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(54) Process for preparing naphtha and middle distillate fractions

(57) The invention provides a process for preparing one or more naphtha fractions and one or more middle distillate fractions, the process comprising the steps of:
(a) providing a Fischer-Tropsch hydrocarbons stream;
(b) subjecting the Fischer-Tropsch hydrocarbons stream as provided in step (a) to a thermal conversion step to obtain a converted hydrocarbon stream comprising paraffins and olefins;
(c) separating at least part of the converted hydrocarbon stream as obtained in step (b) into a first fraction having a boiling point below 380°C and a second fraction having a boiling point which is higher than 300°C;
(d) hydrogenating at least part of the first fraction having a boiling point below 380 °C as obtained in step (c) to obtain a hydrogenated fraction having a boiling point below 380°C;
(e) catalytic dewaxing at least part of the hydrogenated fraction having a boiling point below 380 °C as obtained in step (d) to obtain an at least partially isomerised product; and
(f) separating at least part of the at least partially isomerised product as obtained in step (e) into one or more naphtha fractions and one or more middle distillate fractions.

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Description

Field of the Invention

[0001] The present invention relates to a process for preparing one or more naphtha fractions and one or more middle distillates.

Background of the Invention

[0002] The preparation of hydrocarbons from a gaseous mixture comprising carbon monoxide and hydrogen by contacting the mixture with a suitable catalyst at elevated temperatures and pressures is a well known process, referred to in the art as the Fischer-Tropsch process.

[0003] Much attention has been paid to processes for the preparation of middle distillate fuels and naphtha from Fischer-Tropsch hydrocarbon streams. Such processes comprise two stages: a first stage in which high boiling range hydrocarbons are prepared from a mixture of carbon monoxide and hydrogen by means of the Fischer-Tropsch process, and a second stage in which the hydrocarbons so-produced are subjected to a hydroprocessing treatment yielding the desired middle distillate fuels and naphtha.

[0004] Such a hydroprocessing treatment usually consists of a number of process steps.

[0005] It is for instance known that a Fischer-Tropsch derived product can be subjected to a hydroprocessing treatment which includes a hydrocracking step, a hydrogenation step and/or a catalytic dewaxing step, and various separation steps. In such a hydroprocessing treatment the Fischer-Tropsch derived product is first hydrocracked and the product so obtained is separated into a light fraction and a heavy fraction. The lighter fraction can then by hydrogenated and the hydrogenated product so obtained is subsequently subjected to a catalytic dewaxing step from which by way of separation naphtha and middle distillate fuels can be recovered. Such a known process has however a number of disadvantages. Hydrocracking is carried out at a high temperature and at a high pressure, and in the presence of hydrogen and a hydrocracking catalyst. The reaction conditions and the use of hydrogen and a hydrocracking catalyst make hydrocracking processes expensive processes, especially since the hydrocracking catalyst will deactivate/lose its catalytic activity in the course of time and therefore needs to be regenerated or to be replaced. Hence, it would be highly advantageous to develop a process in which Fischer-Tropsch derived products are converted into naphtha and middle distillate fuels in corresponding yield, but at much lower cost.

[0006] Object of the present invention is to provide a process in which Fischer-Tropsch derived products are converted into products such as naphtha and middle distillates, whilst requiring less catalyst and less severe reaction conditions.

Summary of the invention

[0007] This object is achieved when the hydroprocessing treatment is combined with a thermal conversion step.

[0008] Accordingly, the present invention relates to a process for preparing one or more naphtha fractions and one or more middle distillate fractions, the process comprising the steps of:

(a) providing a Fischer-Tropsch hydrocarbons stream;
(b) subjecting the Fischer-Tropsch hydrocarbons stream as provided in step (a) to a thermal conversion step to obtain a converted hydrocarbon stream comprising paraffins and olefins;
(c) separating at least part of the converted hydrocarbon stream as obtained in step (b) into a first fraction having a boiling point below 380°C and a second fraction having a boiling point which is higher than 300°C ;
(d) hydrogenating at least part of the first fraction having a boiling point below 380 °C as obtained in step (c) to obtain a hydrogenated fraction having a boiling point below 380°C;
(e) catalytic dewaxing at least part of the hydrogenated fraction having a boiling point below 380 °C as obtained in step (d) to obtain an at least partially isomerised product; and
(f) separating at least part of the at least partially isomerised product as obtained in step (e) into one or more naphtha fractions and one or more middle distillate fractions.

[0009] In accordance with the present invention a process is provided with which high yields of naphtha, middle distillates and base oils can be prepared, which process requires less catalyst and less severe reaction conditions.

Detailed description of the invention

[0010] In accordance with the present invention one or more naphtha fractions and one or more middle distillate fractions are prepared. The naphtha fractions in accordance with the present invention include hydrocarbons or hydrocarbon mixtures that have a boiling point in the range of from 30-220 °C, The middle distillate fractions typically include hydrocarbons or hydrocarbon mixtures that have a boiling point in the range of from 140-380 °C.

[0011] In step (a), a Fischer-Tropsch hydrocarbons stream is provided. The Fischer-Tropsch process derived hydrocarbons stream to be used in accordance with the present invention can be obtained by well-known processes, for example the so- called commercial Sasol process, the Shell Middle Distillate Synthesis Process or by the non-commercial Exxon process. These and other processes are for example described in more detail in EP-A-776959, EP-A-668342, US-A-4943672, US-A-5059299, WO-A-9934917 and WO-A-9920720. Typically these Fischer-Tropsch synthesis products will comprise hydrocarbons having 1 to 100 and even more than 100 carbon atoms. This hydrocarbon product will comprise normal paraffins, iso-paraffins, oxygenated products and unsaturated products. The Fischer-Tropsch hydrocarbons stream may be hydrogenated prior to step (a) in order to remove any oxygenates or unsaturated products.

[0012] Preferably, a relatively heavy Fischer-Tropsch hydrocarbons stream is provided in step (a) having at least 30 wt%, preferably at least 50 wt%, and more preferably at least 55 wt% of compounds having at least 30 carbon atoms. Furthermore the weight ratio of compounds having at least 60 or more carbon atoms and compounds having at least 30 carbon atoms of the Fischer-Tropsch product is at least 0.2, preferably at least 0.4 and more preferably at least 0.55. Preferably the Fischer-Tropsch product comprises a $C20^+$ fraction having an ASF-alpha value (Anderson-Schulz-Flory chain growth factor) of at least 0.925, preferably at least 0.935, more preferably at least 0.945, even more preferably at least 0.955. Such a Fischer-Tropsch product can be obtained by any process, which yields a relatively heavy Fischer-Tropsch product as described above. Not all Fischer-Tropsch processes yield such a heavy product. An example of a suitable Fischer-Tropsch process is described in WO-A-9934917 and in AU-A-698392. These processes may yield the relatively heavy Fischer-Tropsch hydrocarbons stream as described above. The Fischer-Tropsch process derived hydrocarbons stream will comprise a Fischer-Tropsch synthesis product. With a Fischer-Tropsch synthesis product is meant the product directly obtained from a Fischer-Tropsch synthesis reaction, which product may optionally have been subjected to a distillation and/or hydrogenation step only. The Fischer-Tropsch synthesis product can be obtained by well-known processes, for example the so- called commercial Sasol process, the Shell Middle Distillate Synthesis Process or by the non-commercial Exxon process. These and other processes are for example described in more detail in EP-A-776959, EP-A-668342, US-A-4943672, US-A-5059299, WO-A-9934917 and WO-A-9920720. Typically these Fischer-Tropsch synthesis products will comprise hydrocarbons having 1 to 100 and even more than 100 carbon atoms. This hydrocarbon product will comprise normal paraffins, iso-paraffins, oxygenated products and unsaturated products. The feed to step (a) may be hydrogenated in order to remove any oxygenates or unsaturated products.

[0013] In step (b), the Fischer-Tropsch hydrocarbons stream is subjected to a thermal conversion step to obtain a converted hydrocarbon stream comprising a mixture of paraffins and olefins. Suitably, the total amount of paraffins and olefins which are present in the converted hydrocarbon stream is more than 75 wt%, preferably more than 80 wt%, based on the total weight of the converted hydrocarbon stream. The thermal conversion step is suitably carried out at an elevated temperature and elevated pressure. Suitably, the thermal conversion step is carried out at a temperature in the range of from 400 - 600°C, preferably in the range of from 450-550 °C, more preferably in the range of from 475-500°C. The pressure in the thermal conversion step is suitably in the range of from 2-70 bara, preferably in the range of from 4-50 bara, and more preferably in the range of from 6-20 bara.

[0014] A major advantage of the present invention is that in the thermal conversion step no use is made of a catalyst and hydrogen, whilst surprisingly high yields of naphtha and middle distillates can be obtained.

[0015] The converted hydrocarbon stream as obtained in step (b) comprises paraffins and olefins. Suitably, the converted hydrocarbon stream comprises 40-60 wt% of paraffins, based on the total converted hydrocarbon stream. Suitably, the converted hydrocarbon stream comprises 30-35 wt% of olefins, based on the total converted hydrocarbon stream. The conversion in step (b) as defined as the weight percentage of the Fischer-Tropsch hydrocarbons stream boiling above 375 °C which reacts per pass to a fraction boiling below 375 °C is preferably at least 30 wt%, more preferably at least 45 wt%, preferably not more than 70 wt% and more preferably not more than 60 wt%.

[0016] In step (c), at least part of the converted hydrocarbon stream as obtained in step (b) is separated into a first fraction having a boiling point below 380 °C and a second fraction having a boiling point which is higher than 300°C. Suitably, the entire converted hydrocarbon stream as obtained in step (b) is separated in step (c) into a first fraction having a boiling point below 380 °C and a second fraction having a boiling point which is higher than 300°C. Suitably, the second fraction as obtained in step (b) has a boiling point above 340 °C, preferably above 360 °C, and more preferably above 375 °C. The separation in step (c) is suitably carried out by means of distillation. The separation in step (c) may be performed by performing a distillation at atmospheric or slightly elevated pressure or under vacuum conditions. The separation in step (c) may also include a first near atmospheric distillation or atmospheric distillation followed by a further distillation at vacuum distillation conditions. The final boiling point of the second fraction may be as high as 700 °C in some cases and in other cases even higher than 750 °C.

[0017] In step (d), at least part of the first fraction having a boiling point below 380 °C is hydrogenated to obtain a hydrogenated fraction having a boiling point below 380 °C. Suitably, the entire first fraction as obtained in step (c) is hydrogenated in step (d) to obtain a hydrogenated fraction having a boiling point below 380 °C. Step (d) is suitably performed in the presence of hydrogen and a hydrogenation catalyst, which catalyst can be chosen from those known to one skilled in the art as being suitable for this reaction. Catalysts for use in step (d) typically are amorphous catalysts comprising a hydrogenation functionality and an amorphous support. Preferred supports are refractory metal oxide carriers. Suitable carrier materials include silica, alumina, zirconia, titania and mixtures thereof. Preferred carrier materials for inclusion in the catalyst for use in the process of this invention are silica and alumina. Preferred hydrogenation functionality catalysts include Group VIII non-noble metals. A particularly preferred catalyst comprises nickel supported on an alumina carrier. The catalyst may comprise the hydrogenation active component in an amount of from 0. 5 to 50 parts by weight, preferably from 2 to 30 parts by weight, per 100 parts by weight of carrier material. The catalyst may also comprise a binder to enhance the strength of the catalyst. The binder will be non-acidic. Examples are clays, alumina and other binders known to one skilled in the art. Preferably, the catalyst is substantially amorphous, meaning that no crystalline phases are present in the catalyst. In step (d), the first fraction having a boiling point below 380 °C as obtained in step (c) is contacted with hydrogen in the presence of the catalyst at elevated temperature and pressure. The temperatures typically will be in the range of from 180-280°C, preferably higher than 190°C and more preferably in the range of from 200-240°C. The pressure will typically be in the range of from 10-70 bar and preferably between 40-60 bar. The first fraction having a boiling point below 380 °C as obtained in step (c) may be provided at a weight hourly space velocity of from 0.1-5 kg/l/hr, preferably higher than 0.5 kg/l/hr and more preferably lower than 2 kg/l/hr. The ratio of hydrogen to hydrocarbon feed may range from 100-5000 Nl/kg and is preferably from 250-2500 Nl/kg. The hydrogenation carried out in step (d) at the process conditions specified above, the olefins and oxygenates present in the light Fischer Tropsch product fraction are hydrogenated almost to extinction (olefins removal of more than 99% and oxygenates removal of more than 97%) In step (e), at least part of the hydrogenated fraction having a boiling point below 380 °C is catalytically dewaxed to obtain an at least partially isomerised product. Suitably, the entire hydrogenated fraction as obtained in step (d) is subjected to the catalytic dewaxing step in step (e).

[0018] The catalytic dewaxing process in step (e) may be any process wherein in the presence of a catalyst and hydrogen the freeze point of the kerosene precursor fraction and the cloud point of the gas oil precursor fraction is reduced. Suitably, catalytic dewaxing is performed in the presence of a catalyst comprising a molecular sieve and a group VIII metal. Suitable dewaxing catalyst are heterogeneous catalysts comprising molecular sieve, more suitably intermediate pore size zeolites and optionally in combination a metal having a hydrogenation function, such as the Group VIII metals. Preferably, the intermediate pore size zeolites have a pore diameter of between 0.35 and 0.8 nm.

[0019] Preferably, catalytic dewaxing is performed in the presence of a catalyst comprising a molecular sieve and a group VIII metal, wherein the molecular sieve is selected from a group consisting of a MTW, MTT, TON type molecular sieve, ZSM-48 and EU-2.

[0020] In the present invention, the reference to ZSM-48 and EU-2 is used to indicate that all zeolites can be used that belong to the ZSM-48 family of disordered structures also referred to as the *MRE family and described in the Catalog of Disorder in Zeolite Frameworks published in 2000 on behalf of the Structure Commission of the International Zeolite Assocation. Even if EU-2 would be considered to be different from ZSM-48, both ZSM-48 and EU-2 can be used in the present invention. Zeolites ZBM-30 and EU-11 resemble ZSM-48 closely and also are considered to be members of the zeolites whose structure belongs to the ZSM-48 family. In the present application, any reference to ZSM-48 zeolite also is a reference to ZBM-30 and EU-11 zeolite.

[0021] Besides ZSM-48 and/or EU-2 zeolite, further zeolites can be present in the catalyst composition especially if it is desired to modify its catalytic properties. It has been found that it can be advantageous to have present zeolite ZSM-12 which zeolite has been defined in the Database of Zeolite Structures published in 2007/2008 on behalf of the Structure Commission of the International Zeolite Assocation.

[0022] Suitable Group VIII metals are nickel, cobalt, platinum and palladium. Preferably, a Group VIII metal is platinum or palladium.

[0023] The dewaxing catalyst suitably also comprises a binder. The binder can be non-acidic. Examples of suitable binders are clay, silica, titania, zirconia, alumina, mixtures and combinations of the above and other binders known to one skilled in the art.

[0024] Preferably the catalyst comprises a silica or a titania binder.

[0025] Catalytic dewaxing conditions are known in the art and typically involve operating temperatures in the range of from 200-500 °C, suitably from 250-400 °C, hydrogen pressures in the range of from 10-200 bara, preferably from 40-70 bara, weight hourly space velocities (WHSV) in the range of from 0.1-10 kg of oil per litre of catalyst per hour (kg/l/hr), suitably from 0.2-5 kg/l/hr, more suitably from 0.5-3 kg/l/hr and hydrogen to oil ratios in the range of from 100-2,000 normal litres of hydrogen per kilogram of oil.

[0026] In step (f), at least part of the at least partially isomerised product as obtained in step (e) is separated into one or more naphtha fractions and one or more middle distillate fractions. Suitably, the entire at least partially isomerised product as obtained in step (e) is separated in step (f) into one or more naphtha fractions and one or more middle distillate fractions. Suitably, the one or more naphtha fractions as obtained in step (f) have a boiling point in the range of from 50-180 °C, preferably in the range of from 80-200 °C. Suitably, the one or more middle distillate fractions as obtained in step (f) have a boiling point in the range of from 180-380 °C, preferably in the range of from 200-360 °C. The middle distillate fractions include a middle distillate kerosene fraction and/or a middle distillate gas oil fraction or diesel oil fraction. The separation in step (f) is suitably carried out by means of distillation. The separation in step (f) may be performed by performing a distillation at atmospheric pressure or under light vacuum conditions. The separation in step (f) may also include a first atmospheric distillation followed by a further distillation at deep vacuum distillation conditions.

[0027] In a first particularly attractive embodiment of the present invention, at least part of the second fraction as obtained in step (c) is recycled to step (b).

[0028] Preferably, at least part of the second fraction as obtained in step (c) is subjected to a hydrogenation step to obtain a hydrogenated fraction, at least part of the hydrogenated fraction so obtained is catalytically dewaxed to obtain an at least partially isomerised product, and at least part of the at least partially isomerised product so obtained is separated into one or more naphtha fractions, one or more middle distillate fractions, and one or more base oil fractions. In such a first particularly attractive embodiment any of the hydrogenation conditions and hydrogenation catalysts as described hereinbefore in respect of step (d) can be used in the hydrogenation step to which the second fraction as obtained in step (c) is subjected. Further, in the catalytic dewaxing step to which the second fraction as obtained in step (c) can be subjected use can be made of any of the dewaxing catalysts and dewaxing conditions as described hereinbefore. The separation step that can subsequently be carried out to separate the at least partially isomerised product into one or more naphtha fractions, one or more middle distillate fractions, and one or more base oil fractions can be carried out as described hereinbefore in respect of step (f). Suitably, the one or more naphtha fractions as obtained in this way have a boiling point in the range of from 50-180 °C, preferably in the range of from 80-200 °C. Suitably, the one or more middle distillate fractions as obtained this way have a boiling point in the range of from 180-380 °C, preferably in the range of from 200-360 °C. The one or more base oil fractions as obtained in this way suitably have a boiling point in the range of from 380-750 °C, preferably in the range of from 360-750 °C.

[0029] In a second particularly attractive embodiment of the present invention, at least part of the second fraction as obtained in step (c) is subjected to a separation treatment to obtain at least a third fraction boiling in the range of from 360-540 °C, the third fraction boiling in the range of from 360-540 °C so obtained is subjected to a hydrogenation step to obtain a hydrogenated fraction boiling in the range of from 360-540 °C, the hydrogenated fraction so obtained is catalytically dewaxed to obtain an at least partially isomerised product, and at least part of the at least partially isomerised product is separated into one or more naphtha fractions, one and more middle distillate fractions, and one or more base oil fractions. In such a further preferred embodiment any of the hydrogenation conditions and hydrogenation catalysts as described hereinbefore in respect of step (d) can be used in the hydrogenation step to which the second fraction as obtained in step (c) is subjected. Further, in the catalytic dewaxing step to which the second fraction as obtained in step (c) can be subjected use can be made of any of the dewaxing catalysts and dewaxing conditions as described hereinbefore. The separation step that can subsequently be carried out to separate the at least partially isomerised product into one or more naphtha fractions, one or more middle distillate fractions, and one or more base oil fractions can be carried out as described hereinbefore in respect of step (f). Suitably, the one or more naphtha fractions as obtained in this way have a boiling point in the range of from 50-180 °C, preferably in the range of from 80-200 °C. Suitably, the one or more middle distillate fractions as obtained this way have a boiling point in the range of from 180-380 °C, preferably in the range of from 200-360 °C. The one or more base oil fractions as obtained in this way suitably have a boiling point in the range of from 380-580 °C, preferably in the range of from 360-540°C.

[0030] In such a second particularly attractive embodiment of the present invention, at least part of the second fraction as obtained in step (c) is preferably subjected to a separation treatment to obtain at least the third fraction boiling in the range of from 360-540 °C and a fourth fraction having a boiling point which is higher than the boiling point of the third fraction, and at least part of the fourth fraction so obtained is recycled to step (b).

[0031] The present invention will be illustrated with the following non-limiting examples.

Examples

Example 1

[0032] A process according to the present invention was carried out as follows. A Fischer-Tropsch product (12.3 wt% naphtha, 13.7 wt% gas oil, 21.8 wt% vacuum gas oil, 52.2 wt% residue; and having a pour point of 105 °C) was subjected to a thermal conversion step. The thermal conversion step was carried out at 490 °C and at a pressure of 10 barg during a residence time of 0.1 hour. The thermally converted Fischer-Tropsch product was split into a fraction boiling below 360 °c and a fraction boiling above 360 °C. The fraction boiling below 360 °C was then subjected to a first hydrogenation step which was carried out at a pressure of 40 barg, at a temperature of 240 °C, a WHSV of 2, and a hydrogen gas to oil ratio of 500. In the first hydrogenation step a commercial 1.6 mm trilobe catalyst was used comprising nickel and an alumina carrier. Subsequently, the hydrogenated product so obtained was subjected to a first catalytic dewaxing step which was caried out a a temperature of 330 °C, a pressure of 40 barg, a WHSV of 2 kg/l/hr, and a hydrogen gas to oil ratio of 500 Nl/kg. In the catalytic dewaxing step a catalyst was used comprising platinum, a medium pore size molecular sieve and a binder material. The fraction boiling above 360 °C was subjected to a second hydrogenation step which was carried out at 40 barg, a temperature of 240 °C, a WHSV of 2 kg/l/hr, and a hydrogen gas to oil ratio of 500 Nl/kg. In the second hydrogenation step a catalyst was used comprising nickel and an alumina carrier. Subsequently, the hydrogenated product so obtained was subjected to a second catalytic dewaxing step which was caried out at a temperature of 330 °C, a pressure of 40 barg, a WHSV of 0.5 kg/l/hr, and a hydrogen gas to oil ratio of 500 Nl/kg. In the catalytic dewaxing step a catalyst was used comprising platinum and a MTW molecular sieve. The total product obtained from the first and second dewaxing steps was then distilled into a naphtha fract, a gas oil fraction, a distillate base oil fraction and a residual base oil fraction. The amounts of these fractions are shown in Table 1.

Example 2 (Comparative Example)

[0033] Example 2 was carried out as Example 1, except that instead of the thermal conversion step a hydrocracking step was carried out. The hydrocracking process was carried out at 80 barg, a temperature of 346°C, a WHSV of 1.0 kg/l/hr, and a hydrogen gas to oil ratio of 750Nl/kg. At these conditions a 370 °C conversion was reached of 50%. The hydrocracking catalyst comprised platinum and a silica-alumina carrier. The fraction boiling above 360 °C of the hydrocracker product was subjected to a catalytic dewaxing step which was caried out at a temperature of 330 °C, a pressure of 40 barg, a WHSV of 0.5 kg/l/hr, and a hydrogen gas to oil ratio of 500 Nl/kg. In the catalytic dewaxing step a catalyst was used comprising platinum and a MTW molecular sieve. The fraction boiling below 360 °C products obtained from the hydrocracker were distilled into a naphtha fraction and a gas oil fraction. The product obtained from the dewaxing step were distilled into a naphtha fraction, a gas oil fraction, a distillate base oil fraction and a residual base oil fraction.The overall amounts of the naphtha, the gas oil, the distillate base oil fraction and the residual base oil fraction so obtained are shown in

Table 1

	Example 1	Example 2
Naphtha wt% on FT feed	11.9	16.8
Gas oil wt% on FT feed	47.5	47.0
Distillate base oils wt% on FT feed	16.4	15.2
Residual base oil wt% on FT feed	20.6	19.0

[0034] From Table 1 it will be clear that in the process according to the present invention a product distribution could be obtained which was similar to that obtained in Example 2, with a slightly higher yield in high value products (gas oil, distillate base oils and residual base oil)and lower yield in low value naphtha. Total product yield is slightly lower due to a slightly higher gas yield for the thermal conversion process (Example 1). Further, in Example 1 much less severe reaction conditions are applied in the thermal conversion step and no hydrocracking catalyst is needed when compared with the hydrocracking step in Example 2.

Claims

1. Process for preparing one or more naphtha fractions and one or more middle distillate fractions, the process comprising the steps of:

(a) providing a Fischer-Tropsch hydrocarbons stream;
(b) subjecting the Fischer-Tropsch hydrocarbons stream as provided in step (a) to a thermal conversion step to obtain a converted hydrocarbon stream comprising paraffins and olefins;
(c) separating at least part of the converted hydrocarbon stream as obtained in step (b) into a first fraction having a boiling point below 380°C and a second fraction having a boiling point which is higher than 300°C;
(d) hydrogenating at least part of the first fraction having a boiling point below 380 °C as obtained in step (c) to obtain a hydrogenated fraction having a boiling point below 380°C;
(e) catalytic dewaxing at least part of the hydrogenated fraction having a boiling point below 380 °C as obtained in step (d) to obtain an at least partially isomerised product; and
(f) separating at least part of the at least partially isomerised product as obtained in step (e) into one or more naphtha fractions and one or more middle distillate fractions.

2. Process according to claim 1, wherein at least part of the second fraction as obtained in step (c) is recycled to step (b).

3. Process according to claim 1, wherein at least part of the second fraction as obtained in step (c) is subjected to a hydrogenation step to obtain a hydrogenated fraction, at least part of the hydrogenated fraction so obtained is catalytically dewaxed to obtain an at least partially isomerised product, and at least part of the at least partially isomerised product so obtained is separated into one or more naphtha fractions, one or more middle distillate fractions, and one or more base oil fractions.

4. Process according to claim 1, wherein at least part of the second fraction as obtained in step (c) is subjected to a separation treatment to obtain at least a third fraction boiling in the range of from 360-580 °C, the third fraction boiling in the range of from 360-540 °C so obtained is subjected to a hydrogenation step to obtain a hydrogenated fraction boiling in the range of from 360-540 °C, the hydrogenated fraction so obtained is catalytically dewaxed to obtain an at least partially isomerised product, and at least part of the at least partially isomerised product is separated into one or more naphtha fractions, one and more middle distillate fractions, and one or more base oil fractions.

5. Process according to claim 4, wherein at least part of the second fraction as obtained in step (c) is subjected to a separation treatment to obtain at least the third fraction boiling in the range of from 360-540 °C and a fourth fraction having a boiling point which is higher than the boiling point of the third fraction, and at least part of the fourth fraction so obtained is recycled to step (b).

6. Process according to any one of claims 1-5, wherein the thermal conversion step in step (b) is carried out at a temperature in the range of from 400-600 °C and a pressure in the range of from 2-70 bara.

7. Process according to any one of claims 1-6, wherein the separation in step (c) is carried out by means of distillation.

8. Process according to any one of claims 1-7, wherein the hydrogenation in step (d) is carried out at a temperature in the range of from 180-280 °C, a pressure in the range of from 10-70 bara, and in the presence of a hydrogenation catalyst and hydrogen.

9. Process according to claim 8, wherein the hydrogenation catalyst comprises an amorphous support and a Group VIII non-nobel metal compound.

10. Process according to any one of claims 1-9, wherein the catalytic dewaxing is carried out at a temperature in the range of from 200-500°C and at a pressure in the range of from 10-200 bar, and in the presence of a dewaxing catalyst and hydrogen.

11. Process according to claim 10, wherein the dewaxing catalyst comprises a molecular sieve and a Group VIII metal, wherein the molecular sieve is selected from a group consisting of a MTW, MTT, TON type molecular sieve or ZSM-48 or EU-2.

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EUROPEAN SEARCH REPORT

Application Number
EP 14 20 0721

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
Y	US 2005/098476 A1 (MILLER STEPHEN J [US]) 12 May 2005 (2005-05-12) * paragraph [[0027]] * -----	1-11	INV. C10G45/02 C10G45/58 C10G69/06 C10G9/00
Y	US 2004/178118 A1 (ROSENBAUM JOHN [US] ET AL) 16 September 2004 (2004-09-16) * paragraphs [[0046]] - [[0047]] * -----	1-11	
			TECHNICAL FIELDS SEARCHED (IPC)
			C10G

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	14 August 2015	Cagnoli, Michele

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
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EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

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This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
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