

DESCRIPTION

Title of Invention

5 METHOD FOR PRODUCING WAX, WAX, AND METHOD FOR
PRODUCING LUBRICANT BASE OIL

Technical Field

[0001] The present invention relates to a method for producing a wax, wax and a method for producing a lubricant base oil.

Background Art

10 [0002] In the related art, a method for producing a lubricant base oil by hydrogenation treatment, hydrogenation dewaxing and hydrogenation refining of a wax-containing raw material is known (for example, Patent Literature 1). For the wax-containing raw material, for example, a slack wax obtained in the process of petroleum refining is used.

15 Citation List

Patent Literature

[0003] [Patent Literature 1] Japanese Unexamined Patent Publication No. 2006-502297

Summary of Invention

20 Technical Problem

[0004] Slack wax is a wax component collected by solvent dewaxing of petroleum fractions, but solvent dewaxing has problems that a large amount of a solvent is required, an operation at a very low temperature is required, and also the yield significantly decreases when the content of normal paraffin is further increased.

25 [0005] An object of the present invention is to provide a novel method

for producing a wax, a wax obtained by the production method, and a method for producing a lubricant base oil using the wax.

Solution to Problem

5 [0006] One aspect of the present invention relates to a method for producing a wax including a first precipitation process in which a first solid component is precipitated from a mixed oil obtained by adding a low-temperature fluidity improving agent to a hydrocarbon oil having a 10% volume distillation temperature of 300°C or higher under a temperature condition of 5 to 40°C; and a first separation process in 10 which the first solid component is collected as a first non-permeate component by a solid-liquid separation method.

[0007] In one aspect of the production method, the pour point of the mixed oil may be 20°C or lower.

15 [0008] In one aspect of the production method, the pour point of a first permeate component separated in the first separation process may be lower than the pour point of the hydrocarbon oil by 5°C or more.

[0009] In one aspect of the production method, the first solid component may contain 40 volume% or more of normal paraffin having 18 or more carbon atoms.

20 [0010] One aspect of the production method may further include a first washing process in which the first solid component is washed with at least one solvent selected from the group consisting of normal pentane, normal hexane, 2-propanol, 2-butanone, acetone and toluene.

25 [0011] In one aspect of the production method, the first solid component after the first washing process may contain 80 volume% or more of normal paraffin having 20 or more carbon atoms.

[0012] One aspect of the production method may further include a second precipitation process in which a solvent containing 80 volume% or more of at least one selected from the group consisting of 2-propanol, 2-butanone and acetone is added to a solution prepared by dissolving the first solid component in a solvent of 40°C or higher containing 80 volume% or more of at least one selected from the group consisting of normal pentane and normal hexane, and a second solid component is precipitated; and a second separation process in which the second solid component is collected as a second non-permeate component by a solid-liquid separation method.

[0013] One aspect of the production method may further include a second washing process in which the second solid component is washed with at least one solvent selected from the group consisting of normal pentane, normal hexane, 2-propanol, 2-butanone, acetone and toluene.

[0014] In one aspect of the production method, the second solid component after the second washing process may contain 90 volume% or more of normal paraffin having 20 or more carbon atoms.

[0015] In one aspect of the production method, the low-temperature fluidity improving agent may be at least one selected from the group consisting of ethylene-vinyl acetate copolymers, polyalkyl methacrylate, imide alkenyl succinate, polyalkylene oxide fatty acid ester, polyalkyl acrylate, alkyl naphthalene and dendrimers.

[0016] In one aspect of the production method, the solid-liquid separation method may be performed by filtration using a filter having a pore size of 2 μm or more or centrifugation, under a temperature condition of higher than 0°C.

[0017] One aspect of the present invention relates to a wax containing a low-temperature fluidity improving agent for a gas oil.

[0018] In one aspect of the wax, the content of the low-temperature fluidity improving agent may be 0.01 to 5 mass%.

5 [0019] In one aspect of the wax, the low-temperature fluidity improving agent may include an ethylene-vinyl acetate copolymer.

[0020] One aspect of the present invention relates to a method for producing a lubricant base oil including a base oil producing process in which a lubricant base oil is obtained from the wax produced by the
10 above production method.

Advantageous Effects of Invention

[0021] According to the present invention, it is possible to provide a novel method for producing a wax, a wax obtained by the production method, and a method for producing a lubricant base oil using the wax.

Brief Description of Drawings

15 [0022] FIG. 1 is a flowchart showing a method for producing a wax according to one embodiment.

Description of Embodiments

20 [0023] Preferable embodiments of the present invention will be described below.

[0024] [Method for producing wax]

25 A method for producing a wax of the present embodiment includes a first precipitation process in which a low-temperature fluidity improving agent is added to a hydrocarbon oil having a 10% volume distillation temperature of 300°C or higher and a first solid component is precipitated under a temperature condition of 5 to 40°C, and a first

separation process in which the first solid component is collected as a first non-permeate component by a solid-liquid separation method.

[0025] FIG. 1 is a flowchart showing a method for producing a wax according to one embodiment. For example, in this flowchart, a mixer 10 for preparing a mixed oil (including precipitates) by mixing raw materials and a solid-liquid separator 11 for separating a first permeate component and a first non-permeate component from the mixed oil supplied from the mixer 10 are shown. In addition, in FIG. 1, a flow path L0 through which the mixed oil is supplied to the solid-liquid separator 11, a flow path L10 through which the first permeate component separated by the solid-liquid separator 11 is extracted, and a flow path L11 through which the first non-permeate component is extracted are shown.

[0026] <First precipitation process>

In the first precipitation process, a low-temperature fluidity improving agent is added to a hydrocarbon oil to prepare a mixed oil, and a first solid component is precipitated under a temperature condition of 5 to 40°C. The 10% volume distillation temperature of the hydrocarbon oil is 300°C or higher and preferably 320°C or higher. Here, the 90 volume% distillation temperature of the hydrocarbon oil is preferably 480°C or lower, and more preferably 460°C or lower. The distillation temperature of the hydrocarbon oil can be determined by JIS (Japanese Industrial Standards) K2254 (petroleum product-distillation test method). The hydrocarbon oil may be derived from, for example, a heavy gas oil. When such a hydrocarbon oil is used, a required amount of wax used in the lubricant base oil process can be secured at a

low cost. Here, in the present embodiment, the precipitation process is performed in the absence of a solvent.

[0027] The hydrocarbon oil contains normal paraffin. Here, normal paraffin means a linear saturated hydrocarbon. The content of normal

5 paraffin in the hydrocarbon oil is not particularly limited, and may be, for example, 5 volume% or more, and is preferably 7 volume% or more, and more preferably 10 volume% or more. In addition, the content of

normal paraffin in the hydrocarbon oil may be, for example, 20 volume% or less, and is preferably 17 volume% or less, and more

10 preferably 15 volume% or less. The content of normal paraffin is a content quantified by a gas chromatograph equipped with a non-polar column and a flame ionization detector (FID) and operated by a predetermined temperature program, and the gas chromatograph is an

analysis method in which compositions are separated and quantitatively

15 analyzed using physical properties (a boiling point, a polarity, etc.) of the compositions in the sample. For example, the content can be determined as follows. First, the normal paraffin component in the sample is separated and measured for each carbon number as a peak by a gas chromatograph. The area of the obtained normal paraffin with

20 each carbon number is divided by the total area of all components including components other than normal paraffin, except for the peak area of a solvent when the sample was diluted or dissolved in the solvent for performing the analysis, and the content of normal paraffin

with each carbon number is determined as area%, and this value is

25 defined as volume%.
[0028] In the hydrocarbon oil, the average carbon number of normal

paraffin is preferably 23 or more and more preferably 25 or more. In addition, in the hydrocarbon oil, the average carbon number of normal paraffin is preferably 28 or less and more preferably 27 or less.

5 [0029] In the hydrocarbon oil, the content of normal paraffin having 20 or more carbon atoms is not particularly limited, and may be, for example, 7 volume% or more, and is preferably 8 volume% or more, and more preferably 9 volume% or more. In addition, the content of normal paraffin having 25 or more carbon atoms in the hydrocarbon oil may be, for example, 3 volume% or more, and is preferably 4 volume%
10 or more, and more preferably 5 volume% or more.

[0030] The hydrocarbon oil may further contain a hydrocarbon compound other than normal paraffin. Examples of other component include isoparaffin, cycloparaffin, aromatic components, and the like.

15 [0031] The hydrocarbon oil may contain a sulfur component. The content of the sulfur component may be, for example, 5 mass% or less, and is preferably 3 mass% or less. In addition, the content of the sulfur component may be 0, and may be, for example, 0.01 mass% or more or 0.1 mass% or more. The sulfur component can be determined by JIS (Japanese Industrial Standards) K2541-6 (crude oil and petroleum
20 product-sulfur component test method: ultraviolet fluorescence method).

[0032] In order to selectively precipitate the wax component which is a lubricant base oil raw material and maintain the fluidity of the hydrocarbon oil after wax precipitation, regarding the raw material
25 hydrocarbon oil, an oil containing 2 mass% or less of the sulfur component and having a linear regression line slope (Y) of 0.03 or more

and 0.08 or less, which is determined from the content of normal paraffin having 23 to 27 carbon atoms, is preferably used. The slope (Y) of the linear regression line is obtained from the content of the normal paraffin having 23 to 27 carbon atoms. Here, the content of normal paraffin is a content quantified by a gas chromatograph equipped with a non-polar column and a flame ionization detector (FID) and operated by a predetermined temperature program, and the gas chromatograph is an analysis method in which compositions are separated and quantitatively analyzed using physical properties (a boiling point, a polarity, etc.) of the compositions in the sample. For example, the slope of the linear regression line of a certain base material can be obtained as follows. First, the normal paraffin component in the sample is separated and measured by a gas chromatograph as peaks with 23 to 27 carbon atoms. The area of the obtained normal paraffin with each carbon number is divided by the total area of all components including components other than normal paraffin, and the content of normal paraffin with each carbon number is determined as volume%. Next, each of these contents is plotted on the Y axis, a carbon number of 23 is plotted as 4, a carbon number of 24 is plotted as 3, a carbon number of 25 is plotted as 2, a carbon number of 26 is plotted as 1, and a carbon number of 27 is plotted as 0 on the X axis, the linear regression line is determined for these plots, and thus the slope Y of the linear regression line of the base material can be specified.

[0033] Examples of low-temperature fluidity improving agents include ethylene-vinyl acetate copolymers, polyalkyl methacrylate, imide alkenyl succinate, polyalkylene oxide fatty acid ester, polyalkyl

acrylate, alkyl naphthalene, olefin copolymers, styrene diene copolymers, and dendrimers. Among these, in order to precipitate the wax component with a low oil content and collect it in the first separation process in a high yield, ethylene-vinyl acetate copolymers, polyalkyl methacrylate and polyalkylene oxide fatty acid ester (all are a low-temperature fluidity improving agent for a gas oil) are preferable, and ethylene-vinyl acetate copolymers are more preferable. These may be used alone or two or more thereof may be used in combination.

[0034] When an ethylene-vinyl acetate copolymer is used, the number average molecular weight (Mn) thereof is preferably 6,000 or less, more preferably 1,000 to 5,000, and still more preferably 2,000 to 4,000 in consideration of the precipitation temperature. In addition, the vinyl acetate content (VA) in the ethylene-vinyl acetate copolymer is preferably 20 mass% or more, more preferably 25 to 60 mass%, and still more preferably 30 to 45 mass% in order to inhibit wax growth.

[0035] The number average molecular weight (Mn) can be determined by JIS (Japanese Industrial Standards) K7252 (plastics-determination of average molecular weight and molecular weight distribution of polymers using size-exclusion chromatography). The vinyl acetate content (VA) can be determined by JIS (Japanese Industrial Standards) K7192 (plastic-ethylene/vinyl acetate resin (EVAC)-vinyl acetate content measuring method).

[0036] The amount of the low-temperature fluidity improving agent added to the hydrocarbon oil is preferably 0.01 parts by mass or more and more preferably 0.025 parts by mass or more with respect to 100 parts by mass (parts by weight) of the hydrocarbon oil in order to

improve the wax recovery rate and the fluidity of the hydrocarbon oil. In addition, in order to reduce the concentration of impurities other than normal paraffin in the obtained wax, the amount thereof is preferably 0.06 parts by mass or less and more preferably 0.05 parts by mass or less with respect to 100 parts by mass of the hydrocarbon oil.

[0037] The pour point of the mixed oil obtained by adding the low-temperature fluidity improving agent to the hydrocarbon oil (before the first solid component is precipitated) is preferably 20°C or lower and more preferably 15°C or lower in consideration of filtration properties. Here, the lower limit of the pour point is not particularly limited, and it can be, for example, -5°C. The pour point can be determined by JIS (Japanese Industrial Standards) K2269 (pour point of crude oil and petroleum product and petroleum product cloud point test method).

[0038] When the low-temperature fluidity improving agent is added to the hydrocarbon oil, and the mixture is then left under a temperature condition of 5 to 40°C, the first solid component is precipitated from the mixed oil. When the first solid component is precipitated, stirring may be performed with a mixer, a glass rod, or the like, as necessary. Here, the temperature condition is more preferably 15 to 25°C in order to maintain the fluidity of the hydrocarbon oil and make the particle size of the precipitated solid component uniform.

[0039] <First separation process>

The first solid component precipitated in the hydrocarbon oil in the first precipitation process is collected as the first non-permeate component in the solid-liquid separation method. Examples of

solid-liquid separation methods include a method of performing separation by filtration using a solid-liquid separation membrane having a pore size of 2 μm or more or centrifugation, under a temperature condition of higher than 0°C. In the former case, a cloth, a net, a packed bed, a porous material or the like can be used as the filter medium, and the solid component can be separated by filter pressing, gravity filtration, pressure filtration, vacuum filtration, centrifugal filtration or the like. Regarding the material constituting the cloth, synthetic fibers, natural fibers, glass fibers, or the like can be used, and specific examples thereof include polypropylene, polyester, polyamide, and cotton cloth. Regarding the net, a metal net can be used, and specific examples of constituent materials include carbon steel, stainless steel, monel metal, nickel, and aluminum. Regarding the material constituting the packed bed, sand, white clay, activated carbon, and the like can be used. Regarding the porous material, a separation membrane containing sintered metal, porous graphite, an inorganic film (a membrane formed of an inorganic material) and the like can be used, and specific examples thereof include a stainless steel sintered component, a separation membrane containing a silica membrane, an alumina membrane, a zeolite membrane, and the like, and a glass filter. The pore size may be determined by a physical measurement method using an optical microscope or the like, and the holding particle size (a particle size at which 90% or more can be held when 7 kinds of powder dispersed water defined in JIS (Japanese Industrial Standards) Z8901 are naturally filtered) may be used. In the latter case, the solid component can be separated by a separator such as a separating plate

type, a cylindrical type, or a decanter type.

[0040] In the first separation process, the first non-permeate component having a high wax content and the first permeate component having a low wax content can be obtained. The first solid component contains
5 normal paraffin having 18 or more carbon atoms. The content of normal paraffin having 18 or more carbon atoms in the first solid component is not particularly limited, and for example, it is preferably 40 volume% or more and more preferably 60 volume% or more. On the other hand, the content of normal paraffin having 18 or more carbon
10 atoms in the first solid component may be, for example 80, volume% or less or 60 volume% or less.

[0041] Since the wax component (normal paraffin having 18 or more carbon atoms, etc.) contained in the first solid component is removed from the first permeate component (hydrocarbon oil), the pour point of
15 the first permeate component is lowered. The pour point of the first permeate component separated in the first separation process may be lower than the pour point of the hydrocarbon oil (raw material hydrocarbon oil) used as the raw material by 5°C or more or 10°C or more.

[0042] The first solid component (wax) obtained in the first separation process can be subjected to a base oil producing process in which a lubricant base oil is obtained. However, in order to obtain a wax suitable for producing a lubricant base oil, a first washing process, or a second precipitation process, a second separation process, and a second
20 washing process may be additionally performed on the first solid component.

[0043] <First washing process>

In the first washing process, the first solid component obtained in the first separation process is washed with a solvent. Examples of solvents used in the first washing process include normal pentane, normal hexane, 2-propanol, 2-butanone, acetone, and toluene. These may be used alone or two or more thereof may be used in combination. The first solid component (wax) after the first washing process can contain 80 volume% or more, and more preferably 90 volume% or more of normal paraffin having 20 or more carbon atoms.

[0044] <Second precipitation process and second separation process>

In the second precipitation process, a solvent containing 80 volume% or more of at least one selected from the group consisting of 2-propanol, 2-butanone and acetone is added to a solution prepared by dissolving the first solid component in a solvent of 40°C or higher containing 80 volume% or more of at least one selected from the group consisting of normal pentane and normal hexane, and a second solid component is precipitated.

[0045] As in the first separation process, the precipitated second solid component is collected as a second non-permeate component by the solid-liquid separation method. A preferred embodiment of the solid-liquid separation method is the same as that of the first separation process.

[0046] <Second washing process>

In the second washing process, the second solid component obtained in the second separation process is washed with a solvent. Examples of solvents used in the second washing process include

normal pentane, normal hexane, 2-propanol, 2-butanone, acetone, and toluene. These may be used alone or two or more thereof may be used in combination. The second solid component (wax) after the second washing process can contain 80 volume% or more, and more preferably 90 volume% or more of normal paraffin having 20 or more carbon atoms.

[0047] <Wax>

According to the method for producing a wax of the present embodiment, a wax can be obtained as the solid component. The obtained wax may contain a low-temperature fluidity improving agent added to the hydrocarbon oil used as a raw material.

[0048] The content of the low-temperature fluidity improving agent contained in the wax is not particularly limited because it varies depending on the initial addition amount and the producing process, and can be 0.01 to 5 mass%, and may be 0.1 to 5 mass% or 1 to 3 mass%. When an ethylene-vinyl acetate copolymer is used as the low-temperature fluidity improving agent, the content can be 0.01 to 5 mass%, and may be 0.03 to 3 mass%, 0.05 to 1 mass% or 0.05 to 0.5 mass%.

[0049] The content of the low-temperature fluidity improving agent contained in the wax can be measured by Fourier transform infrared spectroscopy (FT-IR) or a double shot method in which thermal desorption (TD)-GC/MS in the first stage and instantaneous thermal decomposition (Py)-GC/MS in the second stage are combined.

[0050] [Method for producing lubricant base oil]

A method for producing a lubricant base oil of the present

embodiment includes a base oil producing process in which a lubricant base oil is obtained from the wax produced by the above method for producing a wax.

[0051] <Base oil producing process>

5 In the base oil producing process, for example, a lubricant base oil can be produced from the wax by the same method as the method for producing a lubricant base oil using a slack wax as the raw material oil.

[0052] The base oil producing process may include, for example, a process of performing isomerization dewaxing in which normal paraffin
10 is isomerized using a hydrogenation isomerization catalyst (isomerization dewaxing process).

[0053] Regarding the hydrogenation isomerization catalyst, known hydrogenation isomerization catalysts used for isomerization dewaxing can be used without particular limitation. In addition, isomerization
15 dewaxing conditions may be, for example, the same conditions as known isomerization dewaxing conditions.

[0054] The isomerization dewaxing process may be a process of isomerizing and dewaxing the raw material oil containing a permeate component or a process of isomerizing and dewaxing a processed
20 material obtained by subjecting a raw material oil to the hydrogenation treatment process described below.

[0055] One preferable aspect of the isomerization dewaxing process is shown below, but the isomerization dewaxing process is not limited to the following aspect.

25 [0056] In this aspect, the hydrogenation isomerization catalyst may contain either a crystalline or amorphous material. Examples of

crystalline materials include a molecular sieve containing aluminosilicate (zeolite) or silicoaluminophosphate (SAPO) as a main component and having a 10 or 12-membered ring passage. Specific examples of zeolite include ZSM-22, ZSM-23, ZSM-35, ZSM-48, ZSM-57, ferrierite, ITQ-13, MCM-68, and MCM-71. In addition, examples of aluminophosphate include ECR-42. Examples of molecular sieves include zeolite beta and MCM-68. Among these, one or two or more selected from among ZSM-48, ZSM-22 and ZSM-23 are preferably used, and ZSM-48 is particularly preferable. The molecular sieve preferably has a hydrogen form. The reduction of the hydrogenation isomerization catalyst may occur in situ during isomerization dewaxing, or a hydrogenation isomerization catalyst that has been subjected to a reduction treatment in advance may be subjected to the isomerization dewaxing process.

[0057] In addition, examples of the amorphous material for the hydrogenation isomerization catalyst include alumina, fluorided alumina, silica-alumina, fluorided silica-alumina, silica-alumina and the like doped with Group 3 metals.

[0058] Examples of preferable forms of the hydrogenation isomerization catalyst include those having bifunctionality, that is, to which a metallic hydrogenation component of at least one of Group 6 metals, at least one of Group 8 to 10 metals, or a mixture thereof is attached. Preferable metals are Group 9 to 10 noble metals such as Pt, Pd or mixtures thereof. The amount of these metals attached is preferably 0.1 to 30 mass% based on the total amount of the catalyst. Examples of catalyst preparation and metal attaching method include an

ion exchange method and an impregnation method, using degradable metal salts.

[0059] Here, when the molecular sieve is used, it may be composited with a binder material having heat resistance under isomerization dewaxing conditions or may be provided without a binder (self-bonding). Examples of binder materials include inorganic oxides such as silica, alumina, silica-alumina, combinations of two components including silica and other metal oxides such as titania, magnesia, tria, and zirconia, and combinations of three components including oxides such as silica-alumina-tria and silica-alumina-magnesia. The amount of the molecular sieve in the hydrogenation isomerization catalyst is preferably 10 to 100 mass%, and more preferably 35 to 100 mass% based on the total amount of the catalyst. The hydrogenation isomerization catalyst is formed by a method such as spray drying or extrusion. The hydrogenation isomerization catalyst can be used in a sulfided or non-sulfided form, and a sulfide form is preferable.

[0060] Regarding isomerization dewaxing conditions, the temperature is preferably 250 to 400°C, and more preferably 275 to 350°C, the hydrogen partial pressure is preferably 791 to 20,786 kPa (100 to 3,000 psig), and more preferably 1,480 to 17,339 kPa (200 to 2,500 psig), the liquid hourly space velocity is preferably 0.1 to 10 hr⁻¹, and more preferably 0.1 to 5 hr⁻¹, and the hydrogen/oil ratio is preferably 45 to 1,780 m³/m³ (250 to 10,000 scf/B), and more preferably 89 to 890 m³/m³ (500 to 5,000 scf/B). Here, the above conditions are an example, and the isomerization dewaxing conditions are preferably appropriately selected according to the difference in raw material oils,

catalysts, devices, and the like.

5 [0061] In the isomerization dewaxing process, a dewaxing oil in which normal paraffin is isomerized is obtained. In the present embodiment, the dewaxing oil is subjected to distillation or the like to separate a predetermined component, and thus a lubricant base oil can be obtained. In addition, the dewaxing oil is subjected to a hydrogenation refining process to be described below, and a lubricant base oil can be obtained from the refined oil that has undergone the hydrogenation refining process.

10 [0062] That is, the base oil producing process may further include a process (hydrogenation refining process) in which the processed material (dewaxing oil) obtained in the isomerization dewaxing process is subjected to hydrogenation refining using a hydrogenation refining catalyst.

15 [0063] Hydrogenation refining performed in the hydrogenation refining process can be a form of a mild hydrogenation treatment for saturating olefins and aromatic components by hydrogenation in addition to removal of residual heteroatoms and hue components. Regarding the hydrogenation refining catalyst, known hydrogenation refining catalysts
20 used for hydrogenation refining can be used without particular limitation. In addition, hydrogenation refining conditions may be, for example, the same conditions as known hydrogenation refining conditions. The hydrogenation refining process may be performed, for example, in a cascade manner with the isomerization dewaxing process.

25 [0064] One preferable aspect of the hydrogenation refining process is shown below, but the hydrogenation refining process is not limited to

the following aspect.

[0065] In this aspect, the hydrogenation refining catalyst is preferably a catalyst in which Group 6 metals, Group 8 to 10 metals or mixtures thereof are supported on metal oxide carriers. Examples of preferable metals include noble metals, and particularly, platinum, palladium and mixtures thereof. When a mixture of metals is used, it may be present as a bulk metal catalyst in which the amount of the metal is 30 mass% or more based on the amount of the catalyst. The metal content of the catalyst is preferably 20 mass% or less for non-noble metals and 1 mass% or less for noble metals. In addition, metal oxide carriers may be either amorphous or crystalline oxides. Specific examples thereof include low acidic oxides such as silica, alumina, silica-alumina and titania, and alumina is preferable. In consideration of saturation of aromatic compounds, it is preferable to use a hydrogenation refining catalyst in which a metal having a relatively strong hydrogenation function is supported on a porous carrier.

[0066] Examples of preferable hydrogenation refining catalysts include mesoporous materials belonging to M41S class or system catalysts. M41S system catalysts are mesoporous materials having a high silica content, and specific examples thereof include MCM-41, MCM-48 and MCM-50. Such a hydrogenation refining catalyst has a pore size of 15 to 100Å and MCM-41 is particularly preferable. MCM-41 is an inorganic porous non-layered phase having a hexagonal arrangement of pores with a uniform size. The physical structure of MCM-41 is a bundle of straws with a straw opening (cell diameter of pores) in a range of 15 to 100Å. MCM-48 has a cubic symmetry structure, and

MCM-50 has a layered structure. MCM-41 can be produced with pore openings of different sizes in the mesoporous range. The mesoporous material may have a metallic hydrogenation component which is at least one of Group 8, 9, and 10 metals, and regarding the metallic hydrogenation component, noble metals, and particularly, Group 10 noble metals are preferable, and Pt, Pd or mixtures thereof are most preferable.

[0067] Regarding hydrogenation refining conditions, the temperature is preferably 150 to 350°C, and more preferably 180 to 250°C, the total pressure is preferably 2,859 to 20,786 kPa (about 400 to 3,000 psig), the liquid hourly space velocity is preferably 0.1 to 5 hr⁻¹, and more preferably 0.5 to 3 hr⁻¹, and the hydrogen/oil ratio is preferably 44.5 to 1,780 m³/m³ (250 to 10,000 scf/B). Here, the above conditions are an example, and hydrogenation refining conditions in the hydrogenation refining process are preferably appropriately selected depending on the difference in raw materials, processing devices, and the like.

[0068] In the processed material (refined oil) obtained in the hydrogenation refining process, as necessary, a predetermined component is separated by distillation or the like, and thus a lubricant base oil can be obtained.

[0069] In the present embodiment, the base oil producing process may further include a process (hydrogenation treatment process) in which a raw material oil is subjected to a hydrogenation treatment before the isomerization dewaxing process. The hydrogenation treatment is performed using a hydrogenation treating catalyst, and the processed material obtained by the hydrogenation treatment is subjected to the

isomerization dewaxing process.

5 [0070] The hydrogenation treatment process may be a process of removing a sulfur component and a nitrogen component from the raw material oil in order to avoid deterioration of performance of the hydrogenation isomerization catalyst used in the isomerization dewaxing process. In addition, the hydrogenation treatment process may be provided to decompose a part (for example, about 10 mass%, preferably 1 to 10 mass%) of normal paraffin in the raw material oil.

10 [0071] Regarding the hydrogenation treating catalyst, known hydrogenation treating catalysts used for hydrogenation treatment can be used without particular limitation. In addition, hydrogenation treatment conditions may be, for example, the same conditions as known hydrogenation treatment conditions.

15 [0072] One preferable aspect of the hydrogenation treatment process is shown below, and the hydrogenation treatment process is not limited to the following aspect.

20 [0073] Examples of hydrogenation treating catalysts used in the hydrogenation treatment process include catalysts containing Group 6 metals, Group 8 to 10 metals, and mixtures thereof. Examples of preferable metals include nickel, tungsten, molybdenum, cobalt and mixtures thereof. The hydrogenation treating catalyst can be used in a form in which these metals are supported on heat-resistant metal oxide carriers, and generally, metals are present as an oxide or a sulfide on the carrier. In addition, when a mixture of metals is used, it may be present as a bulk metal catalyst in which the amount of the metal is 30 mass% or more based on the total amount of the catalyst. Examples of

metal oxide carriers include oxides such as silica, alumina, silica-alumina and titania, and among these, alumina is preferable. A preferable alumina is an γ -type or β -type porous alumina. The amount of the metal supported is preferably in a range of 0.5 to 35 mass% based on the total amount of the catalyst. In addition, when a mixture of Group 9 to 10 metals and Group 6 metals is used, it is preferable that the amount of either Group 9 or Group 10 metals be 0.1 to 5 mass% and the amount of Group 6 metals be 5 to 30 mass% based on the total amount of the catalyst. The amount of the metal supported may be measured by atomic absorption spectroscopy, inductively coupled plasma atomic emission spectroscopy or other methods specified in ASTM for individual metals.

[0074] The acidity of the metal oxide carrier can be controlled by addition of additives, control of properties of metal oxide carriers (for example, control of the amount of silica incorporated into silica-alumina carriers), and the like. Examples of additives include halogens, and particularly, fluorine, phosphorous, boron, yttria, alkaline metals, alkaline earth metals, rare earth oxides, and magnesia. Cocatalysts such as halogens generally increase the acidity of metal oxide carriers, but weakly basic additives such as yttria and magnesia tend to weaken the acidity of such carriers.

[0075] Regarding hydrogenation treatment conditions, the treatment temperature is preferably 150 to 450°C, and more preferably 200 to 400°C, the hydrogen partial pressure is preferably 1,400 to 20,000 kPa, and more preferably 2,800 to 14,000 kPa, the liquid hourly space velocity (LHSV) is preferably 0.1 to 10 hr⁻¹, and more preferably 0.1 to

5 5 hr^{-1} , and the hydrogen/oil ratio is preferably 50 to $1,780 \text{ m}^3/\text{m}^3$, and more preferably 89 to $890 \text{ m}^3/\text{m}^3$. Here, the above conditions are an example, and the hydrogenation treatment conditions are preferably appropriately selected according to the difference in raw material oils, catalysts, devices, and the like.

10 [0076] The processed material subjected to the hydrogenation treatment in the hydrogenation treatment process may be directly subjected to the isomerization dewaxing process, but a process in which the processed material is subjected to stripping or distillation, and a gas product is separated and removed from the processed material (liquid product) is preferably provided between the hydrogenation treatment process and the isomerization dewaxing process. Thereby, the nitrogen component and the sulfur component contained in the processed material can be easily reduced to a level that does not affect the long-term use of the hydrogenation isomerization catalyst in the isomerization dewaxing process. Components to be separated and removed by stripping or the like are mainly gas foreign substances such as hydrogen sulfide and ammonia, and stripping can be performed by a general device such as a flash drum or a fractionating device.

20 [0077] In addition, when conditions for hydrogenation treatment in the hydrogenation treatment process are mild, the remaining polycyclic aromatic components may pass through depending on raw materials used, but these foreign substances may be removed by hydrogenation refining in the hydrogenation refining process.

25 [0078] According to the production method of the present embodiment, a light and low-viscosity lubricant base oil can be easily obtained. One

preferable aspect of the lubricant base oil obtained by the production method of the present embodiment will be described below.

5 [0079] For the lubricant base oil, an excellent low temperature viscosity characteristic is required, and this characteristic can be evaluated using a viscosity index. It can be said that a higher viscosity index indicates a better low temperature viscosity characteristic. The viscosity index of the lubricant base oil obtained by the production method of the present embodiment is preferably 110 or more, and more preferably 115 or more. The upper limit of the viscosity index is not particularly limited,
10 and may be, for example 140 or less and is preferably 135 or less.

[0080] The kinematic viscosity of the lubricant base oil at 40°C may be, for example, 15 mm²/s or less, and is preferably 13 mm²/s or less, and more preferably 10 mm²/s or less. If the kinematic viscosity at 40°C is low, the fuel efficiency tends to be improved. In addition, the
15 kinematic viscosity of the lubricant base oil at 40°C may be, for example, 3 mm²/s or more, and is preferably 4 mm²/s or more, and more preferably 5 mm²/s or more. If the kinematic viscosity at 40°C is high, the evaporation resistance tends to be excellent.

[0081] The kinematic viscosity of the lubricant base oil at 100°C may be, for example, 3.5 mm²/s or less, and is preferably 3.0 mm²/s or less, and more preferably 2.8 mm²/s or less. If the kinematic viscosity at
20 100°C is low, the fuel efficiency tends to be improved. In addition, the kinematic viscosity of the lubricant base oil at 100°C may be, for example, 1.5 mm²/s or more, and is preferably 1.8 mm²/s or more, and more preferably 2.0 mm²/s or more. If the kinematic viscosity at
25 100°C is high, the flash point tends to increase.

[0082] The pour point of the lubricant base oil may be, for example, -20°C or lower, and is preferably -25°C or lower, and more preferably -30°C or lower. If the pour point is low, startability at low temperatures tends to be excellent. In addition, the lower limit of the pour point of the lubricant base oil is not particularly limited, and may be, for example, -50°C or higher, and is preferably -45°C or higher.

[0083] The 10 volume% distillation temperature of the lubricant base oil is preferably 300°C or higher, and more preferably 320°C or higher. In addition, the 90 volume% distillation temperature of the lubricant base oil is preferably 420°C or lower, and more preferably 400°C or lower. In the production method of the present embodiment, for example, fractions that satisfy the above distillation properties are collected from the dewaxing oil obtained in the above isomerization dewaxing process or the refined oil obtained in the hydrogenation refining process by vacuum distillation, and thus a lubricant base oil can be obtained.

[0084] The lubricant base oil preferably has a sufficiently low content of normal paraffin. The content of normal paraffin in the lubricant base oil may be, for example, 2.0% or less, and is preferably 1.5% or less, and more preferably 1.0% or less.

[0085] The lubricant base oil may be mainly composed of isoparaffin. The content of isoparaffin in the lubricant base oil may be, for example, 90 mass% or more, and is preferably 93 mass% or more, and more preferably 95 mass% or more.

[0086] The urea adduct value in the lubricant base oil is preferably 4 mass% or less, more preferably 3 mass% or less, and still more

preferably 2.5 mass% or less. The lubricant base oil having such a urea adduct value tends to have a particularly excellent low temperature viscosity characteristic.

5 [0087] Here, in this specification, “urea adduct value” indicates a value measured by the following method. 100 g of the weighed sample oil (lubricant base oil) is put into a round bottom flask, 200 g of urea, 360 ml of toluene and 40 ml of methanol are added, and the mixture is stirred at room temperature for 6 hours. Thereby, white granular crystals are produced in the reaction solution. The reaction solution is
10 filtered through a 1-micron filter to collect the produced white granular crystals, and the obtained crystals are washed 6 times with 50 ml of toluene. The collected white crystals are put into a flask, 300 ml of pure water and 300 ml of toluene are added, and the mixture is stirred at 80°C for 1 hour. An aqueous phase is separated and removed in a
15 separatory funnel, and a toluene phase is washed 3 times with 300 ml of pure water. A drying agent (sodium sulfate) is added to the toluene phase and the dehydration treatment is performed, and toluene is then distilled off. The ratio (mass percentage) of the hydrocarbon component (urea adduct product) obtained in this manner to the sample
20 oil is defined as a urea adduct value.

[0088] In the measurement of the urea adduct value, as a urea adduct product, it is possible to collect accurately and reliably components that adversely affect the low temperature viscosity characteristic among isoparaffin, and also normal paraffin when the normal paraffin remains
25 in the lubricant base oil, and thus the urea adduct value is an excellent evaluation index of the low temperature viscosity characteristic of the

lubricant base oil. Here, according to analysis using GC and NMR, the inventors have confirmed that the main component of the urea adduct product is a urea adduct product of normal paraffin, and isoparaffin having 6 or more carbon atoms from the end of the main chain to the branch position.

[0089] While preferable embodiments of the present invention will be described below, the present invention is not limited to the embodiments.

[Examples]

[0090] While the present invention will be described below in more detail with reference to examples, the present invention is not limited to the examples.

[0091] (Example 1)

300 g of a hydrocarbon oil having a 10 volume% distillation temperature of 324.9°C, a 90 volume% distillation temperature of 432.0°C, and a pour point of 22.5°C was transferred to a 500 mL boron silicate glass beaker (commercially available from Corning Inc.). On the other hand, 0.09 g of an ethylene-vinyl acetate copolymer-based low-temperature fluidity improving agent for a gas oil MD336K (commercially available from Sanyo Chemical Industries, Ltd.: Mn 4,000, VA 38 mass%) was put into a 200 mL screw tube (commercially available from Maruemu Corporation), and this was heated in a water bath (commercially available from As One Corporation) at 60°C for 1 hour. The low-temperature fluidity improving agent for a gas oil prepared in this manner was added to the hydrocarbon oil, and stirred and mixed with a glass rod to obtain a mixed oil. The pour point of the

mixed oil was 4°C.

[0092] Next, 15 g of the mixed oil was put into a 50 mL screw tube (commercially available from Maruemu Corporation), and this was left for 10 minutes in a low temperature constant temperature water tank (commercially available from As One Corporation) set at 15°C. Vacuum filtration was performed on the mixed oil after being left using a suction bottle VT-500 and a vacuum filter KGS-47 (all are commercially available from ADVANTEC) to which a glass filter grade GF/D paraffin (commercially available from Whatman, holding particle size: 2.7 μ m) was attached. In filtration conditions, the vacuum-side pressure was -0.95 MPa, the filtration temperature was 15°C, and the filtration time was 20 minutes. A filtrate (hydrocarbon oil) having a pour point of 5°C was obtained by vacuum filtration.

[0093] 20 mL of 2-propanol (commercially available from FUJIFILM Wako Pure Chemical Corporation, special grade reagent) was added to the wax on the glass filter obtained by vacuum filtration, and vacuum filtration was additionally performed under the same conditions as above. Thereby, 0.5 g of the wax W_1 (solid component) on the glass filter was obtained. Table 1 shows the concentration of normal paraffin with each carbon number in the obtained wax W_1 .

[0094] [Table 1]

Carbon number	Concentration of normal paraffin, vol%
12	0.01
13	0.01
14	0.04
15	0.10
16	0.21
17	0.37
18	0.73

19	1.46
20	3.02
21	5.61
22	8.82
23	11.94
24	14.49
25	12.99
26	11.40
27	7.53
28	4.69
29	3.00
Sum	86.42

[0095] The content of the ethylene-vinyl acetate copolymer contained in the wax W_1 was measured. Specifically, a high performance gas chromatograph–time-of-flight mass spectrometer JMS-T200GC AccuTOFTMGCx (commercially available from JEOL Ltd.) with a multi-shot pyrolyzer EGA/PY-3030D (commercially available from Frontier Laboratories Ltd.) was used as a measurement device, and the content was measured by a double shot method in which thermal desorption TD-GC/MS in the first stage and instantaneous thermal decomposition Py-GC/MS in the second stage were combined. According to a calibration curve separately prepared using the area value of the chromatogram having a mass range of m/z 60, the result in which the content of the ethylene-vinyl acetate copolymer contained in the wax W_1 was 0.08 mass% was obtained. Device analysis conditions are as follows.

[TD-GC/MS] (Double shot first stage analysis conditions)

Sample amount: wax W_1 7 mg

Thermal decomposition furnace temperature: 40-350°C (20°C/min, 1 min hold)

Thermal decomposition furnace-ITF temperature: 350°C

GC inlet temperature: 300°C

GC oven temperature: 40-300°C (20°C/min, 14 min hold)

5 Separation column: Zebulon ZB-5-HT (5% phenyl 95% dimethylpolysiloxane, a length of 30 m, an inner diameter of 0.25 mm, and a film thickness of 0.25 µm)

Column flow rate: 1.0 mL/min

Split ratio: 1/200

GC/MS ITF temperature: 330°C

Scan range: m/z 16-800

10 [Py-GC/MS] (double shot second stage analysis conditions)

Thermal decomposition furnace temperature: 600°C

Split ratio: 1/10

The other conditions were the same as in TD-GC/MS.

[0096] (Example 2)

15 300 g of a hydrocarbon oil having a 10 volume% distillation temperature of 338.1°C, a 90 volume% distillation temperature of 465.5°C, and a pour point of 27.5°C was transferred to a 500 mL boron silicate glass beaker (commercially available from Corning Inc.). On the other hand, 0.09 g of an ethylene-vinyl acetate copolymer-based

20 low-temperature fluidity improving agent for a gas oil MD336K (commercially available from Sanyo Chemical Industries, Ltd.: Mn 4,000, VA 38 mass%) was put into a 200 mL screw tube (commercially available from Maruemu Corporation), and this was heated in a water bath (commercially available from As One Corporation) at 60°C for 1

25 hour. The low-temperature fluidity improving agent for a gas oil prepared in this manner was added to the hydrocarbon oil, and stirred

and mixed with a glass rod to obtain a mixed oil. The pour point of the mixed oil was 20°C.

[0097] Then, 150 g of the mixed oil was put into a 200 mL screw tube (commercially available from Maruemu Corporation), and this was left for 10 minutes in a low temperature constant temperature water tank (commercially available from As One Corporation) set at 15°C. Vacuum filtration was performed on the mixed oil after being left using a suction bottle VT-500 and a vacuum filter KGS-47 (all are commercially available from ADVANTEC) to which a glass filter grade GF/D (commercially available from Whatman, holding particle size: 2.7 μm) was attached. In filtration conditions, the vacuum-side pressure was -0.95 MPa, the filtration temperature was 15°C, and the filtration time was 20 minutes. Thereby, 5 g of the wax W₂ (solid component) on the glass filter and a filtrate (hydrocarbon oil) having a pour point of 15°C were obtained. Table 2 shows the concentration of normal paraffin with each carbon number in the obtained wax W₂.

[0098] [Table 2]

Carbon number	Concentration of normal paraffin, vol%
10	0.00
11	0.00
12	0.01
13	0.02
14	0.03
15	0.06
16	0.10
17	0.13
18	0.17
19	0.24
20	0.29
21	0.39
22	0.61
23	1.16

24	2.46
25	4.10
26	6.48
27	7.46
28	7.95
29	6.93
30	6.01
31	4.54
32	3.41
33	2.23
34	1.52
Sum	56.32

5 [0099] 5 g of normal hexane (commercially available from FUJIFILM Wako Pure Chemical Corporation, special grade reagent) was put into a 200 mL screw tube (commercially available from Maruemu Corporation), and heated and kept at 40°C in a water bath (commercially available from As One Corporation), and 5 g of the wax W₂ obtained above was added and dissolved.

10 [0100] 5 g of 2-propanol (commercially available from FUJIFILM Wako Pure Chemical Corporation, special grade reagent) was added to the obtained permeated solution, and after cooling to 15°C, vacuum filtration was performed using a suction bottle VT-500 and a vacuum filter KGS-47 (all are commercially available from ADVANTEC) to which a glass filter grade GF/D (commercially available from Whatman, holding particle size: 2.7 µm) was attached. In filtration conditions, the vacuum-side pressure was -0.95 MPa, the filtration temperature was 15°C, and the filtration time was 20 minutes.

15 [0101] 2 g of 2-propanol (commercially available from FUJIFILM Wako Pure Chemical Corporation, special grade reagent) was added to the wax on the glass filter obtained by vacuum filtration, and vacuum filtration was additionally performed under the same conditions as

above. Thereby, 2 g of the wax W_2 (solid component) was obtained on the glass filter. Table 3 shows the concentration of normal paraffin with each carbon number in the obtained wax W_2 .

[0102] [Table 3]

Carbon number	Concentration of normal paraffin, vol%
10	0.00
11	0.00
12	0.00
13	0.02
14	0.07
15	0.14
16	0.22
17	0.31
18	0.38
19	0.53
20	0.58
21	0.77
22	0.85
23	1.14
24	1.72
25	2.77
26	5.54
27	8.61
28	12.08
29	13.32
30	13.53
31	11.35
32	8.28
33	5.69
34	4.08
Sum	92.00

5 [0103] (Example 3)

A mixed oil was prepared in the same manner as in Example 2 except that 0.09 g of an ethylene-vinyl acetate copolymer having an Mn of 5,300 and a VA of 36 mass% was used and the filtration temperature was 10°C, and a wax W_3 was obtained from the mixed oil. The pour point of the mixed oil was 10°C. In this example, 16 g of the wax W_3

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(solid component) on the glass filter and a filtrate (hydrocarbon oil) having a pour point of 5°C were obtained. Table 4 shows the concentration of normal paraffin with each carbon number in the obtained wax W₃.

5 [0104] [Table 4]

Carbon number	Concentration of normal paraffin, vol%
13	0.01
14	0.01
15	0.02
16	0.09
17	0.16
18	0.15
19	0.2
20	0.36
21	0.73
22	1.61
23	3.34
24	6.21
25	7.99
26	9.3
27	7.84
28	6.43
29	4.72
30	3.53
31	2.3
32	1.65
33	0.98
34	0.61
Sum	58.16

[0105] (Example 4)

A mixed oil was prepared in the same manner as in Example 3 except that 0.09 g of an ethylene-vinyl acetate copolymer having an Mn of 2,000 and a VA of 29 mass% was used, and a wax W₄ was obtained from the mixed oil. The pour point of the mixed oil was 12°C. In this example, 18 g of the wax W₄ (solid component) on the glass filter and a filtrate (hydrocarbon oil) having a pour point of 7°C were

10

obtained. Table 5 shows the concentration of normal paraffin with each carbon number in the obtained wax W₄.

[0106] [Table 5]

Carbon number	Concentration of normal paraffin, vol%
13	0.01
14	0.01
15	0.05
16	0.1
17	0.18
18	0.2
19	0.24
20	0.39
21	0.73
22	1.52
23	3.03
24	5.41
25	6.81
26	7.87
27	6.62
28	5.41
29	3.93
30	2.87
31	1.96
32	1.33
33	0.92
34	0.63
Sum	50.2

[0107] (Example 5)

- 5 A mixed oil was prepared in the same manner as in Example 3 except that 0.09 g of an ethylene-vinyl acetate copolymer having an Mn of 3,200 and a VA of 42 mass% was used, and a wax W₅ was obtained from the mixed oil. The pour point of the mixed oil was 5°C. In this
- 10 example, 15 g of the wax W₅ (solid component) on the glass filter and a filtrate (hydrocarbon oil) having a pour point of 0°C were obtained. Table 6 shows the concentration of normal paraffin with each carbon number in the obtained wax W₅.

[0108] [Table 6]

Carbon number	Concentration of normal paraffin, vol%
13	0.01
14	0.01
15	0.04
16	0.08
17	0.14
18	0.17
19	0.21
20	0.36
21	0.74
22	1.65
23	3.49
24	6.37
25	8.13
26	9.4
27	7.91
28	6.54
29	4.78
30	3.53
31	2.4
32	1.71
33	1.04
34	0.64
Sum	59.25

[0109] (Example 6)

A mixed oil was prepared in the same manner as in Example 3 except that 0.09 g of an ethylene-vinyl acetate copolymer having an Mn of 3,600 and a VA of 40 mass%, and a wax W₆ was obtained from the mixed oil. The pour point of the mixed oil was -4°C. In this example, 15 g of the wax W₆ (solid component) on the glass filter and a filtrate (hydrocarbon oil) having a pour point of -5°C were obtained. Table 7 shows the concentration of normal paraffin with each carbon number in the obtained wax W₆.

[0110] [Table 7]

Carbon number	Concentration of normal paraffin, vol%
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13	0
14	0.02
15	0.05
16	0.11
17	0.15
18	0.25
19	0.41
20	0.6
21	1.05
22	2.06
23	3.67
24	5.89
25	6.43
26	6.61
27	5.01
28	3.92
29	2.66
30	1.82
31	1.12
32	0.69
33	0.37
34	0.21
35	0.11
36	0.07
37	0.04
38	0.02
39	0.01
40	0
Sum	43.35

Reference Signs List

[0111] 10 Mixer

11 Solid-liquid separator

L0, L10, L11 Flow path

CLAIMS

[Claim 1]

A method for producing a wax, comprising:

5 a first precipitation process in which a first solid component is precipitated from a mixed oil obtained by adding a low-temperature fluidity improving agent to a hydrocarbon oil having a 10% volume distillation temperature of 300°C or higher under a temperature condition of 5 to 40°C; and

10 a first separation process in which the first solid component is collected as a first non-permeate component by a solid-liquid separation method.

[Claim 2]

The production method according to claim 1,

wherein the pour point of the mixed oil is 20°C or lower.

15 [Claim 3]

The production method according to claim 1 or 2,

wherein a pour point of a first permeate component separated in the first separation process is lower than the pour point of the hydrocarbon oil by 5°C or more.

20 [Claim 4]

The production method according to any one of claims 1 to 3,

wherein the first solid component contains 40 volume% or more of normal paraffin having 18 or more carbon atoms.

[Claim 5]

25 The production method according to any one of claims 1 to 4, further comprising

a first washing process in which the first solid component is washed with at least one solvent selected from the group consisting of normal pentane, normal hexane, 2-propanol, 2-butanone, acetone and toluene.

5 [Claim 6]

The production method according to claim 5,

wherein the first solid component after the first washing process contains 80 volume% or more of normal paraffin having 20 or more carbon atoms.

10 [Claim 7]

The production method according to any one of claims 1 to 4, further comprising:

a second precipitation process in which a mixture containing 80 volume% or more of at least one selected from the group consisting of 2-propanol, 2-butanone and acetone is added to a solution prepared by dissolving the first solid component in a mixture of 40°C or higher containing 80 volume% or more of at least one selected from the group consisting of normal pentane and normal hexane, and a second solid component is precipitated; and

15

a second separation process in which the second solid component is collected as a second non-permeate component by a solid-liquid separation method.

20

[Claim 8]

The production method according to claim 7, further comprising

a second washing process in which the second solid component is washed with at least one solvent selected from the group consisting of

25

normal pentane, normal hexane, 2-propanol, 2-butanone, acetone and toluene.

[Claim 9]

5 The production method according to claim 8,
 wherein the second solid component after the second washing process contains 90 volume% or more of normal paraffin having 20 or more carbon atoms.

[Claim 10]

10 The production method according to any one of claims 1 to 9,
 wherein the low-temperature fluidity improving agent includes at least one selected from the group consisting of ethylene-vinyl acetate copolymers, polyalkyl methacrylate, imide alkenyl succinate, polyalkylene oxide fatty acid ester, polyalkyl acrylate, alkyl naphthalene and dendrimers.

15 [Claim 11]

 The production method according to any one of claims 1 to 10,
 wherein the solid-liquid separation method is performed by filtration using a filter having a pore size of 2 μm or more or centrifugation, under a temperature condition of higher than 0°C.

20 [Claim 12]

 A wax containing a low-temperature fluidity improving agent for a gas oil.

[Claim 13]

25 The wax according to claim 12,
 wherein a content of the low-temperature fluidity improving agent is 0.01 to 5 mass%.

[Claim 14]

The wax according to claim 12 or 13,
wherein the low-temperature fluidity improving agent includes
ethylene-vinyl acetate copolymer.

5

[Claim 15]

A method for producing a lubricant base oil, comprising
a base oil producing process in which a lubricant base oil is obtained
from the wax produced by the production method according to any one
of claims 1 to 11.

10