

DESCRIPTION

Title of Invention: FUEL SUPPLY SYSTEM AND SHIP

Technical Field

[0001] The present disclosure relates to a fuel supply system for an internal combustion engine and a ship including the fuel supply system.

Background Art

[0002] Conventionally, fuel supply systems for internal combustion engines such as reciprocating engines and gas turbine engines to be installed on, for example, ships have been known. For example, Patent Literature 1 discloses a fuel supply system for a diesel engine. The fuel supply system forcibly vaporizes liquefied gas, and supplies the vaporized gas to the diesel engine as fuel.

[0003] Specifically, in the fuel supply system of Patent Literature 1, the liquefied gas is led out of a tank through a fuel supply line. A pump and a vaporizer are located on the fuel supply line. The pump increases the pressure of the liquefied gas such that the vaporized gas has a pressure higher than the required pressure of the diesel engine, and the vaporizer is located downstream of the pump. Further, in the fuel supply system of Patent Literature 1, a reflux flow line is branched off from the fuel supply line at a position between the pump and the vaporizer, and connects to the tank. A flow control valve is located on the reflux flow line.

Citation List

Patent Literature

[0004] PTL 1: Japanese Laid-Open Patent Application Publication No. 2016-049881

Summary of Invention

Technical Problem

[0005] Patent Literature 1 describes that the liquefied gas may be liquefied hydrogen. In a case where the liquefied gas is liquefied hydrogen, when the pressure of the liquefied hydrogen is increased by the pump to a pressure higher than the required pressure of the diesel engine, the pressure of the liquefied hydrogen becomes higher than or equal to the critical pressure. Also in a case where the fuel is supplied to an internal combustion engine that is not a diesel engine, when the pressure of the liquefied hydrogen is increased by the pump to a pressure higher than the required pressure of the internal combustion engine, the pressure of the liquefied hydrogen becomes higher than or equal to the critical pressure.

[0006] From the pump, the liquefied hydrogen having a temperature lower than the critical temperature, or supercritical hydrogen having a temperature higher than or equal to the critical temperature, is delivered. In both of these cases, the vaporizer serves as a heater. Particularly in a case where the liquefied hydrogen having a temperature lower than the critical temperature is delivered from the pump, the liquefied hydrogen transitions into supercritical hydrogen due to the heating by the vaporizer.

[0007] In a case where the amount of supercritical hydrogen used per unit time in the internal combustion engine is less than the delivery flow rate of the pump, it is desirable to return the excess liquefied hydrogen having a pressure higher than or equal to the critical pressure, or the excess supercritical hydrogen, to the tank through the reflux flow line. In this case, the flow control valve located on the reflux flow line serves as a pressure reducing valve.

[0008] When the liquefied hydrogen having a pressure higher than or equal to the critical pressure, or the supercritical hydrogen, is reduced in pressure in order to return the hydrogen to the tank, part of or most of the pressure-reduced hydrogen transitions into hydrogen gas. Therefore, it is desirable to condense the hydrogen gas generated by the pressure reduction into liquefied hydrogen, and return the liquefied hydrogen resulting from the condensation to the tank. Moreover, when the liquefied hydrogen resulting from the condensation is returned to the tank, it is desirable for the amount of boil off gas generated in the tank to not increase.

[0009] In view of the above, an object of the present disclosure is to provide a fuel supply system that makes it possible, after reducing the pressure of the excess liquefied hydrogen having a pressure higher than or equal to the critical pressure, or reducing the pressure of the excess supercritical hydrogen, to return it in a state of liquefied hydrogen to the tank, without causing an increase in the amount of boil off gas generated in the tank. Another object of the present disclosure is to provide a ship including the fuel supply system.

Solution to Problem

[0010] One aspect of the present disclosure provides a fuel supply system for supplying supercritical hydrogen to an internal combustion engine as fuel, the fuel supply system including: a tank that stores liquefied hydrogen; a fuel supply line through which the liquefied hydrogen is led out of the tank; a first pump that is located on the fuel supply line; a second pump that is located on the fuel supply line at a position downstream of the first pump and that increases a pressure of the liquefied hydrogen such that the liquefied hydrogen has a pressure higher than or equal to a critical pressure; a reflux flow line that is branched off from the fuel supply line at a position downstream of the second pump and connects to the tank and on which

a pressure reducing valve is located; a gas-liquid separator that is located on the reflux flow line at a position downstream of the pressure reducing valve; and an agitator that agitates the liquefied hydrogen extracted from the fuel supply line at a position between the first pump and the second pump and having a temperature lower than a saturation temperature corresponding to a pressure of a gaseous layer in the tank, and hydrogen gas flowing out of the gas-liquid separator, to condense the hydrogen gas into liquefied hydrogen. The liquefied hydrogen resulting from condensing the hydrogen gas by the agitator is returned into the tank.

[0011] Another aspect of the present disclosure provides a ship including the above-described fuel supply system.

Advantageous Effects of Invention

[0012] The present disclosure provides a fuel supply system that makes it possible, after reducing the pressure of excess liquefied hydrogen having a pressure higher than or equal to the critical pressure, or reducing the pressure of excess supercritical hydrogen, to return it in a state of liquefied hydrogen to the tank, without causing an increase in the amount of boil off gas generated in the tank. The present disclosure also provides a ship including the fuel supply system.

Brief Description of Drawings

[0013] FIG. 1 shows a schematic configuration of a re-liquefier according to one embodiment.

FIG. 2 shows a schematic configuration of the re-liquefier according to a variation.

FIG. 3 shows a schematic configuration of the re-liquefier according to another variation.

Description of Embodiments

[0014] FIG. 1 shows a fuel supply system 1A according to one embodiment. The fuel supply system 1A supplies supercritical hydrogen to an internal combustion engine as fuel. For example, the fuel supply system 1A may be installed on a ship, or may be incorporated in land-based power generating equipment. The internal combustion engine is, for example, a reciprocating engine or a gas turbine engine. The reciprocating engine may be an Otto cycle engine, a diesel cycle engine, or a Sabathe cycle engine.

[0015] Specifically, the fuel supply system 1A includes: a tank 2, which stores liquefied hydrogen; and a fuel supply line 3, through which the liquefied hydrogen is led out of the tank 2.

[0016] In the present embodiment, the tank 2 is a double-shell tank including an inner shell 21 and an outer shell 22. There is a vacuum layer between the inner shell 21 and the outer shell 22. Alternatively, the tank 2 may be a single-shell tank covered with a thermal insulator. In the present embodiment, the tank 2 is a horizontal cylindrical tank. Alternatively, the tank 2 may be a vertical cylindrical tank. Further alternatively, the tank 2 may be a spherical tank, or may be a substantially rectangular parallelepiped tank.

[0017] In the tank 2, boil off gas (BOG) is generated as a result of evaporation of the liquefied hydrogen. That is, in the tank 2, the liquefied hydrogen forms a liquid layer, and the boil off gas forms a gaseous layer.

[0018] Before the liquefied hydrogen is fed into the tank 2, the liquefied hydrogen is cooled sufficiently. Accordingly, after the liquefied hydrogen is fed into the tank 2, for a while during which the liquid level of the liquefied hydrogen is kept high, for example, for several weeks, there is a temperature stratification in the liquefied hydrogen in the tank 2. The upper layer of the liquefied hydrogen is, near the liquid level, maintained in an equilibrium state at the saturation temperature corresponding to the pressure of the gaseous layer in the tank 2, whereas in the lower layer of the liquefied hydrogen, it is possible to maintain the temperature of the liquefied hydrogen at or below the saturation temperature corresponding to the pressure of the gaseous layer in the tank 2. For example, the pressure of the gaseous layer in the tank 2 is the atmospheric pressure or higher, and the temperature of the liquefied hydrogen in the tank 2 is 20 K or higher.

[0019] A first pump 4, a second pump 5, and a heater 6 are sequentially located on the fuel supply line 3 in this order from the upstream side. In the present embodiment, the first pump 4 is located on the fuel supply line 3 at a position downstream of the upstream end of the fuel supply line 3. Further, in the present embodiment, the first pump 4 and the second pump 5 are located outside the tank 2, and the first pump 4 is located inside a vacuum-insulated pod 11. The vacuum-insulated pod 11 includes an inner wall and an outer wall, and there is a vacuum layer between the inner and outer walls.

[0020] The inner shell 21 of the tank 2 and the first pump 4 are connected by a lead-out passage 31. The lead-out passage 31 forms an upstream portion of the fuel supply line 3. The interior of the vacuum-insulated pod 11 is filled with liquefied hydrogen or hydrogen gas. A portion of the lead-out passage 31, the portion being positioned inside the outer shell 22 of the tank 2, is configured as a single pipe. A portion of the lead-out passage 31, the portion being positioned between the outer shell 22 and the inner wall or outer wall of the vacuum-insulated pod 11, is configured as a vacuum-insulated double pipe. A portion of the lead-out passage 31,

the portion being positioned inside the inner wall or outer wall of the vacuum-insulated pod 11, is configured as a single pipe.

[0021] Alternatively, the inner shell 21 of the tank 2 and the vacuum-insulated pod 11 may be connected by the lead-out passage 31; the interior of the vacuum-insulated pod 11 may be filled with the liquefied hydrogen that is led out of the inner shell 21 of the tank 2 through the lead-out passage 31; and the first pump 4 may suck the liquefied hydrogen from the interior of the vacuum-insulated pod 11. In this case, the lead-out passage 31 and the interior of the vacuum-insulated pod 11 form the upstream portion of the fuel supply line 3.

[0022] The first pump 4 sucks the liquefied hydrogen stored in the tank 2 through the lead-out passage 31. The first pump 4 and the second pump 5 are connected by a first delivery passage 32, and the second pump 5 and the heater 6 are connected by a second delivery passage 33. A supply passage 34 extends from the heater 6. A shutoff valve is located on the supply passage 34. The shutoff valve switches whether or not to supply the fuel to the internal combustion engine.

[0023] A portion of the first delivery passage 32, the portion being positioned inside the inner wall or outer wall of the vacuum-insulated pod 11, is configured as a single pipe. A portion of the first delivery passage 32, the portion being positioned outside the inner wall or outer wall of the vacuum-insulated pod 11, is configured as a vacuum-insulated double pipe. The second delivery passage 33 may be configured either as a single pipe or as a vacuum-insulated double pipe. The supply passage 34 is configured as a single pipe. Alternatively, in a case where the fuel supply system 1A is installed on a ship, a portion of the supply passage 34, the portion being positioned inside the engine room, may be configured as a double pipe.

[0024] The first pump 4 feeds the liquefied hydrogen from the tank 2 to the second pump 5. For example, at the outlet of the first pump 4, the pressure of the liquefied hydrogen is from 0.3 MPaG to 1.0 MPaG.

[0025] The second pump 5 increases the pressure of the liquefied hydrogen to a pressure higher than the required pressure of the internal combustion engine, such that the liquefied hydrogen has a pressure higher than or equal to the critical pressure. If the outlet temperature of the second pump 5 is lower than the critical temperature, the liquefied hydrogen having a pressure higher than or equal to the critical pressure is delivered from the second pump 5, whereas if the outlet temperature of the second pump 5 is higher than or equal to the critical temperature, supercritical hydrogen is delivered from the second pump 5. For example, in a case where the internal combustion engine is a diesel cycle reciprocating engine, at the outlet of the second pump 5, the pressure of the liquefied hydrogen having a pressure higher than or equal

to the critical pressure, or the pressure of the supercritical hydrogen, is from 25 MPaG to 35 MPaG.

[0026] The heater 6 heats the liquefied hydrogen having a pressure higher than or equal to the critical pressure or the supercritical hydrogen to a temperature higher than the required temperature of the internal combustion engine. For example, in a case where the internal combustion engine is a diesel cycle reciprocating engine, the temperature of the supercritical hydrogen at the outlet of the heater 6 is from 273K to 333K.

[0027] The fuel supply system 1A further includes a reflux flow line 8, which is branched off from the fuel supply line 3 at a position downstream of the second pump 5 and upstream of the heater 6 and which connects to the tank 2. A downstream portion of the reflux flow line 8 penetrates the tank 2 from the outside to the inside. In the illustrated example, the downstream end of the reflux flow line 8 is open near the bottom of the inner shell 21 of the tank 2.

Alternatively, the downstream end of the reflux flow line 8 may be configured such that the liquefied hydrogen is sprayable from the downstream end of the reflux flow line 8 within the gaseous layer in the tank 2. A portion of the reflux flow line 8, the portion being positioned outside the outer shell 22 of the tank 2, is configured as a vacuum-insulated double pipe, whereas a portion of the reflux flow line 8, the portion being positioned inside the outer shell 22, is configured as a single pipe.

[0028] A pressure reducing valve 81 and a gas-liquid separator 82 are sequentially located on the reflux flow line 8 in this order from the upstream side. The liquefied hydrogen having a pressure higher than or equal to the critical pressure, or the supercritical hydrogen, is reduced in pressure by the pressure reducing valve 81, and consequently transitions into 100% hydrogen gas or a gas-liquid two-phase flow. In a case where the liquefied hydrogen having a pressure higher than or equal to the critical pressure, or the supercritical hydrogen, transitions into a gas-liquid two-phase flow as a result of the pressure reduction, the hydrogen gas and the liquefied hydrogen are separated by the gas-liquid separator 82, and then flow out of the gas-liquid separator 82. The liquefied hydrogen separated by the gas-liquid separator 82 is returned to the tank 2 through the reflux flow line 8.

[0029] The fuel supply system 1A further includes an agitator 7, which condenses the hydrogen gas flowing out of the gas-liquid separator 82. In the present embodiment, the agitator 7 is located inside a vacuum-insulated pod 12. The vacuum-insulated pod 12 includes an inner wall and an outer wall, and there is a vacuum layer between the inner and outer walls. For example, the interior of the vacuum-insulated pod 12 is filled with liquefied hydrogen or hydrogen gas. The interior of the vacuum-insulated pod 12 may be kept under vacuum, in

which case, the inner wall of the vacuum-insulated pod 12 may be eliminated. Instead of locating the agitator 7 inside the vacuum-insulated pod 12, the surface of the agitator 7 may be covered with a vacuum insulation structure.

[0030] The agitator 7 is connected to the gas-liquid separator 82 by a gas feed line 71. The agitator 7 is also connected to the first delivery passage 32 of the fuel supply line 3 by an extraction line 72, and is connected to the tank 2 by a return line 74. A downstream portion of the return line 74 penetrates the tank 2 from the outside to the inside. In the illustrated example, the downstream end of the return line 74 is open near the bottom of the inner shell 21 of the tank 2. Alternatively, the downstream end of the return line 74 may be configured such that the liquefied hydrogen is sprayable from the downstream end of the return line 74 within the gaseous layer in the tank 2.

[0031] The agitator 7 agitates the liquefied hydrogen that is extracted from the fuel supply line 3 through the extraction line 72 and the hydrogen gas that flows out of the gas-liquid separator 82 through the gas feed line 71 to condense the hydrogen gas.

[0032] A portion of the gas feed line 71, the portion being positioned outside the inner wall or outer wall of the vacuum-insulated pod 12, is configured as a vacuum-insulated double pipe, whereas a portion of the gas feed line 71, the portion being positioned inside the inner wall or outer wall of the vacuum-insulated pod 12, is configured as a single pipe. A portion of the extraction line 72, the portion being positioned outside the inner wall or outer wall of the vacuum-insulated pod 12, is configured as a vacuum-insulated double pipe, whereas a portion of the extraction line 72, the portion being positioned inside the inner wall or outer wall of the vacuum-insulated pod 12, is configured as a single pipe. A portion of the return line 74, the portion being positioned inside the inner wall or outer wall of the vacuum-insulated pod 12, and a portion of the return line 74, the portion being positioned inside the outer shell 22, are each configured as a single pipe. A portion of the return line 74, the portion being positioned between the inner wall or outer wall of the vacuum-insulated pod 12 and the outer shell 22, is configured as a vacuum-insulated double pipe.

[0033] A flow control valve 73 is located on the extraction line 72. The flow control valve 73, the first pump 4, the second pump 5, and the pressure reducing valve 81 are controlled by control circuitry 9. In FIG. 1, the illustration of part of signal lines is omitted for the purpose of simplifying the drawing.

[0034] Regarding the control circuitry 9, the functionality of the elements disclosed herein may be implemented using circuitry or processing circuitry which includes general purpose processors, special purpose processors, integrated circuits, ASICs ("Application Specific

Integrated Circuits”), conventional circuitry and/or combinations thereof which are configured or programmed to perform the disclosed functionality. Processors are considered processing circuitry or circuitry as they include transistors and other circuitry therein. In the disclosure, the circuitry, units, or means are hardware that carry out or are programmed to perform the recited functionality. The hardware may be any hardware disclosed herein or otherwise known which is programmed or configured to carry out the recited functionality. When the hardware is a processor which may be considered a type of circuitry, the circuitry, means, or units are a combination of hardware and software, the software being used to configure the hardware and/or processor.

[0035] The control circuitry 9 is electrically connected to a pressure meter 91 and a pressure meter 92. The pressure meter 91 is located on the first delivery passage 32 of the fuel supply line 3, and the pressure meter 92 is located on the second delivery passage 33 of the fuel supply line 3. The pressure meter 91 detects a pressure P1 of the liquefied hydrogen delivered from the first pump 4. The pressure meter 92 detects a pressure P2 of the liquefied hydrogen having a pressure higher than or equal to the critical pressure, or of the supercritical hydrogen, delivered from the second pump 5. Alternatively, the pressure meter 92 may be located on the supply passage 34 of the fuel supply line 3 to detect the pressure of the supercritical hydrogen flowing out of the heater 6.

[0036] The control circuitry 9 controls the rotation speed of the first pump 4 within a predetermined range such the pressure P1 detected by the pressure meter 91 is a predetermined value or higher. The control circuitry 9 also controls the flow control valve 73 to adjust its opening degree to a predetermined opening degree or greater, thereby preventing the delivery flow rate of the first pump 4 from falling to the minimum flow rate or below. By adjusting the opening degree of the flow control valve 73 to the predetermined opening degree or greater, part of the liquefied hydrogen that has been led out of the tank 2 through the fuel supply line 3 and that has a temperature lower than the saturation temperature corresponding to the pressure of the gaseous layer in the tank 2 is extracted from the fuel supply line 3 through the extraction line 72 and supplied to the agitator 7. The liquefied hydrogen that has been supplied to the agitator 7 is, after passing through the agitator 7, returned to the tank 2 through the return line 74. That is, the extraction line 72, the agitator 7, the vacuum-insulated pod 12, and the return line 74 are cooled by the liquefied hydrogen that circulates through a portion of the fuel supply line 3, the extraction line 72, the agitator 7, and the return line 74.

[0037] The control circuitry 9 controls the rotation speed of the second pump 5 and the opening degree of the pressure reducing valve 81 based on the pressure P2 detected by the

pressure meter 92. To be more specific, in a case where the pressure P2 detected by the pressure meter 92 is less than a threshold α , the control circuitry 9 fully closes the pressure reducing valve 81. As a result, most of the liquefied hydrogen that has been led out of the tank 2 through the fuel supply line 3 and that has a temperature lower than the saturation temperature corresponding to the pressure of the gaseous layer in the tank 2 is supplied to the internal combustion engine as supercritical hydrogen.

[0038] On the other hand, in a case where the pressure P2 detected by the pressure meter 92 is greater than the threshold α , the control circuitry 9 opens the pressure reducing valve 81 such that its opening degree corresponds to a deviation ΔP between the pressure P2 and the threshold α . As a result, an excess amount of the liquefied hydrogen having a pressure higher than or equal to the critical pressure, or an excess amount of the supercritical hydrogen, delivered from the second pump 5 is reduced in pressure by the pressure reducing valve 81 and then flows into the gas-liquid separator 82. Also, the hydrogen gas flowing out of the gas-liquid separator 82 is supplied to the agitator 7, and the agitator 7 agitates the hydrogen gas and the liquefied hydrogen extracted from the fuel supply line 3 to condense the hydrogen gas into liquefied hydrogen. The liquefied hydrogen resulting from condensing the hydrogen gas by the agitator 7 is returned into the tank 2 through the return line 74.

[0039] As described above, in the fuel supply system 1A of the present embodiment, by utilizing the cold energy of the liquefied hydrogen that has a temperature lower than the saturation temperature corresponding to the pressure of the gaseous layer in the tank 2, the hydrogen gas that is generated as a result of the excess liquefied hydrogen having a pressure higher than or equal to the critical pressure, or the excess supercritical hydrogen, being reduced in pressure by the pressure reducing valve 81 is condensed into liquefied hydrogen. Accordingly, after the liquefied hydrogen resulting from the condensation is returned to the tank 2, re-vaporization of the returned liquefied hydrogen is suppressed. This makes it possible, after reducing the pressure of the excess liquefied hydrogen having a pressure higher than or equal to the critical pressure, or reducing the pressure of the excess supercritical hydrogen, to return it in a state of liquefied hydrogen to the tank 2, without causing an increase in the amount of boil off gas in the tank 2.

[0040] Further, in the present embodiment, since the first pump 4, the second pump 5, and the agitator 7 are located outside the tank 2, maintenance can be readily performed on the first pump 4, the second pump 5, and the agitator 7.

[0041] <Variations>

The present disclosure is not limited to the above-described embodiment. Various

modifications can be made without departing from the scope of the present disclosure.

[0042] For example, as in a fuel supply system 1B according to a variation shown in FIG. 2, the agitator 7 may be located inside the tank 2, and the first pump 4 and the second pump 5 may be located outside the tank 2. According to this configuration, the fuel supply system 1B can be reduced in size. In a case where the agitator 7 is located inside the tank 2, the vacuum-insulated pod 12 and the return line 74 can be eliminated.

[0043] As in a fuel supply system 1C according to another variation shown in FIG. 3, the first pump 4 and the agitator 7 may be located inside the tank 2, and the second pump 5 may be located outside the tank 2. In the present variation, the first pump 4 is located on the fuel supply line 3 at the upstream end of the fuel supply line 3. According to this configuration, the fuel supply system 1C can be significantly reduced in size. Further, in the present variation, the vacuum-insulated pod 11 can be eliminated.

[0044] <Summary>

One aspect of the present disclosure provides, as a first mode, a fuel supply system for supplying supercritical hydrogen to an internal combustion engine as fuel, the fuel supply system including: a tank that stores liquefied hydrogen; a fuel supply line through which the liquefied hydrogen is led out of the tank; a first pump that is located on the fuel supply line; a second pump that is located on the fuel supply line at a position downstream of the first pump and that increases a pressure of the liquefied hydrogen such that the liquefied hydrogen has a pressure higher than or equal to a critical pressure; a reflux flow line that is branched off from the fuel supply line at a position downstream of the second pump and connects to the tank and on which a pressure reducing valve is located; a gas-liquid separator that is located on the reflux flow line at a position downstream of the pressure reducing valve; and an agitator that agitates the liquefied hydrogen extracted from the fuel supply line at a position between the first pump and the second pump and having a temperature lower than a saturation temperature corresponding to a pressure of a gaseous layer in the tank, and hydrogen gas flowing out of the gas-liquid separator, to condense the hydrogen gas into liquefied hydrogen. The liquefied hydrogen resulting from condensing the hydrogen gas by the agitator is returned into the tank.

[0045] According to the above configuration, by utilizing the cold energy of the liquefied hydrogen that has a temperature lower than the saturation temperature corresponding to the pressure of the gaseous layer in the tank, the hydrogen gas that is generated as a result of the excess liquefied hydrogen having a pressure higher than or equal to the critical pressure, or the excess supercritical hydrogen, being reduced in pressure by the pressure reducing valve is condensed into liquefied hydrogen. Accordingly, after the liquefied hydrogen resulting from

the condensation is returned to the tank, re-vaporization of the returned liquefied hydrogen is suppressed. This makes it possible, after reducing the pressure of the excess liquefied hydrogen having a pressure higher than or equal to the critical pressure, or reducing the pressure of the excess supercritical hydrogen, to return it in a state of liquefied hydrogen to the tank, without causing an increase in the amount of boil off gas in the tank.

[0046] As a second mode, in the first mode, the first pump, the second pump, and the agitator may be located outside the tank. According to this configuration, maintenance can be readily performed on the first pump, the second pump, and the agitator.

[0047] As a third mode, in the first mode, the agitator may be located inside the tank, and the first pump and the second pump may be located outside the tank. According to this configuration, the fuel supply system can be reduced in size.

[0048] As a fourth mode, in the first mode, the agitator and the first pump may be located inside the tank, and the second pump may be located outside the tank. According to this configuration, the fuel supply system can be significantly reduced in size.

[0049] Another aspect of the present disclosure provides, as a fifth mode, a ship including the fuel supply system according to the first to fourth modes.

CLAIMS

[Claim 1] A fuel supply system for supplying supercritical hydrogen to an internal combustion engine as fuel, the fuel supply system comprising:

- a tank that stores liquefied hydrogen;

- a fuel supply line through which the liquefied hydrogen is led out of the tank;

- a first pump that is located on the fuel supply line;

- a second pump that is located on the fuel supply line at a position downstream of the first pump and that increases a pressure of the liquefied hydrogen such that the liquefied hydrogen has a pressure higher than or equal to a critical pressure;

- a reflux flow line that is branched off from the fuel supply line at a position downstream of the second pump and connects to the tank and on which a pressure reducing valve is located;

- a gas-liquid separator that is located on the reflux flow line at a position downstream of the pressure reducing valve; and

- an agitator that agitates the liquefied hydrogen extracted from the fuel supply line at a position between the first pump and the second pump and having a temperature lower than a saturation temperature corresponding to a pressure of a gaseous layer in the tank, and hydrogen gas flowing out of the gas-liquid separator, to condense the hydrogen gas into liquefied hydrogen, wherein

- the liquefied hydrogen resulting from condensing the hydrogen gas by the agitator is returned into the tank.

[Claim 2] The fuel supply system according to claim 1, wherein

- the first pump, the second pump, and the agitator are located outside the tank.

[Claim 3] The fuel supply system according to claim 1, wherein

- the agitator is located inside the tank, and the first pump and the second pump are located outside the tank.

[Claim 4] The fuel supply system according to claim 1, wherein

- the agitator and the first pump are located inside the tank, and the second pump is located outside the tank.

[Claim 5] A ship comprising the fuel supply system according to any one of claims 1 to 4.