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(54) **PROCESS FOR PRODUCING MIDDLE DISTILLATES**

VERFAHREN ZUR HERSTELLUNG VON MITTLEREN DESTILLATEN

PROCÉDÉ DE PRODUCTION DE DISTILLATS INTERMÉDIAIRES

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(73) Proprietor: **Shell Internationale Research
Maatschappij B.V.
2596 HR The Hague (NL)**

(72) Inventor: **VAN DIJK, Nicolaas
1031 HW Amsterdam (NL)**

(74) Representative: **Shell Legal Services IP
p/a Carel van Bylandtlaan 16
2596 HR Den Haag (NL)**

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Description

Field of the Invention

[0001] The present invention relates to process for producing middle distillates.

Background of the Invention

[0002] In view of new emission standards much research and development is nowadays directed to the production of so-called ultra low sulphur middle distillates such as ultra low sulphur diesel fuels.

[0003] It is known to produce ultra low sulphur diesel fuels by first hydrosulphurising a hydrocarbon distillate stream boiling in the gasoil boiling range and then catalytically dewaxing the desulphurised distillate stream. Especially in the winter time the catalytic dewaxing step may be needed for removing waxy molecules from the distillate stream in order to reduce the cloud point and the pour point of the gasoil. The desulphurised and dewaxed gasoil may be hydrofinished for saturation of aromatic compounds. In this way the cetane index or number of the gasoil product may be further enhanced. The resulting desulphurised, dewaxed and optionally hydrofinished gasoil is then used as diesel fuel or diesel fuel component. EP 0 697 455 discloses a process for producing hydrowax from residual hydrocarbon feedstock.

[0004] Object of the present invention is to provide a process for producing ultra low sulphur middle distillates in high yields.

Summary of the invention

[0005] This object is achieved when use is made of a particular multi-step process.

[0006] Accordingly, the present invention is defined in claim 1.

[0007] In accordance with the present invention high yields of middle distillates containing less than 10 ppm sulphur can advantageously be produced from residual hydrocarbonaceous feedstocks.

Detailed description of the invention

[0008] The residual hydrocarbonaceous feedstocks to be used in accordance with the present invention can suitably be residual hydrocarbon oils, such as those obtained in the distillation of crude oils at atmospheric or reduced pressure. Suitably, at least 75 wt%, more preferably at least 85 wt%, and even more preferably at least 90 wt% of the residual hydrocarbonaceous feedstock has a boiling point of above 550 °C. Atmospheric residues or vacuum residues contain however considerable amounts of non-distillable compounds having a high molecular weight such as asphaltenes. It is therefore considered desirable to remove asphaltenes from a residual

hydrocarbon oil feed prior to subjecting the residual hydrocarbon oil to subsequent upgrading steps.

[0009] In step (a), a residual hydrocarbonaceous feedstock is deasphalted to obtain a deasphalted product of which at least 50 wt%, preferably at least 70 %, more preferably at least 80 wt%, and even more preferably at least 85 wt% has a boiling point above 550 °C and an asphaltic product.

[0010] In the present invention the deasphalting in step (a) is carried out by means of a solvent deasphalting treatment.

[0011] In solvent deasphalting the hydrocarbon feed is treated counter-currently with an extracting medium which is usually a light hydrocarbon solvent containing paraffinic compounds. Commonly applied paraffinic compounds include C3-8 paraffinic hydrocarbons, such as propane, butane, isobutane, pentane, isopentane, hexane or mixtures of two or more of these. For the purpose of the present invention, it is preferred that C3-C5 paraffinic hydrocarbons, most preferably butane, pentane or a mixture thereof, are used as the extracting solvent. In general, the extraction depth increases at increasing number of carbon atoms of the extracting solvent. In this connection it is noted that the higher the extraction depth, the larger the amount of hydrocarbons being extracted from the residual hydrocarbonaceous feedstock, the smaller and more viscous the asphaltic product will be, whereby the heavier the asphaltenes will be in the asphaltic product to be obtained in step (a).

[0012] In a solvent deasphalting treatment a rotating disc contactor or a plate column can be used with the residual hydrocarbonaceous feedstock entering at the top and the extracting solvent entering at the bottom. The lighter hydrocarbons which are present in the residual hydrocarbonaceous feedstock dissolve in the extracting solvent and are withdrawn as the deasphalted product at the top of the apparatus. The asphaltenes which are insoluble in the extracting solvent are withdrawn in the form of the asphaltic product at the bottom of the apparatus. The conditions under which deasphalting takes place are known in the art. Deasphalting is carried out at a total extracting solvent to residual hydrocarbon oil ratio of 1.5 to 8 wt/wt, a pressure of from 1 to 60 bara and a temperature of from 40 to 200 °C.

[0013] A deasphalting treatment generally causes a substantial amount of the metallic contaminants present in the feed as high-molecular weight complexes to accumulate in the asphaltic product rather than in the deasphalted product. Nonetheless, the metals content of the deasphalted product will be such that the deasphalted product needs to be subjected to a hydrodemetallizing step before it can be subjected to further hydroprocessing upgrading steps.

[0014] In step (b), at least part of the deasphalted product as obtained in step (a) is hydrodemetallized to obtain a hydrodemetallized product. Preferably, in step (b) the entire deasphalted product as obtained in step (a) is hydrodemetallized.

[0015] The deasphalted product which is hydrodemetallized in step (b) is a pure and heavy deasphalted product. This means that at least 50 wt%, preferably at least 70 wt%, more preferably at least 80 wt%, and even more preferably at least 85 wt% of the deasphalted product to be treated in step (b) has a boiling point of above 550 °C. Unlike in other hydroconversion processes such as for instance disclosed in EP 1731588 A1, the entire undiluted deasphalted product as obtained in step (a) can now be hydrodemetallized in step (b), and there is no need to dilute the deasphalted product before it can be further processed. One of the major advantages of the present invention is the fact that such an undiluted heavy deasphalted product can be further processed, resulting in such a high yield of low sulphur middle distillates. The hydrodemetallization of the deasphalted product in step (b) can be achieved by any well known hydrodemetallization treatment wherein the deasphalted product to be hydrodemetallized is passed at elevated temperature and pressure and in the presence of hydrogen in an upward, downward or radial direction, through one or more vertically disposed reactors containing a fixed or moving bed of hydrodemetallization catalyst particles. The hydrodemetallization is at least partially carried out in a bunker flow.

[0016] In step (b), suitable use is made of a hydrodemetallization catalyst. Suitable hydrodemetallization catalysts to be used in accordance with the present invention consist of oxidic carriers such as alumina, silica or silica-alumina, on which one or more Group VIB or Group VIII metals or metal compounds may be deposited. Such hydrodemetallization catalysts are commercially available from many catalyst suppliers. Particularly suitable hydrodemetallization catalysts are those having as the active agent one of the combinations nickel/molybdenum (Ni-Mo) or cobalt/molybdenum (CoMo), optionally promoted with phosphorus (P), on an alumina (Al₂O₃) carrier. Concrete examples of particularly suitable catalysts are Co-Mo/Al₂O₃, CoMoP/Al₂O₃ and NiMo/Al₂O₃ and NiMoP/Al₂O₃ catalysts.

[0017] The hydrodemetallization in step (b) can suitably be carried out at a hydrogen partial pressure of 20-300 bara, preferably 50-210 bara, a temperature of 300-470 °C, preferably 310-440 °C, and a space velocity of 0.1-10 hr⁻¹, preferably 0.2 to 7 hr⁻¹. The use of the pure and heavy desphalted product in step (b) will result in considerable metals laydown on the hydrodemetallization catalyst(s) to be used in step (b) which in turn results in a very swift deterioration/deactivation of the hydrodemetallization catalyst(s), requiring a much more regular and fast replacement of the hydrodemetallization catalyst(s) when compared with known processes in which a diluted and lighter deasphalted product with a lower metals content is subjected to a hydrodemetallization step. Hence, the hydrodemetallization reactor is preferably a bunker flow reactor, a fixed bed swing reactor or a movable bed reactor. The hydrodemetallization catalyst(s) is (are) regularly replaced for instance every three weeks

or two months, whereas in conventional processes the hydrodemetallization catalyst(s) (like the hydrotreating and hydrocracking catalysts to be used in steps (c) and (d) in the present process) may not be replaced within a year time.

[0018] In step (c), at least part of the hydrodemetallized product as obtained in step (b) is hydrotreated to obtain a hydrotreated product. Preferably, in step (c) the entire hydrodemetallized product as obtained in step (b) is hydrotreated.

[0019] The hydrotreating of the hydrodemetallized product in step (c) can be achieved by any well known hydrotreating process wherein the hydrodemetallized product to be hydrotreated is passed at elevated temperature and pressure and in the presence of hydrogen in an upward, downward or radial direction, through one or more vertically disposed reactors containing a fixed or moving bed of hydrotreating catalyst particles. The hydrotreatment can be carried out in a bunker flow reactor, a fixed bed reactor, a fixed bed swing reactor or a movable bed reactor. Preferably, the hydrotreatment in step (c) is carried out in two reaction zones, whereby the hydrodemetallized product is first passed to a first reaction zone in which the hydrodemetallized product is partly hydrotreated after which the partly hydrotreated effluent so obtained is subjected to further hydrotreatment in a second reaction zone. The first reaction zone and second reaction zone can be arranged in a stacked bed configuration or the two reactions zones can each be arranged in a separate reactor. Preferably, the first reaction zone and the second reaction zone are respectively arranged in a first reactor and a second reactor. The first reactor may be a bunker flow reactor and the second reactor may be a fixed bed reactor.

[0020] The hydrotreating catalyst to be used in step (c) can suitably be a desulphurization catalyst. The desulphurization catalyst may be any hydrodesulphurization catalyst known in the art.

[0021] Suitable hydrodesulphurization catalysts comprise a Group VIII metal of the Periodic Table and a compound of a Group VIB metal of the Periodic Table as hydrogenation components on a porous catalyst support, usually alumina or amorphous silica-alumina. Well-known examples of suitable combinations of hydrogenation compounds are cobalt-molybdenum, nickel-molybdenum, nickel-tungsten, and nickel-cobalt-molybdenum. A hydrodesulphurization catalyst comprising compounds of nickel and/or cobalt and molybdenum as hydrogenation compounds is preferred. The hydrodesulphurization catalyst may further comprise a cracking component such as for example Y zeolite. It is, however, preferred that no substantial hydrocracking takes place in the hydrotreatment in step (c). Therefore, it is preferred that the catalyst is substantially free of a cracking component. A catalyst comprising nickel and/or cobalt and molybdenum supported on alumina without a zeolitic cracking compound is particularly preferred.

[0022] The hydrotreating conditions in step (c), i.e.

temperature, pressure, hydrogen supply rate, weight hourly velocity of the feedstock, are typical hydrotreating conditions. Preferably, the temperature used for the hydrotreating in step (c) is in the range of from 280 to 430 °C, more preferably in the range of from 320 to 420 °C, and most preferably in the range of from 330 to 410 °C.

[0023] Suitable hydrotreating pressures are in the range of from 10 to 300 bara. Preferably, the hydrotreating pressure is in the range of from 30 to 250 bara, more preferably in the range of from 80 to 220 bara.

[0024] In step (d), at least part of the hydrotreated product as obtained in step (c) is hydrocracked to obtain a hydrocracked product. Preferably, in step (d) the entire hydrotreated product as obtained in step (a) is hydrocracked.

[0025] The hydrocracking in step (d) of the process according to the present invention may be conducted in any way known in the art, provided that at least one of the catalysts used in the hydrocracking zone is acidic. Suitably, the hydrocracking is carried out in the presence of hydrogen and a suitable hydrocracking catalyst at elevated temperature and pressure. Suitable hydrocracking catalysts consist of one or more metals from nickel, tungsten, cobalt and molybdenum in elemental, oxidic or sulphidic form on a suitable carrier such as alumina, silica, silica-alumina or a zeolite. There are many commercially available hydrocracking catalysts which can be suitably applied in the process of the present invention. At least one of the catalysts used in the hydrocracking zone must be acidic, i.e. must contain a silica-alumina and/or zeolitic component.

[0026] The hydrocracking in step (d) can be carried out in a single- or multiple-stage mode of operation. In the case of a single-stage mode of operation, a stacked bed of a hydrodenitritication/first-stage hydrocracking catalyst on top of a conversion catalyst can suitably be used. Particularly suitable hydrodenitritication/first-stage hydrocracking catalysts are NiMo/Al₂O₃ and CoMo/Al₂O₃, optionally promoted with phosphorus and/or fluor. Preferred conversion catalysts are those based on NiW/zeolite or NiW/zeolite/silica-alumina. Suitable hydrocracking conditions in step (d) are an operating pressure of 80-250 bara, preferably 90-220 bara, and a temperature of 300-460 °C, preferably 350-430 °C.

[0027] In step (e), at least part of the hydrocracked product as obtained in step (d) is subjected to a separation treatment to obtain at least a middle distillate fraction. Preferably, in step (e) the entire hydrocracked product as obtained in step (d) is subjected to the separation treatment.

[0028] The separation treatment in step (e) can suitably be a fractionating treatment which is carried out at a temperature in the range from 50 to 400 °C, preferably at a temperature in the range of from 70 to 370 °C, and a pressure in the range of from 0.03 to 15 bara, preferably a pressure in the range of from 0.05 to 10 bara.

[0029] Beside of the middle distillate fraction to be obtained in step (e) there can also be obtained a heavy

residual fraction. Suitably, at least 80% of the heavy residual fraction also obtained in the separation treatment in step (e) has a boiling point above 370 °C. Preferably, at least 90% of the heavy residual fraction also obtained in the separation treatment in step (e) has a boiling point above 370 °C.

[0030] At least part of a heavy residual fraction also obtained in step (e) may be recycled to step (a). In this way an improved yield of middle distillates can be obtained.

[0031] Alternatively, said heavy fraction could also be suitably applied as a feed for a fluidised bed catalytic cracking (FCC) unit or as a feedstock for lubricating oil manufacture. Of course, a combination of these options is possible as well.

[0032] In order to achieve an optimum middle distillates yield, it is preferred that at least a part of the heavy fraction obtained in step (e) is again subjected to hydrocracking to improve the yield of middle distillates. Hence, in a preferred embodiment at least part of a heavy residual fraction which is also obtained in step (e) is recycled to step (d).

[0033] In another preferred embodiment of the present invention at least part of the heavy residual fraction also obtained in step (e) is recycled to step (a) and at least part of the heavy residual fraction also obtained in step (e) is recycled to step (d). In this way the yield of middle distillates is further improved.

[0034] In yet another preferred embodiment, at least part of a heavy residual fraction also obtained in step (e) is subjected to a further hydrocracking step (f), and at least part of the hydrocracked product as obtained in such a step (f) is recycled to step (e). Also this embodiment ensures that an optimal yield of middle distillates will be established.

[0035] Preferably, at least part of the heavy residual fraction also obtained in step (e) is also recycled to step (a) to improve the middle distillate yield even further.

[0036] Preferably, the hydrocracking in step (d) and/or step (f) is carried out in two or more reaction zones. Preferably, the two or more reaction zones are arranged in a stacked bed configuration.

[0037] The asphaltic product as obtained in step (a) may be used in several ways. It can for instance be combusted for cogeneration of power and steam. Alternatively, it can be partially combusted for clean fuel gas production, cogeneration of power and steam, hydrogen manufacture or hydrocarbon synthesis. Still another option is application in bitumen, emulsion fuels or solid fuels by means of pelletizing.

[0038] Preferably, at least part of the asphaltic product as obtained in step (a) is subjected to a gasification step (g) to obtain hydrogen and carbon monoxide.

[0039] Preferably, such a gasification step (g) is a partial combustion step.

[0040] In a preferred embodiment at least part of the hydrogen as obtained in step (g) is recycled to at least one of steps (b), (c), (d) and (f).

[0041] The middle distillate fraction as obtained in step (e) comprises middle distillates which contain less than 10 ppmwt of sulphur. Preferably, the middle distillates contain less than 8 ppmwt of sulphur, more preferably less than 6 ppmwt of sulphur, and most preferably less than 5 ppmwt of sulphur.

[0042] Figure 1 depicts the process according to the present invention; Figure 2 depicts a preferred embodiment of the present invention; and Figure 3 depicts a further preferred embodiment of the process according to the present invention.

[0043] In Figure 1 an atmospheric or reduced pressure hydrocarbon oil residue is passed via a line 1 into a deasphalting unit 2 in which a deasphalted product and an asphaltic product are obtained. At least part of the deasphalted product is passed via a line 3 into a hydrodemetallization unit 5 and the asphaltic product is withdrawn from the deasphalting unit 2 via a line 4. At least part of the hydrodemetallized product as obtained in hydrodemetallization unit 5 is passed via a line 6 to hydrotreating unit 7. At least part of the hydrotreated product as obtained in the hydrotreating unit 7 is then passed to a hydrocracking unit 9 via a line 8. At least part of the hydrocracked product as obtained in the hydrocracking unit 9 is passed via a line 10 to a fractionating unit 11 from which at least a middle distillate fraction is recovered via a line 12.

[0044] Figure 2 is an extension of Figure 1 in that in the fractionating unit 11 also a heavy residual fraction is obtained which is withdrawn via a line 13 from the fractionating unit 11 and at least part of the heavy residual fraction is recycled to the deasphalting unit 2. Figure 3 is an extension of Figure 2 in that in the fractionating unit 11 also a heavy residual fraction is obtained which is withdrawn via a line 13 from the fractionating unit 11 and at least part of the heavy residual fraction is recycled via a line 14 to the hydrocracking unit 9 and/or at least part of the heavy residual fraction is recycled via a line 15 to the hydrodemetallization unit 5 and/or at least part of the heavy residual fraction is recycled via a line 16 to the deasphalting unit 2.

[0045] Figure 4 is an extension of Figure 1 in that in the fractionating unit 11 also a heavy residual fraction is obtained which is withdrawn via a line 13 from the fractionating unit 11 and at least part of the heavy residual fraction is passed via the line 13 to a hydrocracking unit 14. At least part of the hydrocracked product as obtained in the hydrocracking unit 14 is recycled to fractionating unit 11 via lines 15 and 16 and at least part of the heavy residual fraction as obtained in the fractionating unit 11 is recycled via lines 15 and 17 to the deasphalting unit 2.

Claims

1. A process for producing middle distillates from a residual hydrocarbonaceous feedstock, comprising the steps of:

- (a) deasphalting the residual hydrocarbonaceous feedstock at a total extracting solvent to residual hydrocarbon oil ratio of 1.5 to 8 wt/wt, a pressure of from 1 to 60 bara and a temperature of from 40 to 200°C to obtain an deasphalted product of which at least 50 wt% has a boiling point above 550 °C and an asphaltic product, wherein at least 70 wt% of the residual hydrocarbonaceous feedstock has a boiling point of above 550 °C;
- (b) hydrodemetallizing at least part of the deasphalted product as obtained in step (a) to obtain a hydrodemetallized product, wherein the hydrodemetallizing is at least partially carried out in a bunker flow reactor;
- (c) hydrotreating at least part of the hydrodemetallized product as obtained in step (b) to obtain a hydrotreated product;
- (d) hydrocracking at least part of the hydrotreated product as obtained in step (c) to obtain a hydrocracked product; and
- (e) subjecting at least part of the hydrocracked product as obtained in step (d) to a separation treatment to obtain at least a middle distillate fraction.

2. A process according to claim 1, wherein the deasphalting in step (a) is carried out by means of a solvent deasphalting treatment.
3. A process according to claim 1 or 2, wherein the hydrodemetallizing in step (b) is carried out in the presence of hydrogen at a temperature in the range of from 300-470 °C and at a pressure in the range of from 20-300 bara.
4. A process according to any one of claims 1 to 3, wherein the hydrotreating in step (c) is carried out in the presence of hydrogen at a temperature in the range of from 280-430 °C and at a pressure in the range of from 10-300 bara.
5. A process according to any one of claims 1 to 4, wherein the hydrocracking in step (d) is carried out in the presence of hydrogen at a temperature in the range of from 300-500 °C and at a pressure in the range of from 80-250 bara.
6. A process according to any one of claims 1 to 5, wherein in the separation treatment which is carried out in step (e) also a heavy residual fraction is obtained, of which at least part of the heavy residual fraction is recycled to step (a) and/or at least part of the heavy residual fraction is recycled to step (b) and/or at least part of the heavy residual fraction is recycled to step (c) and/or at least part of the heavy residual fraction is recycled to step (d).

7. A process according to any one of claims 1 to 6, wherein in the separation treatment which is carried out in step (e) also a heavy residual fraction is obtained of which at least part is subjected to a further hydrocracking step (f), and at least part of the hydrocracked product as obtained in step (f) is recycled to step (e). 5
8. A process according to claim 7, wherein at least part of the heavy residual fraction as obtained in step (e) is also recycled to step (a). 10
9. A process according to any one of claims 1 to 8, wherein the hydrocracking in step (d) and/or step (f) is carried out in two or more stages. 15
10. A process according to any one of claims 1 to 9, wherein at least part of the asphaltic product as obtained in step (a) is subjected to a gasification step (g) to obtain hydrogen and carbon monoxide. 20
11. A process according to claim 10, wherein at least part of the hydrogen as obtained in step (g) is recycled to at least one of steps (b), (c), (d) and (f). 25
12. A process according to any one of claims 6 to 11, wherein at least 80% of the heavy residual fraction as obtained in the separation treatment in step (e) has a boiling point above 370 °C. 30
13. A process according to any one of claims 1 to 12, wherein the middle distillates produced contain less than 6 ppmwt of sulphur. 35

Patentansprüche

1. Vorgang zum Herstellen von Mitteldestillaten aus einem restlichen kohlenwasserstoffhaltigen Ausgangsstoff, die folgenden Schritte umfassend: 40

(a) Entasphaltieren des restlichen kohlenwasserstoffhaltigen Ausgangsstoffs bei einem Gesamtverhältnis von Extraktionsmittel zu restlichem Kohlenwasserstofföl von 1,5 zu 8 Gew./Gew., einem Druck von 1 bis 60 Bar und einer Temperatur von 40 bis 200 °C, um ein entasphaltiertes Produkt, von dem wenigstens 50 Gew.-% einen Siedepunkt über 550 °C aufweisen, und ein asphaltiertes Produkt zu erhalten, wobei wenigstens 70 Gew.-% des restlichen kohlenwasserstoffhaltigen Ausgangsstoffs einen Siedepunkt über 550 °C aufweisen; 45

(b) Hydrodemetallisieren wenigstens eines Teils des in Schritt (a) erhaltenen entasphaltierten Produkts, um ein hydrodemetallisiertes Produkt zu erhalten, wobei das Hydrodemetallisieren wenigstens zum Teil in einem Bunkerströmungsreaktor durchgeführt wird; 50

(c) Wasserstoffbehandeln wenigstens eines Teils des in Schritt (b) erhaltenen hydrodemetallisierten Produkts, um ein wasserstoffbehandeltes Produkt zu erhalten; 55

(d) Hydrokracken wenigstens eines Teils des in Schritt (c) erhaltenen wasserstoffbehandelten Produkts, um ein Hydrokrackenprodukt zu erhalten; und

(e) Unterziehen wenigstens eines Teils des in Schritt (d) erhaltenen Hydrokrackenprodukts einer Trennbehandlung, um wenigstens eine Mitteldestillatfraktion zu erhalten.

2. Vorgang nach Anspruch 1, wobei das Entasphaltieren in Schritt (a) mithilfe einer Lösungsmittelentasphaltierungsbehandlung durchgeführt wird. 20
3. Vorgang nach Anspruch 1 oder 2, wobei das Hydrodemetallisieren in Schritt (b) in der Gegenwart von Wasserstoff bei einer Temperatur im Bereich von 300-470 °C und bei einem Druck im Bereich von 20-300 Bar durchgeführt wird. 25
4. Vorgang nach einem der Ansprüche 1 bis 3, wobei das Hydrobehandeln in Schritt (c) in der Gegenwart von Wasserstoff bei einer Temperatur im Bereich von 280-430 °C und bei einem Druck im Bereich von 10-300 Bar durchgeführt wird. 30
5. Vorgang nach einem der Ansprüche 1 bis 4, wobei das Hydrokracken in Schritt (d) in der Gegenwart von Wasserstoff bei einer Temperatur im Bereich von 300-500 °C und bei einem Druck im Bereich von 80-250 Bar durchgeführt wird. 35
6. Vorgang nach einem der Ansprüche 1 bis 5, wobei bei der Trennbehandlung, die in Schritt (e) durchgeführt wird, ebenso eine restliche schwere Fraktion erhalten wird, wobei wenigstens ein Teil der restlichen schweren Fraktion zu Schritt (a) zurückgeführt wird und/oder wenigstens ein Teil der restlichen schweren Fraktion zu Schritt (b) zurückgeführt wird und/oder wenigstens ein Teil der restlichen schweren Fraktion zu Schritt (c) zurückgeführt wird und/oder wenigstens ein Teil der restlichen schweren Fraktion zu Schritt (d) zurückgeführt wird. 40
7. Vorgang nach einem der Ansprüche 1 bis 6, wobei bei der Trennbehandlung, die in Schritt (e) durchgeführt wird, ebenso eine restliche schwere Fraktion erhalten wird, von der wenigstens ein Teil einem weiteren Hydrokrackenschritt (f) unterzogen wird, und wenigstens ein Teil des in Schritt (f) erhaltenen Hydrokrackenprodukts zu Schritt (e) zurückgeführt wird. 45
8. Vorgang nach Anspruch 7, wobei wenigstens ein Teil 50

der in Schritt (e) erhaltenen restlichen schweren Fraktion ebenso zu Schritt (a) zurückgeführt wird.

9. Vorgang nach einem der Ansprüche 1 bis 8, wobei das Hydrocracken in Schritt (d) und/oder in Schritt (f) in zwei oder mehr Stufen durchgeführt wird. 5
10. Vorgang nach einem der Ansprüche 1 bis 9, wobei wenigstens ein Teil des in Schritt (a) erhaltenen asphaltischen Produkts einem Vergasungsschritt (g) unterzogen wird, um Wasserstoff und Kohlenstoffmonoxid zu erhalten. 10
11. Vorgang nach Anspruch 10, wobei wenigstens ein Teil des in Schritt (g) erhaltenen Wasserstoffs zu Schritt (b), (c), (d) und/oder (f) zurückgeführt wird. 15
12. Vorgang nach einem der Ansprüche 6 bis 11, wobei wenigstens 80 % der in der Trennbehandlung in Schritt (e) erhaltenen restlichen schweren Fraktion einen Siedepunkt über 370 °C aufweist. 20
13. Vorgang nach einem der Ansprüche 1 bis 12, wobei die hergestellten Mitteldestillate weniger als 6 ppmwt Schwefel enthalten. 25

Revendications

1. Procédé de production de distillats intermédiaires à partir d'une charge de départ hydrocarbonée résiduelle, comprenant les étapes de : 30
 - (a) désasphaltage de la charge de départ hydrocarbonée résiduelle selon un rapport en poids du solvant d'extraction total à l'huile hydrocarbonée résiduelle situé dans la plage allant de 1,5 à 8, à une pression située dans la plage allant de 1 à 60 bara et à une température située dans la plage allant de 40 à 200°C, pour obtenir un produit désasphalté, dont au moins 50 % en poids présente un point d'ébullition supérieur à 550°C, et un produit asphaltique, au moins 70 % en poids de la charge de départ hydrocarbonée résiduelle présentant un point d'ébullition supérieur à 550°C ; 35
 - (b) hydrodémétallisation d'au moins une partie du produit désasphalté tel qu'obtenu à l'étape (a) pour obtenir un produit hydrodémétallisé, l'hydrodémétallisation étant au moins partiellement effectuée dans un réacteur à écoulement de mazout lourd ; 40
 - (c) hydrotraitement d'au moins une partie du produit hydrodémétallisé tel qu'obtenu à l'étape (b) pour obtenir un produit hydrotraité ; 45
 - (d) hydrocraquage d'au moins une partie du produit hydrotraité tel qu'obtenu à l'étape (c) pour obtenir un produit hydrocraqué ; et 50

(e) soumission d'au moins une partie du produit hydrocraqué tel qu'obtenu à l'étape (d) à un traitement de séparation pour obtenir au moins une fraction de distillat intermédiaire.

2. Procédé selon la revendication 1, dans lequel le désasphaltage de l'étape (a) est effectué au moyen d'un traitement de désasphaltage au solvant.
3. Procédé selon la revendication 1 ou 2, dans lequel l'hydrodémétallisation de l'étape (b) est effectuée en présence d'hydrogène à une température située dans la plage allant de 300 à 470°C et à une pression située dans la plage allant de 20 à 300 bara.
4. Procédé selon l'une quelconque des revendications 1 à 3, dans lequel l'hydrotraitement de l'étape (c) est effectué en présence d'hydrogène à une température située dans la plage allant de 280 à 430°C et à une pression située dans la plage allant de 10 à 300 bara.
5. Procédé selon l'une quelconque des revendications 1 à 4, dans lequel l'hydrocraquage de l'étape (d) est effectué en présence d'hydrogène à une température située dans la plage allant de 300 à 500°C et à une pression située dans la plage allant de 80 à 250 bara.
6. Procédé selon l'une quelconque des revendications 1 à 5, dans lequel, dans le traitement de séparation effectué à l'étape (e), on obtient également une fraction résiduelle lourde, au moins une partie de la fraction résiduelle lourde étant recyclée vers l'étape (a) et/ou au moins une partie de la fraction résiduelle lourde étant recyclée vers l'étape (b) et/ou au moins une partie de la fraction résiduelle lourde étant recyclée vers l'étape (c) et/ou au moins une partie de la fraction résiduelle lourde étant recyclée vers l'étape (d).
7. Procédé selon l'une quelconque des revendications 1 à 6, dans lequel, dans le traitement de séparation effectué à l'étape (e), on obtient également une fraction résiduelle lourde, dont au moins une partie est soumise à une étape d'hydrocraquage supplémentaire (f), et au moins une partie du produit hydrocraqué tel qu'obtenu à l'étape (f) est recyclée vers l'étape (e).
8. Procédé selon la revendication 7, dans lequel au moins une partie de la fraction résiduelle lourde telle qu'obtenue à l'étape (e) est également recyclée vers l'étape (a).
9. Procédé selon l'une quelconque des revendications 1 à 8, dans lequel l'hydrocraquage de l'étape (d) et/ou de l'étape (f) est effectué en deux étapes ou

plus.

10. Procédé selon l'une quelconque des revendications 1 à 9, dans lequel au moins une partie du produit asphaltique tel qu'obtenu à l'étape (a) est soumise à une étape de gazéification (g) pour obtenir de l'hydrogène et du monoxyde de carbone. 5
11. Procédé selon la revendication 10, dans lequel au moins une partie de l'hydrogène tel qu'obtenu à l'étape (g) est recyclée vers au moins l'une des étapes (b), (c), (d) et (f). 10
12. Procédé selon l'une quelconque des revendications 6 à 11, dans lequel au moins 80 % de la fraction résiduelle lourde telle qu'obtenue lors du traitement de séparation de l'étape (e) présente un point d'ébullition supérieur à 370°C. 15
13. Procédé selon l'une quelconque des revendications 1 à 12, dans lequel les distillats intermédiaires produits contiennent moins de 6 ppm en poids de soufre. 20

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Fig.1

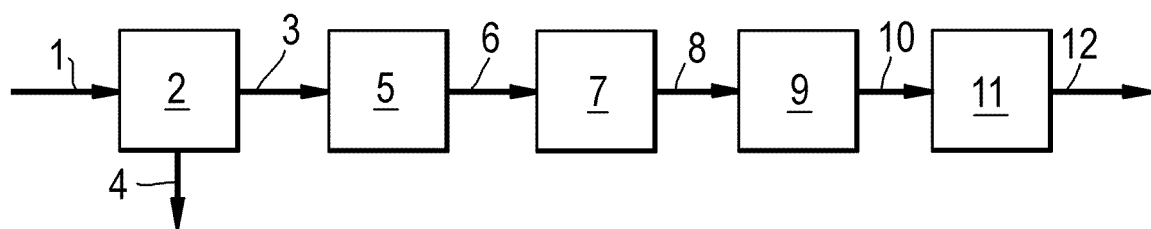


Fig.2

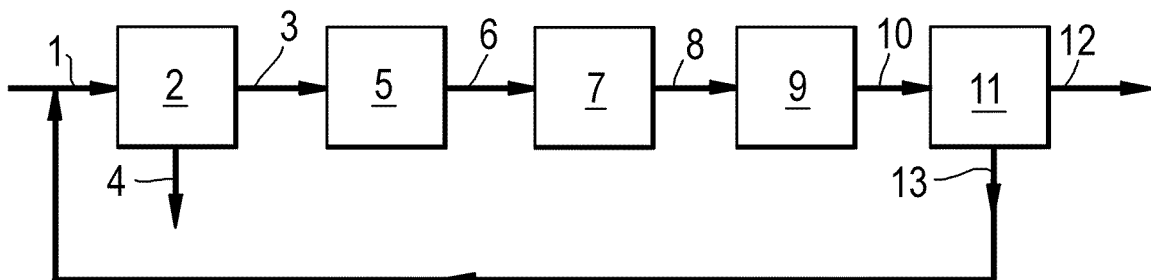


Fig.3

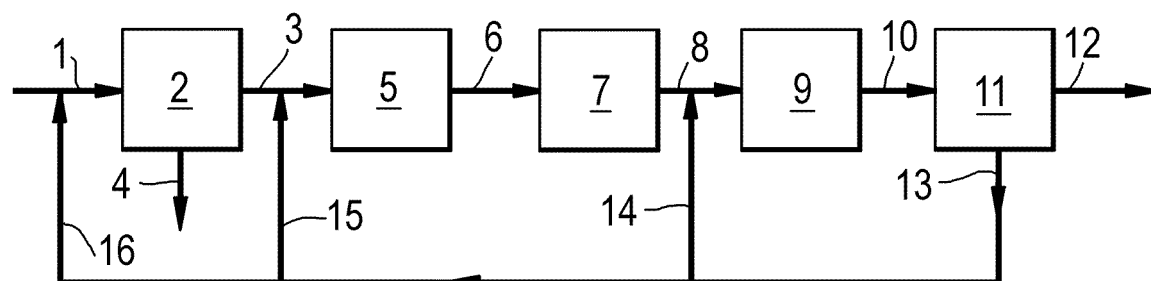
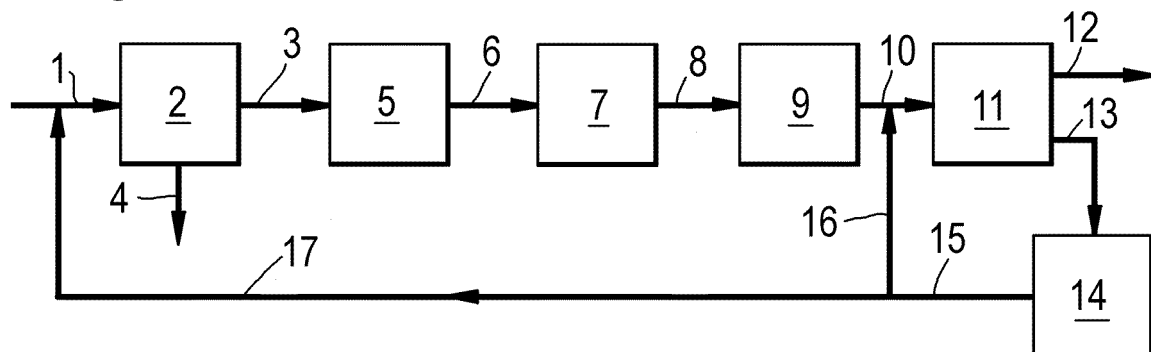


Fig.4



REFERENCES CITED IN THE DESCRIPTION

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