

【DESCRIPTION】**【Invention Title】****FUEL SUPPLY SYSTEM AND METHOD FOR SHIP****【Technical Field】**

[1] The present invention relates to a fuel supply system for ships, which uses an incompressible fluid as fuel for an engine, and a fuel supply method using the same.

【Background Art】

[2] In general, petroleum gas is transported to a distant destination by an LNG carrier after being transformed into liquefied petroleum gas (LPG) through liquefaction at extremely low temperatures at a production site.

[3] Conventionally, fuel oil, such as heavy fuel oil (HFO) or marine diesel oil (MDO), has been used as fuel for an engine of LPG carriers. As cargo of an LPG carrier, LPG is typically stored in a storage tank. Here, boil-off gas (BOG) generated in the storage tank is reliquefied in a reliquefaction plant and then delivered to and stored in the storage tank.

[4] As such, in typical LPG carriers, fuel and cargo are handled or treated by separate systems, without means such as an engine fueled by LPG stored as cargo in a storage tank.

[5] Recently, there is increasing interest in a method of supplying LPG stored as cargo in a storage tank as fuel for an engine.

【Disclosure】

【Technical Problem】

[6] Embodiments of the present invention provide a fuel supply system for ships, which can supply an incompressible fluid as fuel for an engine while preventing generation of a large amount of flash gas due to return of surplus liquefied gas from the engine to a storage tank, and a fuel supply method using the same.

【Technical Solution】

[7] In accordance with one aspect of the present invention, a fuel supply system for ships includes: a pump (10) compressing liquefied gas discharged from a storage tank (T) to a pressure required for an engine (E); a heat exchanger (20) heating the liquefied gas compressed by the pump (10) to a temperature required for the engine (E) through heat exchange; and a buffer tank (50) temporarily storing the liquefied gas discharged from the storage tank (T) and having passed through the pump (10) and the heat exchanger (20) before supplying the liquefied gas to the engine (E), wherein a gas is supplied to the buffer tank (50) via a gas supply line (F3) to maintain and adjust pressure in the buffer tank (50), and as much liquefied gas as required for the engine (E) is supplied from the buffer tank (50) to the engine (E).

[8] When a liquefied gas level in the buffer tank (50) increases, the liquefied gas may be returned from the buffer tank (50) to the storage tank (T).

[9] A gas inside the buffer tank (50) may be sent to the storage tank (T) via a vent line (F5).

[10] The gas inside the buffer tank (50) may be sent to a vent master via the vent line (F5).

[11] The fuel supply system may further include: a level sensor (L) measuring the liquefied gas level in the buffer tank (50); and a third valve (V3) disposed in the return line (F4), the third valve (V3) regulating the flow rate of the liquefied gas discharged from the buffer tank (50) based on a liquefied gas level measured by the level sensor (L).

[12] The third valve (V3) may be maintained in a closed state during normal operation and may be switched to an open state when the liquefied gas level measured by the level sensor (L) is a second predetermined value or more.

[13] The fuel supply system may further include a third pressure sensor (P3) measuring a pressure inside the buffer tank (50).

[14] The fuel supply system may further include a fifth valve (V5) disposed in the gas supply line (F3), the fifth valve (V5) regulating the flow rate of a fluid based on the pressure measured by the third pressure sensor (P3).

[15] The fuel supply system may further include a fourth valve (V4) disposed in the vent line (F5), the fourth valve (V5) regulating the flow rate of a fluid based on the pressure measured by the third pressure sensor (P3).

[16] The fuel supply system may further include a first filter (31) filtering out impurities from the liquefied gas to be supplied to the engine (E).

[17] The first filter (31) may be disposed between the heat exchanger (20) and the buffer tank (50).

[18] In accordance with another aspect of the present invention, a fuel supply method for ships includes compressing and heating liquefied gas, storing a compressed and heated liquefied gas temporarily in a buffer tank 50, and supplying the compressed and heated liquefied gas as much as required for an engine (E) from the buffer tank (50) to the engine (E), wherein when a liquefied gas level in the buffer tank (50) increases, the liquefied gas is returned to a storage tank (T) from the buffer tank (50).

[19] A gas inside the buffer tank (50) may be sent to the storage tank (T).

[20] The gas inside the buffer tank 50 may be sent to a vent master.

【Advantageous Effects】

[21] According to embodiments of the present invention, even when an incompressible liquid fluid is used as fuel for an engine, stable fuel supply to the engine can be ensured.

[22] According to embodiments of the present invention, since generation of a

large amount of flash gas can be prevented with the help of a buffer tank disposed upstream of an engine, it is possible to eliminate the need to provide an additional device or control system for treating a large amount of flash gas and the need to scale up the volume of a storage tank to accommodate the flash gas.

【Description of Drawings】

[23] FIG. 1 is a schematic diagram of a fuel supply system for ships according to a first exemplary embodiment of the present invention.

FIG. 2 is a schematic diagram of a fuel supply system for ships according to a second exemplary embodiment of the present invention.

FIG. 3 is a schematic diagram of a fuel supply system for ships according to a third exemplary embodiment of the present invention.

【Best Mode】

[24] Hereinafter, embodiments of the present invention will be described in detail with reference to the accompanying drawings. It should be understood that the present invention may be embodied in different ways and is not limited to the following embodiments.

[25]

[26] FIG. 1 is a schematic diagram of a fuel supply system for ships according to a first exemplary embodiment of the present invention. Referring to FIG. 1, the fuel supply system for ships according to this embodiment includes a pump 10, a heat exchanger 20, a first pressure sensor P1, a first valve V1, a second pressure sensor P2, and a second valve V2.

[27] A storage tank T stores liquefied gas, and liquefied gas discharged from the storage tank T is supplied as fuel to an engine E. The engine E may be a dual-fuel (DF) engine that is fueled by liquefied petroleum gas (LPG) and diesel oil.

[28] The pump 10 compresses the liquefied gas discharged from the storage tank T to a pressure required for the engine E and the heat exchanger 20 heats the

liquefied gas compressed by the pump 10 to a temperature required for the engine E through heat exchange.

[29] The first pressure sensor P1 is disposed in a fuel supply line F1 delivering the liquefied gas heated by the heat exchanger 20 to the engine E to measure pressure inside the fuel supply line F1, and the first valve V1 is disposed in the fuel supply line F1 to regulate the flow rate of liquefied gas based on a pressure value measured by the first pressure sensor P1.

[30] When the fuel requirement of the engine E decreases due to decrease in load of the engine E, the pressure inside the fuel supply line F1 increases due to decrease in liquefied gas consumption by the engine E. Accordingly, the first pressure sensor P1 transmits an increased pressure value of the fuel supply line F1 to the first valve V1. Upon receiving the increased pressure value of the fuel supply line F1 from the first pressure sensor P1, the first valve V1 reduces the flow rate of liquefied gas through reduction in degree of opening thereof.

[31] When the fuel requirement of the engine E increases due to increase in load of the engine E, the pressure inside the fuel supply line F1 decreases due to increase in liquefied gas consumption by the engine E. Accordingly, the first pressure sensor P1 transmits a decreased pressure value of the fuel supply line F1 to the first valve V1. Upon receiving the decreased pressure value of the fuel supply line F1 from the first pressure sensor P1, the first valve V1 increases the flow rate of liquefied gas through increase in degree of opening thereof.

[32] A first filter 31 is disposed upstream of the engine E to filter out impurities from liquefied gas to be supplied to the engine E. Preferably, the first filter 31 is disposed between the heat exchanger 20 and the first valve V1.

[33] Among the liquefied gas supplied to engine E, remaining surplus liquefied gas (not consumed by the engine E) is sent back to the storage tank T. According to this embodiment, after an excess of liquefied gas is supplied as fuel to the engine E, liquefied gas remaining after consumption of the engine E is discharged from the engine E and then returned to the storage tank T.

[34] When a compressible gaseous fluid is used as fuel for the engine E, the fuel supply line F1 may be filled with the fluid to a pressure slightly higher than the

pressure required for the engine E such that fuel (that is, the compressible fluid) compressed to some degree can be present in the fuel supply line F1. As a result, even when the engine E suddenly needs a large amount of fuel, the fuel can be immediately supplied to the engine, thereby allowing stable fuel supply regardless of sudden change in load of the engine E.

[35] However, when an incompressible liquid fluid is used as fuel for the engine E, the above method of filling the fuel supply line F1 with the fluid to a pressure slightly higher than the pressure required for the engine E cannot be used since the incompressible liquid fluid undergoes insignificant volume change upon application of pressure to the fluid.

[36] If the fuel requirement of the engine E fails to be met when the engine E suddenly needs a large amount of fuel, the engine E can suffer from cavitation.

[37] Thus, the inventors of the present invention concluded that it is better to supply more fuel than the amount of fuel required for the engine than to cause a situation in which the engine E is short of fuel.

[38] According to this embodiment, a sufficient amount of liquefied gas to accommodate change in load of the engine E, rather than only as much liquefied gas as required for the engine E, is supplied to the engine E, and liquefied gas remaining after use in the engine E is discharged from the engine E.

[39] Thus, according to the present invention, even when an incompressible liquid fluid is used as fuel for the engine, stable fuel supply to the engine can be ensured.

[40] According to this embodiment, the fuel supply system may supply liquefied gas to the engine E in an amount of 100% to 120% of the fuel requirement of the engine E. Preferably, the fuel supply system supplies liquefied gas to the engine E in an amount of 110% of the fuel requirement of the engine E.

[41] The second pressure sensor P2 is disposed in a fuel discharge line F2 delivering surplus liquefied gas discharged from the engine E to the storage tank T to measure pressure inside the fuel discharge line F2, and the second valve V2 is disposed in the fuel discharge line F2 to regulate the flow rate of liquefied gas such that a pressure value measured by the second pressure sensor P2 is less than or equal

to a first predetermined value. That is, the surplus liquefied gas having been compressed to a high pressure required for the engine E is reduced in pressure by the second valve V2 while being returned to the storage tank T.

[42] A second filter 32 may be disposed downstream of the engine E to filter out impurities from the remaining liquefied gas discharged from the engine E. Preferably, the second filter 32 is disposed between the second valve V2 and the storage tank T.

[43] A first knockout drum 41 may be disposed between the engine E and the second valve V2 and a second knockout drum 42 may be disposed between the second valve V2 and the storage tank T.

[44] A knockout drum (K.O. Drum) serves as a buffer that discharges only a gaseous fuel fraction therefrom and allows the other fuel fraction to be stored therein or to be returned to the storage tank T in an emergency in which fuel needs to be discharged from the fuel supply system.

[45] Gases discharged from the first knockout drum 41 and the second knockout drum 42 may be sent to a vent master.

[46] Flash gas generated upon reducing the pressure of the surplus liquefied gas discharged from the engine E by the second valve V2 may be sent to a reliquefaction system to be reliquefied.

[47]

[48] FIG. 2 is a schematic diagram of a fuel supply system for ships according to a second exemplary embodiment of the present invention.

[49] Referring to FIG. 2, the fuel supply system for ships according to this embodiment includes a pump 10 compressing liquefied gas discharged from a storage tank T to a pressure required for an engine E and a heat exchanger 20 heating the liquefied gas compressed by the pump 10 to a temperature required for the engine E, wherein the liquefied gas heated by the heat exchanger 20 is supplied to the engine E, as in the first embodiment. In addition, a first filter 31 may be disposed upstream of the engine E to filter out impurities from the liquefied gas to be supplied to the engine E, as in the first embodiment.

[50] However, the fuel supply system according to this embodiment differs from

the fuel supply system according to the first embodiment in that the fuel supply system according to this embodiment further includes a buffer tank 50 and does not include the first pressure sensor P1 and the first valve V1.

[51] The buffer tank 50 temporarily stores the liquefied gas discharged from the storage tank T and having passed through the pump 10 and the heat exchanger 20 before supplying the liquefied gas to the engine E. In this embodiment, only as much liquefied gas as required for the engine E is supplied from the buffer tank 50 to the engine E and, when the liquefied gas level in the buffer tank 50 increases due to continuous decrease in load of the engine E, the liquefied gas is returned from the buffer tank 50 to the storage tank T via a return line F4, unlike in the first embodiment in which a sufficient amount of liquefied gas to accommodate change in load of the engine E and liquefied gas remaining after use in the engine E is discharged from the engine E.

[52] A level sensor L may be provided to the buffer tank 50 to measure the liquefied gas level in the buffer tank 50, and a third valve V3 controlling the flow rate of a fluid may be disposed in the return line F4 returning surplus liquefied gas not consumed by the engine E to the storage tank T from the buffer tank 50.

[53] The third valve V3 may regulate the flow rate of the liquefied gas discharged from the buffer tank 50 based on a value of the liquefied gas level in the buffer tank 50 measured by the level sensor L. The third valve V3 may be maintained in a closed state during normal operation and may be switched to an open state to send the liquefied gas to the storage tank T from the buffer tank 50 when the value of the liquefied gas level in the buffer tank 50 measured by the level sensor L is a second predetermined value or more.

[54] A gas such as nitrogen (N_2) is supplied to the buffer tank 50 to maintain and adjust the pressure inside the buffer tank 50. Since liquefied gas to be supplied as fuel can be adjusted to a pressure required for the engine E through maintenance and adjustment of the pressure inside the buffer tank 50, there is no need to regulate the pressure of liquefied gas to be delivered to the engine E using the first pressure sensor P1 and the first valve V1, as in the first embodiment. Accordingly, in this embodiment, the first pressure sensor P1 and the first valve V1 may be omitted,

unlike in the first embodiment.

[55] A third pressure sensor P3 may be provided to the buffer tank 50 to measure the pressure inside the buffer tank 50, a fourth valve V4 regulating the flow rate of a fluid and controlling the opening/closing of line may be disposed in a vent line F5 discharging gases inside the buffer tank 50 (including the gas (such as nitrogen) supplied to maintain and adjust the pressure inside the buffer tank 50, boil-off gas, and flash gas), and a fifth valve V5 regulating the flow rate of a fluid may be disposed in a gas supply line F3 delivering the gas such as nitrogen to the buffer tank 50.

[56] The fourth valve V4 and the fifth valve V5 may regulate the flow rate of a fluid based on the pressure value inside the buffer tank 50 measured by the third pressure sensor P3 such that the pressure inside the buffer tank 50 can be maintained within a predetermined range. That is, through regulation of opening/closing or the degree of opening of the fourth valve V4, the gases inside the buffer tank 50 may be sent to the storage tank T via the vent line F5 and, through regulation of opening/closing or the degree of opening of the fifth valve V5, the gas (such as nitrogen) may be supplied to the buffer tank 50. During normal operation, the fifth valve V5 may be adjusted in degree of opening thereof while being maintained in an open position.

[57] When the fuel supply system for ships according to this embodiment includes a first filter 31, the first filter 31 is preferably disposed between the heat exchanger 20 and the buffer tank 50.

[58] According to the first embodiment, as the remaining surplus liquefied gas having been compressed to a high pressure required for the engine E is returned to the storage tank T, a large amount of flash gas is generated in the storage tank T due to sharp pressure drop of the surplus liquefied gas to an internal pressure of the storage tank T. Generation of a large amount of flash gas requires scaling up the volume of the storage tank T, the knockout drums 41, 42, the vent master, and the like to a level capable of accommodating the flash gas, as well as requiring an additional device or control system for treating the flash gas.

[59] According to this embodiment, since only as much liquefied gas as required

for the engine E is supplied from the buffer tank 50, liquefied gas compressed to the pressure required for the engine E will not be sent to the storage tank T, thereby preventing generation of a large amount of flash gas in the storage tank T.

[60] Accordingly, according to this embodiment, it is possible to eliminate the need to provide an additional device or control system for treating a large amount of flash gas and the need to scale up the volume of the storage tank T to accommodate the flash gas.

[61]

[62] FIG. 3 is a schematic diagram of a fuel supply system for ships according to a third exemplary embodiment of the present invention.

[63] Referring to FIG. 3, the fuel supply system for ships according to this embodiment is substantially the same as the fuel supply system for ships according to the second embodiment of FIG. 2 except that gases discharged from the buffer tank 50 are sent to a vent master, rather than to the storage tank T via the vent line F5.

[64] According to this embodiment, since the gases discharged from the buffer tank 50 are not sent to the storage tank T, it is possible to scale down the volume of the storage tank T more than according to the second embodiment.

[65]

[66] Although some embodiments have been described herein, it should be understood that these embodiments are provided for illustration only and are not to be construed in any way as limiting the invention, and that various modifications, changes, alterations, and equivalent embodiments can be made by those skilled in the art without departing from the spirit and scope of the invention.

【CLAIMS】**【Claim 1】**

A fuel supply system for ships, comprising:

a pump (10) compressing liquefied gas discharged from a storage tank (T) to a pressure required for an engine (E);

a heat exchanger (20) heating the liquefied gas compressed by the pump (10) to a temperature required for the engine (E) through heat exchange; and

a buffer tank (50) temporarily storing the liquefied gas discharged from the storage tank (T) and having passed through the pump (10) and the heat exchanger (20) before supplying the liquefied gas to the engine (E),

wherein a gas is supplied to the buffer tank (50) via a gas supply line (F3) to maintain and adjust pressure inside the buffer tank (50) and as much liquefied gas as required for the engine (E) is supplied from the buffer tank (50) to the engine (E).

【Claim 2】

The fuel supply system according to claim 1, further comprising:

a return line (F4) along which the liquefied gas is returned from the buffer tank (50) to the storage tank (T) when a liquefied gas level in the buffer tank (50) increases.

【Claim 3】

The fuel supply system according to claim 2, further comprising:

a vent line (F5) delivering a gas inside the buffer tank (50) to the storage tank (T).

【Claim 4】

The fuel supply system according to claim 2, further comprising:

a vent line (F5) delivering a gas inside the buffer tank (50) to a vent master.

【Claim 5】

The fuel supply system according to any one of claims 2 to 4, further comprising:

a level sensor (L) measuring the liquefied gas level in the buffer tank (50);
and

a third valve (V3) disposed in the return line (F4), the third valve (V3) regulating a flow rate of the liquefied gas discharged from the buffer tank (50) based on the liquefied gas level measured by the level sensor (L).

【Claim 6】

The fuel supply system according to claim 5, wherein the third valve V3 is maintained in a closed state during normal operation and is switched to an open state when the liquefied gas level measured by the level sensor (L) is a second predetermined value or more.

【Claim 7】

The fuel supply system according to any one of claims 1 to 4, further comprising:

a third pressure sensor (P3) measuring a pressure inside the buffer tank (50).

【Claim 8】

The fuel supply system according to claim 7, further comprising:

a fifth valve (V5) disposed in the gas supply line (F3), the fifth valve (V5) regulating a flow rate of a fluid based on the pressure measured by the third pressure sensor (P3).

【Claim 9】

The fuel supply system according to claim 7, further comprising:
a fourth valve (V4) disposed in the vent line (F5), the fourth valve (V5) regulating a flow rate of a fluid based on the pressure measured by the third pressure sensor (P3).

【Claim 10】

The fuel supply system according to any one of claims 1 to 4, further comprising:
a first filter (31) filtering out impurities from the liquefied gas to be supplied to the engine (E).

【Claim 11】

The fuel supply system according to claim 10, wherein the first filter (31) is disposed between the heat exchanger (20) and the buffer tank (50).

【Claim 12】

A fuel supply method for ships, comprising:
compressing and heating liquefied gas,
storing a compressed and heated liquefied gas temporarily in a buffer tank 50, and
supplying the compressed and heated liquefied gas as much as required for an engine (E) from the buffer tank (50) to the engine (E),
wherein when a liquefied gas level in the buffer tank (50) increases, the liquefied gas is returned to a storage tank (T) from the buffer tank (50).

【Claim 13】

The fuel supply method according to claim 12, wherein a gas inside the

buffer tank (50) is sent to the storage tank (T).

【Claim 14】

The fuel supply method according to claim 12, wherein a gas inside the buffer tank 50 is sent to a vent master.