900° F. (316° to about

482° C.), and preferably about 700° to about 850° F. (371° to about 454° C.); a pressure in the range from about 2500 to about 10,000 psi (176 to 705 kgs/sq.cm.), and a liquid hourly space velocity in the range from about 0.1 to about 10 volumes of crude lubricating oil feed stock per volume of catalyst per hour. A hydrogen partial pressure in the range from about 2,200 to about 10,000 psi (155 to 705 kgs/sq.cm.) and a hydrogen feed rate in the range from about 3,000 to about 10,000 standard cubic feet per barrel (84,000 to 283,200 liters/159 liters) of charge stock are maintained in the hydrotreating zone. Hydrogen streams containing from about 70 to about 90 percent hydrogen are employed as feed to the hydrotreating zone.

The catalyst employed in the hydrotreating stage is comprised of hydrogenating components comprising at least one component selected from Group VI and one component selected from Group VIII metals and their sulfides. The concentration of the hydrogenation metals in the hydrotreating catalyst composition will be at least 20 weight percent. Suitable hydrogenating components include nickel-tungsten, nickel-cobalt-molybdenum, and cobalt-molybdenum, with nickel-tungsten being a preferred combination, particularly in a ratio of about 1 to 4 mols of nickel per mol of tungsten. With the feed to the hydrotreating stage containing sulfur, the metalliferous components are employed in their sulfided form. While such catalysts can be supported or unsupported, it is preferred to employ the catalyst supported on a refractory oxide such as silica, alumina, magnesia, silica-alumina, silica-magnesia, etc. Additionally, the catalyst composition can contain from 0.5 to 5.0 weight percent of a halogen, preferably fluorine.

Further, operating conditions employed in the hydrotreating stage are selected so as to obtain a yield of at least 50 percent by volume, based upon the charge to the hydrodesulfurizing step, 650° F.+ (343° C.+) material. Accordingly, the operating conditions are selected so at the hydrotreating reactor conditions 650° F.+ (343° C.+) material comprises at least 22.0 mols of the product which is normally at liquid 60° F. (16°C.) and one atmosphere. Furthermore, operating conditions are selected so that the actual hydrogen consumption measured as standard cubic feet per barrel is less than the product of 30 multiplied by the volume percent [measured at 60° F. (16° C.) and one atmosphere] of 625° F.+ (330°C.+) liquid in the total C_5+ liquid product.

The product of the hydrotreating stage is substantially free of sulfur and contains a substantially reduced concentration of aromatics and polynuclear cyclic compounds than that present in the feed to the hydrodesulfurization and hydrotreating process stages. The viscosity index of the lubricating oil stock has been substantially improved.

Referring to the drawing, the invention will hereafter be described as it relates to a specific embodiment. A lubricating oil feed stock is passed via conduit **11** in combination with a hydrogen gas as hereafter described to the top of reactor **10.** Within reactor **10,** the feed is contacted with a catalyst at a liquid hourly space velocity of 2.0. The catalyst comprises nickel, cobalt and molybdenum dispersed on an alumina support. A temperature of 690° F. (366° C.) is maintained in reactor **10** and the reactor inlet pressure is 1500 psi (105.6 Kgs/sq.cm.) Circulating gas having a hydrogen concentration of 65 mol percent is passed to reactor **10** at the rate of 2000 standard cubic feet per barrel of feed (56,500 liters/159 liters).

The effluent is withdrawn from reactor **10** via conduit **12** and passed to a separator **13.** Within separator **13,** normally operating at a pressure of about 1450 psi, the effluent is separated into a gaseous stream which is withdrawn via conduit **14** and a liquid product stream which is withdrawn from separator **13** via conduit **20.** The liquid stream is heated by a heat exchanger **21** and passed via conduit **22** to the top of reactor **23** in combination with a hereafter described hydrogen feed stream.

The gaseous stream withdrawn from separator **13** via conduit **14** is passed to a conventional hydrogen sulfide separation step such as an amine scrubber **16.** A hydrogen stream substantially free of hydrogen sulfide is withdrawn from the top of scrubber **16** via conduit **17** and passed to a compressor **18.** Compressor **18** compresses the recycle hydrogen gas stream and passes the compressed recycle stream via conduit **19** to conduit **33** where it is combined with makeup hydrogen from the hydrotreating stage via conduit **33** and pressure letdown **31** as required and the resultant combined gaseous stream mixed with the lubricating oil feed stock in conduit **11.**

The lubricating oil feed to reactor **23** is heated via heat exchanger **21** to a temperature so as to maintain the temperature within reactor **23** at 745°F. (397° C.). Hydrogen is introduced into reactor **23** via conduit **30** and conduit **22** so as to maintain a reactor inlet pressure of 3000 psi. A gas circulation rate of 5000 standard cubic feet per barrel of feed (141,800 liters/159 liters) with a hydrogen concentration of 80 mol percent is maintained to reactor **23.** The lubricating oil feed is passed through reactor **23** at a liquid hourly space velocity of 2.0. The catalyst composition within reactor **23** comprises nickel and tungsten on a fluorine-promoted silica-alumina support.

An effluent stream is withdrawn from reactor **23** via conduit **24** and passed to a separator **26.** The pressure within separator **26** is about 2950 psi. A liquid lubricating oil product stream substantially sulfur-free is withdrawn from separator **26** via conduit **27** and a gaseous stream is withdrawn from separator **26** via conduit **28.**

A portion of the recycle gaseous stream in conduit **28** is passed to a compressor **29.** Compressor **29** functions so as to provide a compressed hydrogen gaseous stream in conduit **30** that when mixed with the lubricating oil feed to reactor **23** will provide an inlet pressure in reactor **23** of 3000 psi. Makeup hydrogen as required is introduced to conduit **30** via conduit **32.** A portion of the gaseous stream from separator **26** is passed as makeup hydrogen to reactor **10** via conduits **28, 33,** and **11** and pressure letdown means **31** (such as a valve).

The following examples are presented to demonstrate the objects and advantages of the invention. It is not intended, however, to limit the invention to the specific embodiments presented therein.

EXAMPLE I

In this example, the invention will be illustrated employing the process parameters described in the specific embodiment, referred above and as illustrated in the drawing. The catalyst employed in the hydrodesulfurization stage comprises 2.25 weight percent nickel, 1.25 weight percent cobalt, and 11.0 weight percent molybdenum dispersed on an alumina support. The lubricating oil feed to the hydrodesulfurization reactor is characterized as follows:

Gravity: °API	19.5	
Viscosity: SUV at 210°F., secs.	125.4	
Sulfur: weight %	3.07	
Distillation, Vacuum:		
10% Condensed	905° F.	(485°C)
20%	949	(510°C)
30%	989	(537°C)

In the hydrodesulfurization stage, 450 standard cubic feet of hydrogen per barrel of feed (12,700 liters/159 liters) is consumed. The API gravity of the product recovered from the hydrodesulfurization reactor is 25.4, the viscosity, SUV at 210° F., is 80.0 seconds and the concentration of sulfur in the desulfurized product is 0.37 weight percent.

In the hydrotreating stage, the catalyst comprises 5.5 weight percent nickel, 18.5 weight percent tungsten, and 2.0 weight percent fluorine dispersed on a silica-alumina support. Hydrogen at the rate of 475 standard cubic feet per barrel of feed (13,430 liters/159 liters) is consumed in the hydrotreating stage. The yield of hydrotreated products based on the feed to the hydrodesulfurization stage is 85.0 volume percent and the mol percent liquid in the C_5+ product is 61.5.

The hydrotreated liquid product is solvent dewaxed and the properties of the dewaxed product are as follows:

Viscosity:	
SUV at 100° F., secs.	317
SUV at 210° F., secs.	54.3
Viscosity Index	105
Pour Point: °F.	−10

EXAMPLE II

In this example the effect of employing a single stage hydrotreating process in the treatment of the lubricating oil feed stock of Example I is demonstrated. The lubricating oil feed is passed through the hydrotreater at a liquid hourly space velocity of 1.0. The reaction zone is maintained at a total pressure of 3000 psi with a hydrogen partial pressure of 2500 psi. The gas circulation rate is 5000 standard cubic feet per barrel of feed with a hydrogen purity of 80 mol percent. The average temperature in the hydrotreating zone is 745° F.

Hydrogen at the rate of 925 standard cubic feet per barrel of feed is consumed in the hydrotreating zone. The yield of waxy lubricating oil stock based on the feed to the hydrotreating zone is 85.0 volume percent. The mol percent liquid in the C_5+ product is 61.5.

The hydrotreated product is solvent dewaxed to produce a product having the characteristics essentially identical to the characteristics of the product of Example I.

A comparison of the runs of Example I and II illustrates the advantage of the inventive process to obtain a satisfactory lubricating oil product at twice the space velocity as that of the more conventional process exemplified in Example II. Therefore, a substantially smaller high pressure reactor with fewer catalyst beds can be employed in the novel two-stage process than that required by the single-stage hydrotreating process of the prior art.

Additionally, less capacity is required of a makeup compressor having an outlet pressure of 3000 psig when operating according to the novel process of this invention than would be required by the conventional single-stage hydrotreating process. Reference is made to the drawing wherein it is illustrated that by employing prior desulfurization and therefore a smaller reactor in the second high pressure stage, substantially less 3000 psi hydrogen would be required.

Further, by employing the two-stage process of this invention, no scrubbing of a gas recovered from the high pressure separator of the hydrotreating stage would be required to separate hydrogen sulfide therefrom. Makeup hydrogen to the hydrodesulfurization stage can be supplied by the hydrotreating operation. Obviously, by employing a single-stage hydrotreating process as exemplified in Example II, it would be necessary to employ a gas scrubber operating at nominally 2950 psi to separate the hydrogen sulfide generated in the hydrotreating zone and present in the gaseous stream withdrawn from the high pressure separator.

Yet another advantage of the two-stage hydrogenation process of this invention is the substantially lower catalyst cost when compared with the conventional single-stage hydrotreating process. The desulfurization catalyst contains a substantially lower metals concentration than that required in the hydrotreating catalyst of Example II.

Although the invention has been described with references to specific embodiments, references, and details, various modifications and changes will be apparent to one skilled in the art and are contemplated to be embraced in this invention.

We claim:

1. A process which comprises contacting a substantially asphaltic-free lubricating oil feed boiling completely above 650°F. and containing at least 2.0 weight percent sulfur with a catalyst composition in a hydrodesulfurization zone under hydrodesulfurization conditions to include a hydrogen partial pressure in the range from about 200 to 2000 psi, the hydrodesulfurization catalyst composition comprising at least one Group VI-B hydrogenation metal, oxide or sulfide thereof and at least one Group VIII hydrogenation metal, oxide or sulfide thereof or alumina support, the total concentration of hydrogenation metals in said hydrodesulfurization catalyst composition being in the range of 5.0 to 15.0 weight percent, contacting the product of said hydrodesulfurization step containing from 0.15 to 1.0 weight percent sulfur with a hydrotreating catalyst composition in a hydrotreating zone under hydrotreating conditions to include a hydrogen partial pressure in the range from about 2200 to about 10,000 psi, the hydrotreating catalyst composition comprising at least one hydrogenation metal or sulfide thereof selected from Group VI-B metals and at least one hydrogenation metal or sulfide thereof selected from Group VIII metals on a support selected from the group consisting of alumina and silica-alumina, the total concentration of said hydrogenation metals in said hydrotreating catalyst composition being at least 20 weight percent, and recovering therefrom a substantially sulfur-free lubricating oil product of reduced aromatics concentration and increased viscosity index.

2. The process of claim **1** wherein the temperature maintained in the hydrodesulfurization zone is in the range from about 600° to about 900°F. and the temperature in said hydrotreating zone is maintained in the range from about 700° to about 850°F.

3. The process of claim **2** wherein the catalyst in the hydrodesulfurization zone comprises nickel, cobalt, molybdenum and an alumina support.

4. The process of claim **3** wherein the catalyst in the hydrotreating zone comprises nickel, tungsten, fluorine and a silica-alumina support.

5. A process which comprises contacting a substantially asphaltic-free 650°F. + lubricating oil feed containing at least 2.0 weight percent sulfur with a catalyst composition comprising at least one Group VI-B hydrogenation metal, oxide or sulfide thereof and at least one Group VIII hydrogenation metal, oxide or sulfide thereof on alumina support, the total concentration of said hydrogenation metals in said hydrodesulfurization catalyst composition being in the range of 5.0 to 15.0 weight percent, in a hydrodesulfurization zone under hydrodesulfurization conditions to include a hydrogen partial pressure in the range from about 200 to about 2000 psi, passing an effluent mixture from said hydrodesulfurization zone to a first separation zone, separating the hydrogen sulfide from a gaseous phase withdrawn from said first separation zone, and recycling said gaseous phase substantially free of hydrogen sulfide to said hydrodesulfurization zone, passing a liquid lubricating oil from said first separation zone to a hydrotreating zone, contacting said oil from said hydrodesulfurization step containing from 0.15 to 1.0 weight percent sulfur with a hydrotreating catalyst composition comprising at least one hydrogenation metal or sulfide thereof selected from Group VI-B metals and at least one hydrogenation metal or sulfide thereof selected from Group VIII metals on a support selected from the group consisting of alumina and silica-alumina, the total concentration of said hydrogenation metals in said hydrotreating catalyst composition being at least 20 weight percent, said contacting being carried out in said hydrotreating zone under hydrotreating conditions to include a hydrogen partial pressure in the range of about 2200 to about 10,000 psi, passing an effluent mixture from said hydrotreating zone to a second separation zone, withdrawing a liquid lubricating oil product from said second separation zone, recycling a first portion of the gaseous phase withdrawn from said second separation zone to said hydrotreating zone, and passing a second portion of the gaseous phase withdrawn from said second separation zone to said hydrodesulfurization zone.

6. The process of claim **5** wherein the temperature maintained in the hydrodesulfurization zone is in the range from about 600° to about 900°F. and the temperature in said hydrotreating zone is maintained in the range from about 700° to about 850°F.

7. The process of claim **6** wherein the catalyst in the hydrodesulfurization zone comprises nickel, cobalt, molybdenum and an alumina support.

8. The process of claim **7** wherein the catalyst in the hydrotreating zone comprises nickel, tungsten, fluorine and a silica-alumina support.

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