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FR-A1- 3 107 530

DESCRIPTION

Description

FIELD OF THE INVENTION

[0001] The present invention relates to a method of treating waste plastic, especially liquified waste plastic treatment by hydrotreatment. The method includes removal of impurities and hydrogenation of the LWP. In detail, the method comprises two separate hydrotreatments of the LWP, where the second hydrotreatment is performed on a blend of hydrocarbons and already hydrotreated LWP.

BACKGROUND OF THE INVENTION

[0002] Environmental concerns and a wish to limit the use of fossil based feedstock leads to a need to develop possibilities to use waste plastic. Waste plastic is a growing environmental concern, since many of the polymers constituting the plastics are very stable and do not degrade in nature. Incineration of waste plastic increases greenhouse gases and also leads to other environmental concerns in the form of air and land pollution. Incineration of waste plastic is largely considered a waste of valuable raw material, even if the energy in form of heat is collected.

[0003] Plastics or polymers mainly constitute carbon, hydrogen and heteroatoms such as oxygen and/or nitrogen. However, waste plastics also contain many impurities, such as metal and chlorine impurities. There is a growing interest in making use of waste plastic for producing various hydrocarbon components. Fuels are mixtures of hydrocarbons, but production of liquid fuels from waste plastic is generally not considered useful. Direct incineration of waste plastic also produces energy, which can be captured and used for heating and/or production of electricity etc. Therefore, there is a need to upgrade waste plastic to high end hydrocarbon components, which can be utilized in the production of new plastics, chemicals or other materials.

[0004] Waste plastics have been treated by pyrolysis to produce liquefied waste plastic (LWP), but the LWP feed still contains large amounts of various impurities and contaminants. The LWP feed therefore needs to undergo various purification and pre-treatment steps before it can be used as feedstock for various upgrading processes.

[0005] Document WO2021/110395 describes a process for treating a feed comprising waste

plastic pyrolysis oil, the process includes a hydrogenation step at a temperature of 100 °C to 250 °C, followed by a hydrotreatment step at a temperature of 250 °C to 430 °C. The product thus obtained is further separated into a gaseous effluent, an aqueous effluent and a hydrocarbon effluent.

[0006] WO2021/204819, FR3107530 and WO2021/105326 all disclose a method of processing LWP and the obtained product.

[0007] The current invention provides an improved process of treating and purifying LWP obtained e.g. through pyrolysis of waste plastic.

BRIEF DESCRIPTION OF THE INVENTION

[0008] The present invention aims to provide an optimised solution for chemical recycling of waste plastics. The invention strives to make chemical recycling a viable and economical and thereby a complementary solution to recycled waste plastic streams that are not suitable for mechanical recycling. The chemical processes needed are devised in such a way that they can handle the complexities of chemical components in the waste products. Waste plastics are, on a general level, very heterogeneous materials. Depending on the polymer type and in what application it has been used, different plastic products will contain different types of additives such as pigments, fillers, flame retardants and so forth. When the waste plastic is converted into LWP via e.g. pyrolysis, the polymers and the various additives etc. will react/decompose in certain ways, and consequently a plurality of different compounds will be transferred into the product LWP. Conversion of LWP into higher quality value-added products entails the use of catalytic processes, and catalysts that are typically employed in such processes are sensitive to different impurities, i.e. the activity of the catalysts can be deactivated due to deposition of various catalyst poisons. It has been observed that LWP contains various impurities that are detrimental to catalysts, and consequently its further catalytic processing is technically more challenging e.g. when compared to conventional crude oil. This has led to the present invention, where these problems have been resolved by the process steps as claimed. Claimed process allows the processing of waste plastics to be made continuous and economical without having to worry about the damage and detrimental effects caused to the assets carrying out those processing.

[0009] The objects of the invention are achieved by a method characterized by what is stated in the independent claim. The preferred embodiments of the invention are disclosed in the dependent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010] In the following the invention will be described in greater detail by means of preferred

embodiments with reference to the attached drawings, in which

Figure 1 is a schematic view of a specific embodiment of the current invention. In figure 1 the dotted box= optional step; P1= Product 1; P2=Product 2; A1/A2= hydrotreatment step a); B= blending step b); C=hydrotreatment step c); CF= hydrocarbons stream.

DETAILED DESCRIPTION OF THE INVENTION

[0011] The current invention relates to a method of processing liquefied waste plastic, wherein the method comprises a first hydrotreatment of the LWP in mild conditions followed by blending the hydrotreated LWP with a stream comprising hydrocarbons.

[0012] With the term "liquefied waste plastic" is hereby meant a liquid product produced from any waste plastic through a non-oxidative thermolysis process. Typically, liquefied waste plastic is produced by pyrolysis of waste plastic. Other processes to produce LWP include but are not limited to hydrothermal liquefaction processes. The LWP is a mixture of hydrocarbonaceous organic components with a wide range of carbon chain lengths. Provided the large variations of carbon chain lengths and chemical structures and the properties of the LWP varies depending on the types of plastics (polymers) used in the production of LWP, the type of liquefaction process and conditions of the liquefaction process. Typical waste plastic feedstock used in the liquefaction method includes mainly polyethylene with varying amounts of polypropylene, polystyrene and other minor components such as polyamides, polyethylene terephthalate and polyvinyl chloride.

[0013] The liquefied waste plastic can be obtained by pyrolyzing waste plastic and subsequently collecting a liquid fraction from the pyrolyzed waste plastic. In a typical pyrolysis process, the solid waste plastic is heated to a temperature of 400-600 °C under non-oxidative conditions. The polymers thermally decompose and consequently release vapours and gases that exit the reactor in the gas phase. This vapor/gas stream is subsequently cooled down to condense the LWP product and to separate the gases. The LWP typically has a boiling range of about 40 °C - 550 °C, which corresponds approximately to carbon chain lengths of C5 to C55. Depending on the conversion technology, the final boiling point of the LWP can go up to 750 °C.

[0014] LWP is a thermal cracking product of various polymers and is a complex mixture of mainly paraffins, olefins, naphthenes and aromatic hydrocarbons. The total amount of olefins is typically high, from 40 wt.% to 60 wt.%, whereas the amount of aromatic hydrocarbons is typically lower than 20 wt.%. LWP also contains heteroatoms, including oxygen, nitrogen, chlorine and sulphur, in the form of organic compounds with heteroatom substituents. The amounts of heteroatoms vary depending on the polymers used in production of LWP. Water is usually removed from the LWP product, but some dissolved water may still be present in the LWP.

[0015] The liquefied waste plastic can also undergo pre-treatment processes before the

hydrotreatments according to the present invention. The LWP undergoes a pre-treatment step before hydrotreatment step a) and the pre-treatment step comprises reactive extraction, solvent extraction, adsorption, filtration, centrifugation, oxidation, reduction or any combination thereof.

[0016] All of the hydrotreatments stated herein are performed in the presence of at least one catalyst. The catalyst may, for example, comprise at least one component selected from IUPAC group 6, 8 or 10 of the Periodic Table of Elements. When employing a supported catalyst, the catalyst preferably contains Mo and at least one further transition metal on a support. Examples of such a supported catalyst are a supported NiMo catalyst or a supported CoMo catalyst, or a mixture of both. In a supported catalyst, the support preferably comprises alumina and/or silica. These catalysts are usually employed as sulphided catalysts to ensure that the catalysts are in their active (sulphided) form. Turning the catalysts into their active (sulphided) form may be achieved by sulphiding them in advance (i.e. before starting the hydrotreatment reaction) and/or by adding a sulphur-containing feed (containing sulphur e.g. as an organic or inorganic sulphide). The feed may contain the sulphur from the start, or a sulphur additive may be admixed to the feed. In a preferable embodiment, the hydrotreating employs a catalyst and the catalyst is a supported NiMo catalyst and the support comprises alumina (NiMo/Al₂O₃) and/or the catalyst is a supported CoMo catalyst and the support comprises alumina (CoMo/Al₂O₃).

[0017] The catalyst of the hydrotreatment step a) is preferably supported NiMo, wherein the support preferably comprises alumina and/or silica.

[0018] In one embodiment of the current invention the hydrotreatment step a) is repeated before the subsequent blending step. The hydrotreatment step a) can be repeated to ensure sufficient hydrotreatment of LWP in the stream. The possible need for repeating the hydrotreatment step a) depends on among others, on the hydrotreatment conditions, the hydrotreatment catalyst and reactor design, such as number of reactors, type of catalyst beds and number of catalyst beds in the reactors and so forth.

[0019] In one embodiment of the current invention the stream of LWP consists only of LWP and the hydrotreatment in step a) is performed only on LWP. In this specific embodiment, the hydrotreatment a) in mild hydrotreatment conditions is performed solely on a stream containing only LWP and no other streams are directed to the first hydrotreatment step (step a) in claims). The hydrotreatment step a) in this embodiment is a step where only components of the stream of LWP originating from waste plastic are hydrotreated in the mild hydrotreatment conditions.

[0020] In one embodiment of the current invention the hydrotreatment step a) includes a step where a part of the formed stream of hydrotreated LWP from the hydrotreatment step a) is recycled back to the reactor carrying out the hydrotreatment step a). The amount of recycling, if present, depends among others on the hydrotreatment conditions, the hydrotreatment catalyst and reactor design, such as number of reactors, type of catalyst bed and number of catalyst beds in the reactors.

[0021] As a result of the hydrotreatment step a), a stream of first hydrotreated LWP is formed. The formed hydrotreated LWP stream contains lower amounts of impurities, contaminants and harmful components compared to the before hydrotreated LWP feed. With impurities, contaminants and harmful components is herein meant any substance, compound or composition which have detrimental properties to any component, equipment or catalyst downstream of the hydrotreatment. Especially harmful components are compounds containing hetero atoms, metals and metalloids. Especially harmful hetero atoms include halogens such as chlorine. Especially harmful metals include but are not limited to mercury, lead, sodium, arsenic, vanadium, iron, zinc and aluminium. Compounds containing silicon, phosphorous, oxygen, nitrogen and sulphur can also be problematic downstream from the hydrotreatment, if not removed. Furthermore, the conjugated diolefins and olefins are considered agents causing coking or fouling which have to be minimised from the LWP in order for the treated LWP to be used downstream as a feedstock for steam cracking for example.

[0022] The purpose of hydrotreating a stream of liquified waste plastic (LWP) according to the invention is to reduce the risk of harmful and/or detrimental properties of any of the impurities, contaminants and harmful components, which might be present in the LWP. The hydrotreating step reduces the amount of these components and therefore reduces the risks and harms they would otherwise pose on any component, equipment or catalyst downstream of the hydrotreatment. After the hydrotreatment step a) in mild hydrotreatment conditions as specified, the conjugated diolefin content in the LWP is reduced to below 0.2 wt.%.

[0023] The method of the current invention further comprises blending the stream of hydrotreated LWP obtained from mild hydrotreatment step a), with a stream comprising hydrocarbons to form a mixed stream comprising hydrotreated LWP and hydrocarbons. The stream comprising hydrocarbons would have a different impurities profile than the LWP feed being subjected to the hydrotreatment step a), since said hydrocarbons is of any origins other than LWP thus "hydrocarbons" and "hydrocarbons of other origins" are to mean synonymously.

[0024] In one embodiment of the current invention hydrocarbons of other origins in the form of stream is selected from vacuum gas oil (VGO) fraction, gas oil (GO) fraction, heavy gas oil (HGO) fraction, kerosene fraction, light gas oil fraction, atmospheric residue (AR) fraction, vacuum residue (VR) fraction and deasphalted oil (DAO) fraction. The other suitable hydrocarbon streams to be used for blending include a crude oil-derived feedstock comprising at least one crude oil-fraction, or a bio-based fats or oils or fatty acids, or lignocellulosic based hydrocarbons, or Fischer Tropsch or other synthetic hydrocarbons.

[0025] In one embodiment the stream comprising hydrocarbons have one or more of the following properties:

- a boiling point range from 60 °C - 700 °C, most preferably from 100 °C - 600 °C, boiling point can be measured according to ASTM D2887, or EN15199-2 depending on the boiling point range;

- a molecular weight of 250 - 400 g/mol, most preferably 280 - 350 g/mol, as measured according to ASTM D2887;
- aromatics content >10 wt.%, most preferably >35 wt.%, as measured according to ASTM D2549;
- density from 870-940 kg/m³, most preferably 890-920 kg/m³, as measured according to EN ISO 12185;
- a sulphur content of <5 wt.%, preferably <1.8 wt.%;
- bromine number <10 g Br/100g, preferably < 4g Br/100g according to ISO 3839M;
- asphaltenes content of <300 mg/kg, preferably 250 mg/kg according to TOTAL 642; and
- a silicon content of < 2.5 mg/kg, preferably < 1 mg/kg according to ASTM D5185.

[0026] Keeping the mixed stream at an elevated temperature to ensure sufficient mixing of the two streams. Mixing at an elevated temperature also ensures no or minimal precipitation of impurities. The stream of hydrocarbons to be blended with the hydrotreated LWP will typically have a higher temperature compared to the stream of hydrotreated LWP.

[0027] According to one embodiment of the invention the mixed stream of hydrotreated LWP and hydrocarbons contains up to 70 wt.% LWP based on total weight of stream, preferably the content of LWP in said stream is from 5 wt.% to 70 wt.%, more preferably from 10 wt.% to 50 wt.% and even more preferably from 15 wt.% to 30 wt.%.

[0028] According to the current invention the method further comprises

c) hydrotreating said mixed stream of hydrotreated LWP and hydrocarbons in the presence of hydrogen and a catalyst in severe hydrotreatment conditions to provide a refined stream.

[0029] The hydrotreatment step c) is defined by its severe conditions which is carried out at a temperature of 355 °C to 400 °C, preferably 360 °C to 390 °C. In addition, hydrotreatment step c) is referred to as the hydrotreatment step subsequent to hydrotreatment step a) after the hydrotreated stream of step a) has been blended with a stream of hydrocarbons of other origins.

[0030] In one embodiment of the present invention, the catalyst of the hydrotreatment step a) and c) is a supported catalyst, and the catalyst preferably comprises at least one component selected from IUPAC group 6, 8 or 10 of the Periodic Table of Elements. Furthermore, the supported catalyst can contain Mo and at least one further transition metal on a support, such as a supported NiMo catalyst or a supported CoMo catalyst, wherein the support preferably comprises alumina and/or silica. In particular, the catalyst is a supported CoMo catalyst and the support comprises alumina (CoMo/Al₂O₃) and/or the catalyst is a supported NiMo catalyst and the support comprises alumina (NiMo/Al₂O₃).

[0031] The conditions of the hydrotreatment step c) are preferably selected from the following:

- a H₂ to oil ratio is 150 - 400 Nm³/stdm³, preferably 180 - 250 Nm³/stdm³;
- a LHSV of 0.5 - 2.0 h⁻¹, preferably 1.1 - 1.5 h⁻¹;
- a temperature of 355-400 °C, preferably 360-390 °C
- a pressure of 4000-6000 kPa(a), preferably 4800-5500 kPa(a).

[0032] In one embodiment, hydrotreatment steps a) and c) can be carried out respectively in a single reactor unit comprising at least one catalyst bed. In another embodiment, hydrotreatment step a) and c), can be carried out respectively in a reactor system comprising at least two reactor units, wherein each reactor unit contains at least one catalyst bed.

[0033] In one embodiment of the present invention, hydrogen is being mixed with the LWP before carrying out hydrotreatment step a) and/or step c).

[0034] In one embodiment of the invention, the LWP undergoes a pre-treatment step before hydrotreatment step a) and the pre-treatment step comprises reactive extraction, solvent extraction, adsorption, filtration, centrifugation, oxidation, reduction or any combination thereof.

[0035] In one embodiment the method further comprises a step of adding water to said process and/or removal of an aqueous phase from said process after said hydrotreatment step a) and/or after said hydrotreatment c). In one embodiment of the current invention, water is added to the process after any of the hydrotreatment steps in order to remove impurities. The impurities are or become water soluble in the hydrotreatment and can thus be removed by washing the hydrotreated LWP stream with water. The water soluble impurities are dissolved in the water stream and the aqueous phase containing the impurities is then decanted from the hydrotreated LWP stream.

[0036] In one embodiment of the invention, the method further comprises a step of subjecting the refined stream after the hydrotreatment step c), to one or more fractionation step(s) to form two or more product streams. Preferably the fractionated product streams include a naphtha fraction having a 5-95 wt.% boiling point range of 30-200 °C, preferably from about 30 °C to about 180 °C, more preferably from about 30 °C to about 110 °C, and a middle distillate fraction having a 5-95 wt.% having a boiling point from about 150 °C to about 400 °C, preferably from about 160 °C to about 360 °C, and more preferably from about 160 °C to about 330 °C, and a liquefied petroleum gas (LPG) fraction comprising one or more of ethane, propane or butane. The naphtha fraction can further be subjected to steam cracking, and/or the middle distillate can further be subjected to steam cracking, and/or the LPG fraction can further be subjected to steam cracking.

[0037] In one further embodiment of the current invention, hydrotreatment step a) and hydrotreatment step c) are carried out in a reactor system comprising one or more reactors, each reactor having one or more catalyst beds and at least one reactor with a direct hydrogen feed to the reactor. The reactor designated for the hydrotreatment step a) and c) can also be

carried out respectively in separate reactors, each having a plurality of independent catalyst beds and independent reaction temperatures, or any combination thereof.

[0038] In one embodiment of the present invention, it further relates to a LWP product, P1, obtainable by hydrotreating LWP according to hydrotreatment step a) and blending according to step b) and wherein the product comprises

- a reduced amount of silicon to be below 6 mg/kg, more preferably < 1 mg / kg, and/or phosphorous to be below 5 mg/kg, more preferably 1 mg/kg, as measured by ICP-MS/MS,
- a low ratio of diolefin to total olefin content to be below 0.01, more preferably below 0.001, measured by ASTM D8071
- a low ratio of conjugated diolefin to non-conjugated diolefin to be below 2, more preferably below 1, measured by ASTM D8071
- a halogen content to be under 5 mg/kg, preferably 1 mg/kg

[0039] Metals measurement by ICP-MS/MS is performed on a sample that is warmed to liquid if needed prior to weighing. It is digested with acids in the microwave oven to a clear water/acid matrix, diluted to a known amount and analysed against the acid based calibration using ICP-MS/MS. Low elemental results are determined as ppb ($\mu\text{g/kg}$).

[0040] In one embodiment of the invention, the method further comprises a step of subjecting the refined stream after the hydrotreatment step a), and blending step b), i.e., product P1, to one or more fractionation step(s) to form two or more product streams. Preferably the fractionated product streams include a naphtha fraction having a 5-95 wt.% boiling point range of 30-200 °C, preferably from about 30 °C to about 180 °C, more preferably from about 30 °C to about 110 °C, and a middle distillate fraction having a 5-95 wt.% having a boiling point from about 150 °C to about 400 °C, preferably from about 160 °C to about 360 °C, and more preferably from about 160 °C to about 330 °C, and a liquefied petroleum gas (LPG) fraction comprising one or more of ethane, propane or butane. The naphtha fraction can further be subjected to steam cracking, and/or the middle distillate can further be subjected to steam cracking, and/or the LPG fraction can further be subjected to steam cracking.

[0041] It will be obvious to a person skilled in the art that, as the technology advances, the inventive concept can be implemented in various ways. The invention and its embodiments are not limited to the examples described above but may vary within the scope of the claims.

REFERENCES CITED IN THE DESCRIPTION

Cited references

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- [WO2021110395A \[0005\]](#)
- [WO2021204819A \[0006\]](#)
- [FR3107530 \[0006\]](#)
- [WO2021105326A \[0006\]](#)

Patentkrav

1. Fremgangsmåde til behandling af flydendegjort plastaffald (LWP), hvor fremgangsmåden omfatter:

- 5 trin a) hydrobehandling af en strøm af flydendegjort plastaffald (LWP) i nærvær af hydrogen og en katalysator i et første hydrobehandlingstrin under milde hydrobehandlingsbetingelser ved en temperatur fra 170°C til 350°C, for at danne en strøm af hydrobehandlet LWP, i et reaktorsystem, der omfatter mindst en reaktor, der hver indeholder mindst et
- 10 katalysatorleje,
- trin b) blanding af strømmen af hydrobehandlet LWP med en strøm omfattende carbonhydrider for at danne en blandet strøm af hydrobehandlet LWP og carbonhydrider, hvor den blandede strøm omfattende hydrobehandlet LWP og carbonhydrider holdes ved en
- 15 temperatur på 140°C til 350°C, før den udsættes for hydrobehandlingstrin c), og
- trin c) hydrobehandling af den blandede strøm af hydrobehandlet LWP og carbonhydrider i nærvær af hydrogen og en katalysator under strenge hydrobehandlingsbetingelser ved en temperatur på fra 355°C til 400°C for
- 20 at tilvejebringe en raffineret strøm.

2. Fremgangsmåden ifølge krav 1, hvor strømmen af LWP gennemgår et forbehandlingstrin før hydrobehandlingstrin a), og forbehandlingstrinnet omfatter reaktiv ekstraktion, opløsningsmiddelekstraktion, adsorption, filtrering,

25 centrifugering, oxidation, reduktion eller en hvilken som helst kombination deraf.

3. Fremgangsmåden ifølge et hvilket som helst af de foregående krav, hvor strømmen omfattende carbonhydrider er et råolieafledt råmateriale omfattende mindst en råoliefraktion eller et biobaseret fedtstof eller olier eller fedtsyrer, eller

30 lignocellulosebaserede carbonhydrider, eller Fischer Tropsch-carbonhydrider, hvor råoliefraktionen er valgt fra vakuum gasolie- (VGO) fraktion, gasolie- (GO) fraktion, tung gasolie- (HGO) fraktion, petroleumskraftfraktion, let gasoliefraktion, atmosfærisk rest- (AR) fraktion, vakuumrest- (VR) fraktion og fraktion af olie med frasepareret asfalt (DAO).

- 4.** Fremgangsmåden ifølge et hvilket som helst af de foregående krav, hvor den blandede strøm af hydrobehandlet LWP og carbonhydrider indeholder op til 70 vægt-% LWP baseret på den samlede vægt af strømmen, fortrinsvis er indholdet af LWP i strømmen fra 5 vægt-% til 70 vægt-%, mere fortrinsvis fra 10 vægt-% til 50 vægt-% og endnu mere fortrinsvis fra 15 vægt-% til 30 vægt-%.
- 5.** Fremgangsmåden ifølge et hvilket som helst af de foregående krav, hvor katalysatoren i hydrobehandlingstrin a) er en båret katalysator, og katalysatoren fortrinsvis omfatter mindst en komponent valgt fra IUPAC-gruppe 6, 8 eller 10 i det periodiske system af grundstoffer.
- 6.** Fremgangsmåden ifølge krav 5, hvor den bårne katalysator indeholder Mo og mindst et yderligere overgangsmetal på en bærer, såsom en båret NiMo-katalysator eller en båret CoMo-katalysator, hvor bæreren fortrinsvis omfatter aluminiumoxid og/eller silica.
- 7.** Fremgangsmåden ifølge krav 6, hvor katalysatoren er en båret CoMo-katalysator, og bæreren omfatter aluminiumoxid ($\text{CoMo/Al}_2\text{O}_3$), og/eller katalysatoren er en båret NiMo-katalysator, og bæreren omfatter aluminiumoxid ($\text{NiMo/Al}_2\text{O}_3$).
- 8.** Fremgangsmåden ifølge et hvilket som helst af de foregående krav, hvor fremgangsmåden yderligere omfatter et trin med tilsætning af vand til processen og/eller fjernelse af en vandig fase fra processen efter hydrobehandlingstrin a) og/eller efter hydrobehandlingstrin c).
- 9.** Fremgangsmåden ifølge et hvilket som helst af de foregående krav, hvor hydrobehandlingstrin a) gentages før trinnet med blanding af strømmen af hydrobehandlet LWP med en strøm omfattende carbonhydrider til dannelse af en blandet strøm af hydrobehandlet LWP og carbonhydrider.

10. Fremgangsmåden ifølge et hvilket som helst af de foregående krav, hvor strømmen af LWP kun består af LWP, og hydrobehandlingstrin a) kun udføres på LWP.

5 **11.** Fremgangsmåden ifølge et hvilket som helst af de foregående krav, hvor hydrobehandlingstrin a) udføres under følgende betingelser

- et forhold mellem H₂ og olie er 200 - 450 Nm³/stdm³, fortrinsvis 220 - 400 Nm³/stdm³;

- en LHSV på 0,1 - 2,0 timer⁻¹, fortrinsvis 0,2 - 0,5 timer⁻¹;

10 - en temperatur på 170-340°C.

12. Fremgangsmåden ifølge et hvilket som helst af kravene 1 - 11, hvor hydrobehandlingstrin c) udføres under følgende betingelser

- et forhold mellem H₂ og olie er 150 - 400 Nm³/stdm³, fortrinsvis 180 - 250 Nm³/stdm³;

15 - en LHSV på 0,5 - 2,0 timer⁻¹, fortrinsvis 1,0 - 1,5 timer⁻¹;

- en temperatur på 355-400°C, fortrinsvis 360-390°C.

13. Fremgangsmåden ifølge et hvilket som helst af kravene 1-12, hvor
20 fremgangsmåden yderligere omfatter et trin med udsættelse af den raffinerede strøm for et eller flere fraktioneringstrin for at danne to eller flere produktstrømme, fortrinsvis omfatter produktstrømmene en naphtha-fraktion med et 5-95 vægt-% kogepunktsområde på 30-200°C, fortrinsvis fra ca. 30°C til ca. 180°C, mere fortrinsvis fra ca. 30°C til ca. 110°C, og en mellemdestillatfraktion
25 med en 5-95 vægt-% med et kogepunkt fra ca. 150°C til ca. 400°C, fortrinsvis fra ca. 160°C til ca. 360°C, og mere fortrinsvis fra ca. 160°C til ca. 330°C.

14. Fremgangsmåden ifølge krav 13, hvor naphtha-fraktionen yderligere udsættes for dampkrakning, og/eller mellemdestillatet yderligere udsættes for
30 dampkrakning, og/eller LPG-fraktionen yderligere udsættes for dampkrakning.

15. Fremgangsmåden ifølge et hvilket som helst af kravene 1 - 14, hvor hydrobehandlingstrin a) og c) udføres henholdsvis i en enkelt reaktorenhed omfattende mindst et katalysatorleje, eller hydrobehandlingstrin a) og c) udføres
35 henholdsvis i et reaktorsystem omfattende mindst to reaktorenheder, hvor hver

reaktorenhed indeholder mindst et katalysatorleje eller en hvilken som helst kombination deraf.

16. Fremgangsmåden ifølge et hvilket som helst af de foregående krav, hvor den
5 mindst ene reaktor har en direkte hydrogenquench til reaktoren.

17. Fremgangsmåden ifølge et hvilket som helst af kravene 1-16, hvor hydrogen
blandes med strømmen af LWP før udførelse af hydrobehandlingstrin a) og trin c).

10 **18.** Oprensset carbonhydridprodukt, opnået ved hydrobehandling af LWP ifølge
hydrobehandlingstrin a) og blanding ifølge trin b) ifølge krav 1, og hvor produktet
omfatter

- en reduceret mængde silicium som skal være under 6 mg/kg, mere
fortrinsvis < 1 mg/kg, og/eller phosphor som skal være under 5 mg/kg,
15 mere fortrinsvis 1 mg/kg, målt ved ICP-MS/MS,
- et lavt forhold mellem diolefin og totalt olefinindhold som skal være under
0,01, mere fortrinsvis under 0,001, målt ved ASTM D8071
- et lavt forhold mellem konjugeret diolefin og ikke-konjugeret diolefin som
skal være under 2, mere fortrinsvis under 1, målt ved ASTM D8071
- 20 - et halogenindhold som skal være under 5 mg/kg, fortrinsvis 1 mg/kg.

DRAWINGS

Drawing

Figure 1

