[DESCRIPTION]

[TITLE OF THE INVENTION]

# LOW SULFUR MARINE FUELS USING HYDROTREATED RESIDUE

[BACKGROUND OF THE INVENTION]

## 1. Field of the Invention

The present invention relates to a low sulfur marine fuels using a hydrotreated residue, and more specifically, to a low sulfur marine fuels including the hydrotreated residue and other blendstocks.

## 2. Description of the Related Art

Sulfur oxide (SOx) is one of three major atmosphere pollution matters along with nitrogen oxides and particulate matter, and is a causative substance that accounts for about 13% of a total emission amount of sulfur oxides from a ship. In order to reduce the emission of sulfur oxides that cause acid rain, the International Maritime Organization (IMO) would implement a regulation to significantly strengthen an upper limit of sulfur content in marine fuels from 3.5 % by weight ('wt.%') to 0.5 wt.% from January 1, 2020. As a result, ships have to change their fuels from high sulfur fuels to low sulfur fuels. In this process, if viscosity on temperature, pour point, and stability characteristics of marine fuels are changed, it

may affect the fuel supply systems (fuel pump, filter, heater, etc.) of the ship to hinder a safe operation.

Meanwhile, when heating crude oil to 350℃ or higher and separating components by distillation, a heavy fraction with higher boiling point is not separated in the atmospheric distillation column and remains as a residue. An atmospheric residue (AR) from the atmospheric distillation column enters a vacuum distillation column, which is close to 10 mmHg to 40 mmHg of vacuum pressure, such that it is possible to distill some compounds having higher boiling points from AR. A vacuum residue (VR) from a vacuum distillation tower is very inexpensive, however it has high contents of sulfur and transition metals such as nickel, vanadium, etc. A vacuum residue desulfurization (VRDS) facility produces the distillates and the low sulfur straight-run residue by performing a hydro-desulfurization reaction using the vacuum residue (VR) as a raw material.

However, the marine fuels, which is inexpensive, has excellent stability characteristics and satisfies the regulations of the International Maritime Organization, has not yet been introduced.

For example, Korean Patent Laid-Open Publication No. 2014-0080803 discloses a desulfurization method of liquid fuel, but does not provide a design that satisfies the viscosity on temperature, pour point, and stability characteristics of the marine fuelss as described above.

[Prior Art Document]

[Patent Document]

Korean Patent Laid-Open Publication No. 2014-0080803

[SUMMARY OF THE INVENTION]

An object of the present invention is to provide the marine fuels that satisfies the regulations of the International Maritime Organization by processing a high sulfur residue which is inexpensive.

Another object of the present invention is to provide the marine fuels having suitable specific viscosity on temperature, pour point and stability characteristics.

To achieve the above object, according to an aspect of the present invention, there is provided the marine fuels including: a hydrotreated residue in an amount of 70 % by volume or more and less than 100 % by volume; and at least one selected from the group consisting of diesel fuels and the low sulfur straight-run fuel oil in an amount of more than 0 % by volume and 30 % by volume or less, wherein a sulfur content thereof is 0.5% by weight or less.

In some embodiments, the hydrotreated residue may include at least one hydrogenated residue or hydro-desulfurized residue of an atmospheric residue and a vacuum residue.

In some embodiments, the atmospheric residue and the vacuum residue may be mixed in a mixing volume ratio of 25:75

to 99:1.

In some embodiments, the hydrotreated residue may have a sulfur content of 0.5% by weight or less.

In some embodiments, when the hydrotreated residue has a kinematic viscosity of 700 mm2/s (50℃)or more, the hydrotreated residue may be included in an amount of 70 % by volume or more and less than 80 % by volume in the marine fuels oil, and when the hydrotreated residue has a kinematic viscosity of less than 700 mm2/s (50℃), the hydrotreated residue may be included in an amount of 80 % by volume or more and less than 100 % by volume in the marine fuels.

In some embodiments, the hydrotreated residue may have a sulfur content of 0.5% by weight or less.

In some embodiments, when the hydrotreated residue has a kinematic viscosity of 1000 mm2/s (50℃) or more, the low sulfur straight-run residue may be included in an amount of more than 0 % by volume and 5 % by volume or less, when the hydrotreated residue has a kinematic viscosity of 700 mm2/s (50℃) or more and less than 1000 mm2/s (50℃), the low sulfur straight-run residue may be included in an amount of more than 0 % by volume and less than 10 % by volume, and when the hydrotreated residue has a kinematic viscosity less than 700 mm2/s (50℃), the low sulfur straight-run residue may be included in an amount of more than 0% and less than 20 % by volume.

In some embodiments, the blendstock may have a sulfur

content of 0.5% by weight or less.

In some embodiments, the distillates may include heavy cracked naphtha (HCN).

In some embodiments, the hydrotreated residue may be included in an amount of 60 to 80 % by volume, and the distillates may be included in an amount of 5 to 20 % by volume, and the low sulfur straight-run residue may be included in an amount of 10 to 30 % by volume.

In some embodiments, other properties except for the sulfur content may satisfy the residual marine fuel standards defined in ISO 8217.

According to embodiments of the present invention, it is possible to produce the marine fuels using a high sulfur fuel oil which cannot itself satisfy the residual marine fuel standards as a raw material through a hydrotreating step and a mixing step.

The hydrotreating step may perform a hydro-desulfurization process by applying a hydrogenation catalyst to a feed containing the atmospheric residue. Therefore, 0.5 wt.% or less, which is the sulfur content standard of IMO 2020, may be satisfied, and other properties except for the sulfur content may satisfy the residual marine fuels standards defined in ISO 8217.

According to exemplary embodiments of the present invention, it is possible to provide the marine fuels having a

sulfur content of 0.5 wt.% or less by mixing the blendstock with the hydrotreated residue. Therefore, it is possible to provide an economical marine fuels having suitable viscosity on temperature.

[BRIEF DESCRIPTION OF THE DRAWINGS]

The above and other objects, features and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawing, in which:

FIG. 1 is a schematic flowchart for describing a method of producing the marine fuels according to exemplary embodiments.

[DETAILED DESCRIPTION OF THE INVENTION]

Embodiments of the present invention provide the marine fuels including a hydrotreated residue and a blendstock. The term marine fuels as used herein refers to a fuel composition suitable for use in a marine engine.

Hereinafter, embodiments of the present invention will be described in more detail with reference to specific experimental examples and drawing. However, the following descriptions attached to the present specification are intended to illustrate a preferred embodiment of the present invention, and are provided to allow a more clear understanding of the technical

idea of the present invention together with the above-described contents, therefore it should not be interpreted that the present invention is limited only to the matters described in the experimental examples and the drawing.

FIG. 1 is a schematic flowchart for describing a method of producing the marine fuels according to exemplary embodiments.

Referring to FIG. 1, a hydrotreating process of a feed 110 in which an atmospheric residue and a vacuum residue are mixed may be performed in a single stage or in multiple stages within any suitable reactor or a combination of reactors. For example, the hydrotreating process may be performed by introducing the feed into a hydrotreating reactor 100 loaded with a hydrogenation catalyst 120.

In exemplary embodiments, the hydrogenation catalyst 120 may be a suitable catalyst generally known in the art. For example, the hydrogenation catalyst may be a supported catalyst fixed to the hydrotreating reactor 100. The hydrotreating process includes exposing the feed 110 to the supported catalyst under effective hydrotreating conditions.

A hydrotreated residue 130 is obtained from the hydrotreating process as a product, and at least a part thereof may be separated into other products 140. The hydrotreated residue 130 may be introduced into a mixing tank 150 together with a blendstock 160 to be mixed while satisfying a certain mixing ratio. The hydrotreated residue 130 and the blendstock

160 mixed in the mixing tank 150 may be provided as the marine fuels 170 that satisfies suitable viscosities and flow characteristics for a range of temperatures.

**<Hydrogenated residue>**

The hydrotreated residue 130 according to exemplary embodiments may include at least one hydrogenated residue or hydro-desulfurized residue of the atmospheric residue and the vacuum residue. The hydrotreating process may use the feed 110 in which the atmospheric residue and the vacuum residue are mixed.

A type of the atmospheric residue (AR) is not particularly limited, and residues from a distillation column of an atmospheric distillation facility that separates the crude oil at atmospheric pressure may be used. For example, a fraction obtained by removing naphtha, kerosene, and gas oil from the crude oil may be used as the atmospheric residue.

As the vacuum residue (VR), a residue produced from a distillation operation using a vacuum distillation facility (VDU) may be used by decompressing the atmospheric residue to a state close to a vacuum. For example, the fraction from which vacuum gas oil (VGO) is removed from the atmospheric residue may be used as the vacuum residue.

The atmospheric residue and the vacuum residue may be provided as the feed 110 of the hydrotreating process while

satisfying conditions which will be described below. For example, the atmospheric residue and the vacuum residue may be mixed in a mixing volume ratio of 25:75 to 99:1. If the mixing volume ratio of the vacuum residue is 75% or less, the desulfurization reaction using the hydrogenation catalyst 120 may be more efficiently performed. In addition, since the atmospheric residue is priced higher than the vacuum residue, the price of the raw material may be increased as the mixing volume ratio of the atmospheric residue is increased. The mixing volume ratio of the atmospheric residue and the vacuum residue may be 25:75 to 90:10, 25:75 to 80:20, 25:75 to 70:30, 25:75 to 60:40, 25:75 to 50:50, or 25:75 to 40:60.

The atmospheric residue and the vacuum residue may be a high sulfur fuel oil (HSFO). The high sulfur fuel oil as used herein refers to all fuel oils having a sulfur content of 1.0 wt.% or more. For example, the sulfur content of the atmospheric residue and the vacuum residue may be 0.5 wt.% or more. Preferably, the sulfur content thereof is 1.0 wt.% or more, more preferably, 2.0 wt.% or more, more preferably, 3.0 wt.% or more, more preferably, 4.0 wt.% or more, and more preferably, 5.0 wt.% or more. The vacuum residue may have a higher sulfur content than the atmospheric residue.

The atmospheric residue and the vacuum residue may contain nitrogen in an amount of 6000 ppm by weight ('ppmw') or less. For example, the atmospheric residue and the vacuum residue may

contain nitrogen in an amount of 5500 ppmw or less, 5000 ppmw or less, 4500 ppmw or less, 4000 ppmw or less, or 3500 ppmw or less. The vacuum residue may have a higher nitrogen content than the atmospheric residue.

The atmospheric residue and the vacuum residue may contain carbon residue in an amount of 10 wt.% or more. For example, the atmospheric residue and the vacuum residue may contain carbon residue in an amount of 12 wt.% or more, 15 wt.% or more, 18 wt.% or more, 20 wt.% or more, or 22 wt.% or more. The vacuum residue may have a higher carbon residue content than the atmospheric residue.

The atmospheric residue and the vacuum residue may contain a metal component. The metal component may be a component such as vanadium, nickel, iron, sodium, calcium and the like. The content of the metal component may be 350 ppmw or less. Preferably, the content thereof is 300 ppmw or less, more preferably, 250 ppmw or less, more preferably, 200 ppmw or less, and more preferably, 150 ppmw or less. The vacuum residue may have a higher metal content than the atmospheric residue.

The atmospheric residue may have a kinematic viscosity of 50 to 120 mm2/s at 100℃. Preferably, the atmospheric residue has a kinematic viscosity of 60 to 110 mm2/s, more preferably, 70 to 100 mm2/s, and more preferably, 80 to 90 mm2/s.

The vacuum residue may have a kinematic viscosity of 2900 to 3700 mm2/s at 100℃. Preferably, the vacuum residue has a

kinematic viscosity of 3000 to 3600 mm2/s, more preferably, 3100 to 3500 mm2/s, and more preferably, 3200 to 3400 mm2/s.

The feed 110 in which the atmospheric residue and the vacuum residue are mixed may be introduced into the hydrotreating reactor 100 while satisfying physical properties which will be described below. For example, the sulfur content of the feed 110 may be 3.0 to 6.5 wt.%. Preferably, the sulfur content thereof is 3.5 to 6.0 wt.%, and more preferably, 4.0 to 5.5 wt.%.

A nitrogen content of the feed 110 may be 2800 to 4200 ppmw. Preferably, the nitrogen content thereof is 2900 to 4100 ppmw, more preferably, 3000 to 4000 ppmw, more preferably, 3100 to 3900 ppmw, and more preferably, 3200 to 3800 ppmw.

A carbon residue content of the feed 110 may be 5 to 35 wt.%. Preferably, the carbon residue content thereof is 7 to 30 wt.%, more preferably, 10 to 25 wt.%, more preferably, 12 to 21 wt.%, and more preferably, 14 to 19 wt.%.

A vanadium content of the feed 110 may be 60 to 140 ppmw. Preferably, the vanadium content thereof is 65 to 135 ppmw, more preferably, 70 to 130 ppmw, and more preferably, 75 to 126 ppmw.

A nickel content of the feed 110 may be 10 to 55 ppmw. Preferably, the nickel content thereof is 15 to 50 ppmw, more preferably, 20 to 45 ppmw, and more preferably, 25 to 38 ppmw.

An iron content of the feed 110 may be 10 to 35 ppmw. Preferably, the iron content thereof is 15 to 30 ppmw, and more

preferably, 18 to 25 ppmw.

The feed 110 may have a kinematic viscosity of 50 to 1300 mm2/s at 100℃. Preferably, the feed has a kinematic viscosity of 60 to 1250 mm2/s, more preferably, 70 to 1200 mm2/s, more preferably, 80 to 1150 mm2/s, and more preferably, 85 to 1110 mm2/s.

The hydrotreating reactor 100 may perform the hydrotreating process while satisfying process conditions which will be described below.

The hydrotreating process may use a general-purpose hydro-desulfurization process to which the hydrogenation catalyst 120 is applied. The hydrogenation catalyst 120 may include any catalyst composition useful for facilitating hydrogenation of a hydrocarbon feed to increase a hydrogen content thereof, and remove sulfur, nitrogen, oxygen, phosphorus and metal heteroatomic contaminants. For example, one or more Group VIII metals (e.g., selected from Ni, Co and a combination thereof) and one or more Group VIB metals (e.g., selected from Mo, W and a combination thereof), as well as optionally a catalyst including a suitable support and filler (e.g., including alumina, silica, titania, zirconia or a combination thereof).

The hydrotreating process may have an operating temperature condition of 300 to 450℃. Preferably, the hydrotreating process has an operating temperature condition of

320 to 430 ℃, more preferably, 340 to 410℃, and more preferably, 350 to 395℃. If the above temperature condition is not satisfied, a reaction rate of the desulfurization reaction including the hydrogenation catalyst 120 may be decreased or the reaction may not be performed.

The hydrotreating process may have a hydrogen partial pressure condition of 140 to 180 atmospheres. Preferably, the hydrotreating process has a hydrogen partial pressure condition of 150 to 170 atmospheres. If the hydrogen partial pressure condition is not satisfied, a yield of the hydro-desulfurization reaction may be decreased.

The process product of the hydrotreating process may be the hydrotreated residue 130. The hydrotreated residue 130 may include at least one hydrogenated residue or hydro-desulfurized residue of the atmospheric residue and the vacuum residue.

The process product of the hydrotreating process may have a yield of 80 % by volume ('vol.%') or more at 360℃ or higher. Preferably, the process product thereof has a yield of 80 to 90 vol.%, more preferably, 83.5 to 88.8 vol.%, and more preferably, 85 to 87 vol.%. If the yield of the process product is reduced, process costs of the marine fuels 170 including the hydrotreated residue 130 may be increased.

The process product of the hydrotreating process may have a sulfur content of 0.4 to 0.6 wt.%. Preferably, the process product thereof has a sulfur content of 0.45 to 0.55 wt.%, and

more preferably, 0.475 to 0.525 wt.%. In the hydrotreating process, a sulfur content of high sulfur fuel oil which cannot itself satisfy the residual marine fuels standards may be decreased to 0.5 wt.% or less.

The process product of the hydrotreating process may have a kinematic viscosity of 400 to 1400 mm2/s at 50℃. Preferably, the process product thereof has a kinematic viscosity of 500 to 1300 mm2/s, more preferably, 600 to 1200 mm2/s, and more preferably, 700 to 1000 mm2/s. By controlling the kinematic viscosity of the process product, the kinematic viscosity of the marine fuels 170 including the hydrotreated residue 130 may be appropriately adjusted.

**<Blendstock>**

The blendstock 160 according to exemplary embodiments may include at least one selected from the group consisting of distillates and low sulfur straight-run residue. The low sulfur straight-run residue as used herein refers to a fuel oil having a sulfur content of 1.0 wt.% or less.

The type of the distillates is not particularly limited, and a fraction, which has a boiling point in a range of 200 to 370℃ and flows out after kerosene, may be used. For example, heavy cracked naphtha (HCN) produced in a fluidized catalytic cracking (FCC) process may be used as the distillates. The HCN may have a boiling point within a range of 170 to 300℃, and an aromatic component content of 65% or more.

According to exemplary embodiments, the distillates may satisfy the physical properties which will be described below. For example, a density thereof at 15℃ may be 0.80 to 0.98 Kg/$m^3$. In addition, the kinematic viscosity thereof at 50℃ may be 1.0 to 3.0 $mm^2/s$. In addition, the sulfur content thereof may be 0.001 to 0.5 wt.%.

The type of the low sulfur straight-run residue is not particularly limited, and a fuel oil having a sulfur content of 1.0 wt.% or less may be used.

According to exemplary embodiments, the low sulfur straight-run residue may satisfy the physical properties which will be described below. For example, the density thereof at 15℃ may be 0.87 to 0.99 Kg/$m^3$. In addition, the kinematic viscosity thereof at 50℃ may be 80 to 700 $mm^2/s$. In addition, the sulfur content thereof may be 0.1 to 0.5 wt.%.

The blendstock 160 may contain 0 to 30 vol.% of the distillates, and preferably, 5 to 20 vol.%. The blendstock 160 may contain 0 to 30 vol.% of the low sulfur straight-run residue , and preferably, 10 to 25 vol.%.

**<Marine fuels>**

The marine fuels 170 according to exemplary embodiments may include the hydrotreated residue 130 in an amount of 70 vol.% or more and less than 100 vol.%, and the blendstock 160 in an amount of more than 160 vol.% and 30 vol.% or less. When

mixing the hydrotreated residue 130 and the blendstock 160 by introducing them into the mixing tank 150 according to the mixing ratio, the marine fuels may have the improved viscosity characteristics for a range of temperatures.

According to exemplary embodiments, the content of the hydrotreated residue 130 included in the marine fuels 170 may vary according to the kinematic viscosity. For example, when the kinematic viscosity thereof is 700 mm2/s or more, the hydrotreated residue 130 may be included in the marine fuels 170 in a range of 70 vol.% or more and less than 80 vol.%, and when the kinematic viscosity thereof is less than 700 mm2/s, it may be included in the marine fuels 170 in a range of 80 vol.% or more and less than 100 vol.%. When the hydrotreated residue 130 is included in the above range, it is possible to exhibit more excellent kinematic viscosity and stability characteristics over time.

The marine fuels 170 is a colloidal dispersion and may be produced by mixing the distillates with the low sulfur straight-run residue in the hydrotreated residue 130 having low storage stability.

According to exemplary embodiments, when the hydrotreated residue 130 has a kinematic viscosity of 1000 mm2/s or more, the low sulfur straight-run residue may be included in an amount of more than 0 vol.% and 5 vol.% or less, when the kinematic viscosity of the hydrotreated residue 130 is 700 mm2/s

or more and less than 1000 mm2/s, the low sulfur straight-run residue may be included in an amount of more than 0% and 10 vol.% or less, and when the kinematic viscosity of the hydrotreated residue 130 is less than 700 mm2/s, the low sulfur straight-run residue may be included in an amount of more than 0% and 20 vol.% or less. In this case, the distillates may be included as the balance of the blendstock.

According to some exemplary embodiments, when the hydrotreated residue 130 has a kinematic viscosity of 1000 mm2/s or more, the low sulfur straight-run residue may be included in an amount of more than 0 vol.% and 5 vol.% or less, when the hydrotreated residue 130 has a kinematic viscosity of 700 mm2/s or more and less than 1000 mm2/s, the low sulfur straight-run residue may be included in an amount of more than 5% and 10 vol.% or less, and when the hydrotreated residue 130 has a kinematic viscosity of less than 700 mm2/s, the low sulfur straight-run residue may be included in an amount of more than 10% and 20 vol.% or less. In this case, the distillates may be included as the balance of the blendstock.

The marine fuels 170 may exhibit excellent kinematic viscosity and stability characteristics over time by mixing the hydrotreated residue 130, the distillates and the low sulfur fuel according to the above mixing ratio. Therefore, it is possible to improve driving efficiency and life characteristics of the marine engine.

The marine fuels 170 may have a sulfur content of 0.5 wt.% or less by mixing the blendstock 160 with the hydrotreated residue 130.

The marine fuels 170 may satisfy the marine fuel standards of ISO 8217 for other properties except for the sulfur content.

Hereinafter, a method of producing the marine fuels according to embodiments of the present invention will be described in detail with reference to specific experimental examples. Examples and comparative examples included in the experimental examples are merely illustrative of the present invention, and do not limit the scope of the appended claims. Therefore, it will be apparent to those skilled in the art that various alterations and modifications of the embodiments are possible within the scope and technical idea of the present invention and duly included within the range as defined by the appended claims.

**Experimental Example 1: Preparation of marine fuels**

A hydro-desulfurization process was performed by introducing atmospheric residue and vacuum residue (atmospheric residue:vacuum residue = 25:75 (in volume ratio)) discharged from atmospheric and vacuum distillation processes at a feed rate of 270.1 t/h and applying a hydrogenation catalyst thereto, while satisfying conditions of a hydrogen partial pressure of 2250 psi, and an operating temperature of 371 to 395℃. Then, 223.26 t/h of hydrotreated residue was obtained as a process

product, and the hydrotreated residue included 93.4 t/h of desulfurized vacuum gas oil (DSVGO) and 129.86 t/h of desulfurized vacuum residue (DSVR). The hydrotreated residues were mixed with the blendstocks in ratios listed in Table 1 below. The blendstock includes the distillates and a low sulfur straight-run residue. The distillates has a density of 0.922 $Kg/m^3$ (15℃), a flash point of 77℃, a kinematic viscosity of 1.863 $mm^2/s$ (50℃), a pour point of -50℃, and a sulfur content of 0.18 wt.%. In addition, the low sulfur straight-run residue has a density of 0.955 $Kg/m^3$ (15℃), a flash point of 104℃, a kinematic viscosity of 345.3 $mm^2/s$ (50℃), a pour point of 36℃, CCR of 7.74 wt.%, and a sulfur content of 0.18 wt.%.

Contents of the hydrotreated residue, the distillates and the low sulfur straight-run residue are listed in Table 1 below in volume %.

**Experimental Example 2: Evaluation of physical properties of examples and comparative examples**

**<Measurement of pour point>**

Pour points of the marine fuels compositions prepared according to Examples 1 to 8 and Comparative Examples 1 to 4 were measured. Specifically, about 20 ml of a sample was cooled and observed at 3℃ intervals to measure a maximum temperature at which there is a flow. The evaluation results thereof are shown in Table 1 below.

[Table 1]

| Classification | Hydrotreated residue (vol.%) | Distillates (vol.%) | Low sulfur straight-run residue (vol.%) | Pour point (℃) |
|---|---|---|---|---|
| Example 1 | 90 | 5 | 5 | 12 |
| Example 2 | 90 | 0 | 10 | 15 |
| Example 3 | 80 | 10 | 10 | 18 |
| Example 4 | 80 | 5 | 15 | 18 |
| Example 5 | 80 | 15 | 5 | 18 |
| Example 6 | 70 | 15 | 15 | 21 |
| Example 7 | 70 | 10 | 20 | 21 |
| Example 8 | 70 | 5 | 25 | 21 |
| Comparative Example 1 | 60 | 20 | 20 | 27 |
| Comparative Example 2 | 50 | 20 | 30 | 30 |
| Comparative Example 3 | 50 | 30 | 20 | 27 |
| Comparative Example 4 | 40 | 30 | 30 | 30 |

Referring to Table 1, in the case of examples in which the mixing volume ratio of the hydrotreated residue is 70 vol.% or more, a pour point of about 21℃ or less was exhibited. Therefore, in ships operating in low temperature regions or seasons, it is possible to prevent substances in the marine fuels from being precipitated/separated, and a separate device or mixture of the substances for using the marine fuels having a high pour point may be excluded. On the other hand, the case of the comparative examples, the pour point is increased as the content of the hydrotreated residue is decreased, and in storage and use of a fuel oil having a high pour point, defects in the fuel tank and engine, etc. of the ship may occur.

[Description of Reference Numerals]

100: Hydrotreating reactor

110: Feed

120: Hydrogenation catalyst

130: Hydrotreated residue

140: Other products

150: Mixing tank

160: Blendstock

170: Marine fuels

WHAT IS CLAIMED IS:

1. The marine fuels comprising:

a hydrotreated residue in an amount of 70 % by volume or more and below 100 % by volume; and

at least one blendstock selected from the group consisting of distillates and a low sulfur straight-run residue in an amount of above 0 % by volume and 30 % by volume or less, wherein a sulfur content of the marine fuel oil is 0.5% by weight or less,

wherein the hydrotreated residue includes at least one hydrogenated residue or hydro-desulfurized residue of an atmospheric residue and a vacuum residue,

wherein the atmospheric residue and the vacuum residue are mixed in a mixing volume ratio of 25:75 to 99:1.

4. The marine fuels according to claim 1, wherein the hydrotreated residue has a sulfur content of 0.5% by weight or less.

5. The marine fuels according to claim 1, wherein when the hydrotreated residue has a kinematic viscosity of 700 $mm^2/s$ (50℃) or more, the hydrotreated residue is included in an amount of 70 % by volume or more and below 80 % by volume in the marine fuels, and when the hydrotreated residue has a kinematic viscosity of below 700 $mm^2/s$ (50℃), the hydrotreated residue is included in an amount of 80 % by volume or more and below 100 % by volume in the marine fuels.

6. The marine fuels according to claim 1, wherein when the hydrotreated residue has a kinematic viscosity of 1000 $mm^2/s$ (50℃)or more, the low sulfur straight-run residue is included in an amount of above 0 % by volume and 5 % by volume or less, when the hydrotreated residue has a kinematic viscosity of 700 $mm^2/s$ (50℃)or more and below 1000 $mm^2/s$ (50℃), the low sulfur straight-run residue is included in an amount of above 0 % by volume and less than 10 % by volume, and when the hydrotreated residue has a kinematic viscosity less than 700 $mm^2/s$ (50℃), the low sulfur straight-run residue is included in an amount of above 0% and below 20 % by volume.

7. The marine fuels according to claim 1, wherein the blendstock has a sulfur content of 0.5% by weight or less.

8. The marine fuels according to claim 1, wherein the distillates includes heavy cracked naphtha (HCN).

9. The marine fuels according to claim 1, wherein the hydrotreated residue is included in an amount of 60 to 80 % by volume, and the distillates is included in an amount of 5 to 20 % by volume, and the low sulfur straight-run residue is included in an amount of 10 to 30 % by volume.

10. The marine fuels according to claim 1, wherein other properties except for the sulfur content satisfy the residual marine

fuels standards defined in ISO 8217 2017.