【DESCRIPTION】

【Invention Title】

SYSTEM AND METHOD FOR SUPPLYING FUEL GAS FOR SHIP

【Technical Field】

[1] The present invention relates to a system and method for supplying fuel gas to an engine of a ship using heat quantity of cooling water for the engine.

【Background Art】

[2] Liquefied natural gas (LNG) is a colorless and transparent liquid obtained by liquefying natural gas mainly composed of methane to about -163°C to liquefy the natural gas and has a volume of about 1/600 that of natural gas. Thus, liquefaction of natural gas enables very efficient transportation. In general, liquefied natural gas obtained through liquefaction of natural gas is stored in a storage tank and transported by a ship.

[3] Examples of a marine engine capable of being fueled by natural gas include gas fuel engines, such as a DFDE engine, an ME-GI engine, and an X-DF engine. The DFDE engine is used for power generation and has four strokes per cycle. The DFDE engine is operated by an Otto cycle in which natural gas having a relatively low pressure of about 6.5 bar is injected into a combustion chamber, followed by pushing a piston to compress the gas. The ME-GI engine is used for propulsion and has two strokes per cycle. The ME-GI engine is operated by a diesel cycle in which natural gas having a high pressure of about 300 bar is injected directly into a combustion chamber near the top dead point of a piston. The X-DF engine is used for propulsion and has two strokes per cycle. The X-DF engine is operated by the Otto cycle using natural gas having a pressure of about 16 bar as fuel.

[4] In order to supply fuel to the engine using natural gas as the fuel, liquefied natural gas stored in the storage tank is often vaporized to be supplied to the engine and heat source is required for vaporization of the liquefied natural gas. A technology using engine jacket water as heat source for vaporization of the liquefied natural gas has been developed in the art.

【Disclosure】

【Technical Problem】

[5] Generally, after cooling an engine, cooling water is regulated to have a constant temperature. For example, after cooling an ME-GI engine, the cooling water may be controlled to have a temperature of about 85°C.

[6] However, since a higher engine load generates a larger quantity of heat, the cooling water is required to cool the larger quantity of heat, and since a lower engine load generates a smaller quantity of heat, the cooling water is required to cool the smaller quantity of heat. In addition, since the engine is not cooled below a predetermined temperature to prevent low temperature corrosion of the engine, decrease in engine load results in decrease in quantity of heat obtained from the cooling water.

[7] Embodiments of the present invention provide a method for suitable distribution of heat of cooling water varied depending upon engine load and efficient arrangement of equipment for suitable distribution of the heat of the cooling water.

【Technical Solution】

[8] In accordance with one aspect of the present invention, a system for supplying fuel gas for a ship includes: a vaporizer vaporizing liquefied natural gas to supply the liquefied natural gas to an engine; a first heater heating a fluid used as a heating medium in the vaporizer through heat exchange between cooling water discharged from the engine after cooling the engine and the heating medium; and a fresh water generator generating fresh water by heating sea water with some or the entirety of a heat source of the cooling water having passed through the first heater after being discharged from the engine, wherein the vaporizer vaporizes the liquefied natural gas by heat exchanging between the heating medium heated by the first heater and the liquefied natural gas.

[9] The system may further include an expansion tank absorbing volume change caused by expansion or shrinkage of the cooling water.

[10] The engine may be disposed in an engine room and the expansion tank may

be disposed at a distance of 20 m to 25 m above the engine room.

[11] The first heater may be disposed at a higher location than the expansion tank.

[12] The system may further include a second heater heating the cooling water discharged from the fresh water generator to be supplied to the engine.

[13] The cooling water discharged from the engine may be divided into two flows such that some of the cooling water is supplied to the first heater and the remaining cooling water bypasses the first heater, and the system may further include a first three-way valve disposed where the cooling water having bypassed the first heater merges with the cooling water having passed through the first heater.

[14] The first three-way valves may be disposed at a lower location than the expansion tank.

[15] The system may further include a cooler cooling the cooling water having passed through the first heater and the fresh water generator after being discharged from the engine.

[16] The system may further include a third temperature regulation sensor disposed on a line along which the cooling water discharged from the cooler is supplied to the engine and regulating temperature of the cooling water, wherein a preset value of the third temperature regulation sensor decreases with increasing load of the engine.

[17] The heat source obtained by the cooling water while cooling the engine may be primarily used by the first heater and secondarily used by the fresh water generator, and the heat remaining after being used by the fresh water generator may be cooled by the cooler.

[18] The system may further include a storage tank storing the remaining cooling water not sent to the first heater among the cooling water used to cool the engine.

[19] The system may further include a first compression unit disposed on a line along which the cooling water discharged from the storage tank is supplied to the expansion tank, wherein the first compression unit is operated when a liquid level of the storage tank reaches a predetermined value or more or when a liquid level of the expansion tank reaches a predetermined value or less.

[20] The system may further include a second compression unit compressing the

cooling water discharged from the fresh water generator to supply the compressed cooling water to the engine.

[21] The system may further include a first valve preventing the cooling water supplied from the engine to the first heater from flowing backward when the second compression unit is stopped.

[22] The vaporizer, the first heater, the fresh water generator, and the second compression unit may be connected to one another in series to allow the cooling water to be circulated only by the second compression unit.

[23] The system may further include a third compression unit disposed on a line along which the cooling water discharged from the engine is supplied to the first heater.

[24] The fresh water generator may have a load represented by Equation: $B = (y-x)A/z$, where A indicates a load of the engine, x indicates the maximum quantity of heat transferred to the fluid used as the heating medium in the vaporizer, B indicates a load of the fresh water generator, y indicates the maximum quantity of heat obtained by the cooling water while cooling the engine, and z indicates quantity of heat required when the load of the fresh water generator is 100%.

[25] The system may further include at least one of a first temperature regulation sensor disposed on a line along which the cooling water discharged from the engine is supplied to the first heater to maintain the cooling water at a constant temperature and a second temperature regulation sensor disposed on a line along which the cooling water discharged from the fresh water generator is supplied to the engine to regulate the temperature of the cooling water, wherein a preset value of the second temperature regulation sensor decreases with increasing load of the engine.

[26] The system may further include an air separator disposed on a line along which the cooling water discharged from the engine and having passed through the first heater is supplied to the fresh water generator to remove air from the cooling water.

[27] The system may further include an air discharge tank discharging air from the cooling water sent from the fresh water generator to the engine.

[28] A part or the entirety of a pipe through which cooling water flows may be subjected to heat insulation treatment.

[29] In accordance with another aspect of the present invention, a method for supplying fuel gas for a ship includes: 1) heating, by a first heater, a heating medium through heat exchange between cooling water discharged from an engine after cooling the engine and the heating medium; 2) vaporizing liquefied natural gas through heat exchange between the heating medium heated by heat exchange in Step 1) and the liquefied natural gas; 3) supplying natural gas vaporized in Step 2) to the engine; and 4) generating, by a fresh water generator, fresh water by heating sea water using some or the entirety of a heat source obtained by the cooling water used for heat exchange of the heating medium in Step 1).

[30] The method may further include 5) heating the cooling water used in the fresh water generator in Step 4).

[31] In Step 5), when the engine is not operated, the cooling water may be heated to a temperature or more at which low temperature corrosion of the engine can be prevented.

[32] In Step 5), when it is judged that the temperature of the cooling water is decreased below a temperature at which low temperature corrosion of the engine can be prevented upon 100% operation of the fresh water generator in Step 4), the cooling water may be heated to a temperature or more at which low temperature corrosion of the engine can be prevented, after 100% operation of the fresh water generator.

[33] The method may further include 5) compressing, by a second compression unit, the cooling water discharged from the fresh water generator to supply the compressed cooling water to the engine.

[34] The cooling water discharged from the engine may be divided into two flows such that some of the cooling water is supplied to the first heater and the remaining cooling water bypasses the first heater, and a first three-way valve may be disposed where the cooling water having bypassed the first heater merges with the cooling water having passed through the first heater.

[35] When the second compression unit is stopped, a valve portion of the first three-way valve directed toward the first heater may be closed and remaining valve portions thereof may be kept in an open state.

[36] An algorithm may be constituted to allow the valve portion of the first three-

way valve directed toward the first heater to be automatically closed by a control board when the second compression unit is stopped.

[37] In accordance with a further aspect of the present invention, there is provided an arrangement method, wherein an engine is disposed in an engine room, an expansion tank adapted to buffer volume change due to expansion or shrinkage of cooling water is disposed at a distance of 20 m to 25 m above the engine room, a first heater heating a heating medium for vaporization of liquefied natural gas is disposed at a higher location than the expansion tank, and a first three-way valve is disposed where the cooling water having bypassed the first heater merges with the cooling water having passed through the first heater to be disposed at a lower location than the expansion tank.

[38] In accordance with yet another aspect of the present invention, there is provided a method of distributing quantity of heat obtained by cooling water to a vaporizer and a fresh water generator while cooling an engine in accordance with Equation: $B = (y-x)A/z$, where A indicates a load of the engine, x indicates the maximum quantity of heat transferred to a fluid used as a heating medium in the vaporizer, B indicates a load of the fresh water generator, y indicates the maximum quantity of heat obtained by the cooling water while cooling the engine, and z indicates quantity of heat required when the load of the fresh water generator is 100%.

【Advantageous Effects】

[39] According to embodiments of the invention, the quantity of heat obtained by cooling water while cooling an engine can be suitably distributed to a vaporizer and a fresh water generator through regulation of load of the fresh water generator in accordance with an equation representing a relationship between the load of the engine and the load of the fresh water generator.

[40] According to embodiments of the invention, the system includes the first heater and the vaporizer, thereby reducing capacity of a cooler and energy for operation of the cooler.

[41] According to embodiments of the invention, surplus cooling water is stored in a storage tank before reuse thereof, thereby minimizing consumption of the cooling

water to be subjected to chemical treatment.

[42] According to embodiments of the invention, devices disposed along a cooling water circulation line are connected to each other in series, whereby the cooling water can be circulated only by pressure of a second compression unit without installation of an additional compression means.

[43] According to embodiments of the invention, even when an engine has low load, the cooling water can be heated by a second heater after 100% operation of the fresh water generator, thereby enabling more efficient operation of the system.

[44] According to embodiments of the invention, the system and method can prepare for the structure wherein the first heater is disposed above the expansion tank, particularly when the second compression unit is stopped.

[45] According to embodiments of the invention, the system and method can efficiently control each device through a control board and can automatically prepare for, particularly, when the second compression unit breaks down.

【Description of Drawings】

[46] FIG. 1 is a schematic diagram of a system for supplying fuel gas for a ship in accordance with a first embodiment of the present invention.

[47] FIG. 2 is a schematic diagram of a system for supplying fuel gas for a ship in accordance with a second embodiment of the present invention.

【Best Mode】

[48] Hereinafter, exemplary embodiments of the present invention will be described in detail with reference to the accompanying drawings. It should be understood that the following embodiments may be modified in various ways and do not limit the scope of the present invention.

[49] FIG. 1 is a schematic diagram of a system for supplying fuel gas for a ship in accordance with a first embodiment of the present invention.

[50] Referring to FIG. 1, the fuel gas supply system according to this embodiment includes a first heater 110, a vaporizer 180, and a fresh water generator 120.

[51] Examples of an engine E to which fuel is supplied by the fuel gas supply

system according to this embodiment may include an ME-GI engine, an X-DF engine, a DF engine, and the like, which use natural gas as fuel, and the fuel gas supply system according to this embodiment may be applied to other combustion devices, such as a gas turbine and the like, which uses natural gas as fuel. Here, the fuel gas supply system according to this embodiment is preferably applied to an ME-GI engine used as a main propulsion engine. According to this embodiment, the engine E is disposed in an engine room.

[52] According to this embodiment, the first heater 110 exchanges heat between cooling water (line L10) discharged from the engine E after cooling the engine E and a fluid (line L3) used as a heating medium in the vaporizer 180. That is, the first heater 110 supplies some of heat, which is obtained by the cooling water while cooling the engine E, to the fluid (line L3) used as the heating medium in the vaporizer 180 to heat the fluid (line L3) used as the heating medium in the vaporizer 180.

[53] On the line L10 along which the cooling water is supplied from the engine E to the first heater 110, a first temperature regulation sensor 210 may be disposed to regulate the temperature of the cooling water discharged from the engine E to be supplied to the first heater 110. According to this embodiment, the first temperature regulation sensor 210 may regulate the temperature of the cooling water discharged from the engine E to about 85°C.

[54] According to this embodiment, since the temperature of the cooling water discharged from the engine E is regulated to about 85°C and the quantity of heat generated from the engine E increases with increasing load of the engine E, the temperature of the cooling water supplied to the engine E varies depending upon load of the engine E. That is, in order to prevent low temperature corrosion of the engine E, the temperature of the cooling water supplied to the engine E is increased with decreasing load of the engine E.

[55] According to this embodiment, the vaporizer 180 vaporizes liquefied natural gas through heat exchange between the heating medium (line L4) heated by the first heater 110 and the liquefied natural gas. That is, the vaporizer 180 uses some of the heat, which is obtained by the cooling water while cooling the engine E, to vaporize the liquefied natural gas via the heating medium. Natural gas (line L1) obtained

through vaporization of the liquefied natural gas by the vaporizer 180 is supplied to the engine E to be used as fuel. The fluid used as the heating medium in the vaporizer 180 may be glycol water.

[56] According to this embodiment, the fresh water generator 120 generates fresh water by heating sea water using some or the entirety of the heat obtained by the cooling water (line L20) discharged from the engine E and having passed through the first heater 110.

[57] Since the quantity of heat, which can be obtained by the cooling water while cooling the engine E, is proportional to the load of the engine E and the amount of fuel to be consumed increases with increasing load of the engine E, the amount of the liquefied natural gas to be vaporized by the vaporizer 180 also increases with increasing load of the engine E. As a result, the quantity of heat to be transferred from the first heater 110 to the fluid used as the heating medium by the vaporizer 180 is also proportional to the load of the engine E.

[58] Accordingly, when A indicates the load of the engine E, x indicates the maximum quantity of heat transferred to the fluid used as the heating medium in the vaporizer 180, B indicates the load of the fresh water generator 120, y indicates the maximum quantity of heat obtained by the cooling water while cooling the engine E, and z indicates the quantity of heat required when the load of the fresh water generator 120 is 100%, the following equation is established.

[59] $Ax + Bz = Ay$

[60] Thus, the load of the fresh water generator is represented by Equation: $B = (y-x)A/z$ and the quantity of heat obtained by the cooling water while cooling the engine E may be suitably distributed to the vaporizer 180 and the fresh water generator 120 by regulating the load of the fresh water generator 120 according to this equation.

[61] According to this embodiment, the heat obtained by the cooling water while cooling the engine E is primarily used by the first heater 110 and the remaining heat is used by the fresh water generator 120.

[62] The cooling water (line L10) discharged from the engine E may be divided into two flows such that some of the cooling water (line L10) is sent to the first heater 110 and the remaining cooling water (line L12) bypasses the first heater 110. The

cooling water (line L12) having bypassed the first heater 110 may merge with the cooling water (line L20) having passed through the first heater 110 to be sent to the fresh water generator 120 and a first three-way valve 810 may be disposed where the cooling water (line L12) having bypassed the first heater 110 merges with the cooling water (line L20) having passed through the first heater 110. According to this embodiment, the amount of the cooling water to be sent to the first heater 110 may be regulated by regulating the degree of opening of the first three-way valve 810, thereby enabling regulation of the quantity of heat transferred from the cooling water to the first heater 110.

[63] On the line L4 along which the heating medium is sent from the first heater 110 to the vaporizer 180, a temperature sensor (not shown) may be disposed to allow the degree of opening of the first three-way valve 810 to be regulated depending upon the temperature detected thereby. Since the temperature of the heating medium supplied along the line L4 increases with increasing amount of the liquefied natural gas to be vaporized by the vaporizer 180, the amount of the liquefied natural gas to be vaporized by the vaporizer 180 can be regulated by regulating the temperature of the heating medium supplied along the line L4 and the temperature of the heating medium supplied along the line L4 can be regulated by regulating the amount of the cooling water sent to the first heater 110 by the first three-way valve 810.

[64] In addition, the fuel gas supply system according to this embodiment may be operated to maintain the heating medium flowing along the line L4 at a constant temperature. Since the temperature of the fluid (line L3) discharged from the vaporizer 180 decreases after being used as the heating medium for vaporization of the liquefied natural gas in the vaporizer 180, the degree of opening of the first three-way valve 810 is regulated so as to allow the fluid supplied to the first heater along the line L3 to be heated thereby.

[65] A second valve 720 for regulating the flow rate of the fluid and the degree of opening may be disposed on the line L4 along which the heating medium is sent from the first heater 110 to the vaporizer 180.

[66] The fuel gas supply system according to this embodiment may further include an air separator 330 disposed on the line L20 along which the cooling water

discharged from the engine E and having passed through the first heater 110 is sent to the fresh water generator 120. The air separator 330 according to this embodiment removes air from the cooling water sent from the first heater 110 to the fresh water generator 120, thereby preventing failure of various devices in the fuel gas supply system according to this embodiment.

[67] On the other hand, the cooling water (line L20) discharged from the engine E and having passed through the first heater 110 may be divided into two flows such that some of the cooling water (line L20) is sent to the fresh water generator 120 and the remaining cooling water (line L22) bypasses the fresh water generator 120. The cooling water (line L22) having bypassed the fresh water generator 120 may merge with the cooling water (line L30) having passed through the fresh water generator 120 to be sent to the engine E, and a second three-way valve 820 may be disposed where the cooling water (line L22) having bypassed the fresh water generator 120 merges with the cooling water (line L30) having passed through the fresh water generator 120. According to this embodiment, the amount of the cooling water to be sent to the fresh water generator 120 may be regulated by regulating the degree of opening of the second three-way valve 810, thereby enabling regulation of the quantity of heat transferred from the cooling water to the fresh water generator 120.

[68] On the line L30 along which the cooling water discharged from the fresh water generator 120 is sent to the engine E, a second temperature regulation sensor 220 may be disposed to regulate the temperature of the cooling water. According to this embodiment, a preset value of the second temperature regulation sensor 220 decreases with increasing load of the engine E.

[69] The fuel gas supply system according to this embodiment may further include a cooler 130 that reduces the temperature of the cooling water discharged from the engine E and having passed through the first heater 110 and the fresh water generator 120. The cooler 130 according to this embodiment reduces the temperature of the cooling water so as to allow the cooling water to cool the engine E to a predetermined temperature for the engine E, when the temperature of the cooling water is not sufficiently reduced even after the cooling water obtaining the quantity of heat while cooling the engine E supplies some of the heat to the first heater 110 and

the fresh water generator 120.

[70] In the structure wherein the fuel gas supply system according to this embodiment includes the cooler 130, the cooling water (line L30) discharged from the fresh water generator 120 may be divided into two flows such that some of the cooling water (line L30) is sent to the cooler 130 and the remaining cooling water (line L32) bypasses the cooler 130. The cooling water (line L32) having bypassed the cooler 130 may merge with the cooling water (L40) having passed through the cooler 130 to be sent to the engine E, and a third three-way valve 830 may be disposed where the cooling water (line L32) having bypassed the cooler 130 merges with the cooling water (line L40) having passed through the cooler 130. According to this embodiment, the amount of the cooling water to be sent to the cooler 130 may be regulated by regulating the degree of opening of the third three-way valve 830, thereby enabling regulation of the degree of cooling the cooling water by the cooler 130.

[71] A conventional system allows the cooling water to be supplied to the engine E after cooling the cooler 130 instead of using the heat of the cooling water to heat the liquefied natural gas, whereas the fuel gas supply system according to this embodiment includes the first heater 110 and the vaporizer 180 to allow the cooling water to be cooled by the cooler 130, only if needed, after using the heat of the cooling water to heat the liquefied natural gas, thereby reducing the capacity of the cooler 130 and energy for operation of the cooler 130.

[72] In the structure wherein the fuel gas supply system according to this embodiment includes the cooler 130, the heat obtained by the cooling water while cooling the engine E is primarily used by the first heater 110 and secondarily used by the fresh water generator 120, and the heat remaining after being used by the fresh water generator 120 is cooled by the cooler 130.

[73] In the structure wherein the fuel gas supply system according to this embodiment includes the cooler 130, a third temperature regulation sensor 230 may be disposed on the line L40, along which the cooling water discharged from the cooler 130 is sent to the engine E, to regulate the temperature of the cooling water. According to this embodiment, a preset value of the third temperature regulation sensor 230 decreases with increasing load of the engine E.

[74] The fuel gas supply system according to this embodiment may further include at least one of a storage tank 160, an expansion tank 170, and an air discharge tank 140.

[75] The storage tank 160 according to this embodiment stores the cooling water not sent to the first heater 110 among the cooling water used to cool the engine E and some of the cooling water stored in the storage tank 160 may be sent to the expansion tank 170 (line L50). According to this embodiment, since the surplus cooling water is stored in the storage tank 160 to be used again, the fuel gas supply system can minimize consumption of cooling water to be subjected to chemical treatment.

[76] According to this embodiment, the expansion tank 170 serves to improve stability of the system by absorbing volume change due to expansion or shrinkage of the cooling water and to apply pressure for circulation of the cooling water. The expansion tank 170 receives the cooling water supplied from the storage tank 160 and air discharged from the air discharge tank 140. When the internal pressure of the expansion tank 170 excessively increases, the gas may be discharged from the expansion tank 170 along a gas discharge line L2.

[77] According to this embodiment, the expansion tank 170 may be installed at a distance of about 20 m to 25 m above the engine room in which the engine E is disposed. If the installation distance of the expansion tank 170 above the engine room exceeds 25 m, the pressure of the cooling water supplied to the engine E exceeds a predetermined pressure. The installation distance of the expansion tank 170 may vary depending upon the temperature of the cooling water required by the engine E. Since decrease in pressure of the cooling water can cause bubble generation and bubble generation pressure varies depending upon the temperature of the cooling water, the installation distance of the expansion tank 170 is determined to prevent bubble generation in the cooling water depending upon the temperature of the cooling water required by the engine E.

[78] According to this embodiment, the air discharge tank 140 discharges air, which is obtained from the cooling water sent from the fresh water generator 120 to the engine E, to the expansion tank 170, and serves to relieve influence of rapid volume change due to temperature change of the fluid. The cooling water sent from

the fresh water generator 120 to the engine E may be sent to the engine E after being temporarily stored in the air discharge tank 140.

[79] The fuel gas supply system according to this embodiment may further include a first compression unit 410 disposed on the line L50 along which the cooling water discharged from the storage tank 160 is supplied to the expansion tank 170.

[80] The first compression unit 410 according to this embodiment may be operated in association with a first level regulator 310 adapted to regulate a water level of the storage tank 160 and a second level regulator 320 adapted to regulate a water level of the expansion tank 170. That is, according to this embodiment, the first compression unit 410 is operated to send the cooling water of the storage tank 160 to the expansion tank 170 when the water level of the storage tank 160 reaches a predetermined value or more or when the water level of the expansion tank 170 reaches a predetermined value or less.

[81] The fuel gas supply system according to this embodiment may further include at least one of a second compression unit 420 which compresses the cooling water discharged from the fresh water generator 120 to supply the compressed cooling water to the engine E; and a first valve 710 disposed on the line L10 along which the cooling water is supplied from the engine E to the first heater 110 to prevent backward flow of the cooling water.

[82] According to this embodiment, the second compression unit 420 may be provided in plural to be connected in parallel and may compress the cooling water under a pressure of about 3 bar. According to this embodiment, the second compression unit 420 may compress the cooling water to satisfy both the pressure for circulation of the cooling water and the pressure required by the engine E.

[83] In the structure wherein the fuel gas supply system according to this embodiment includes the second compression unit 420, it is desirable that the devices disposed on the line along which the cooling water discharged from the engine E is supplied again to the engine E be connected to one another in series in order to allow the cooling water to be circulated only with the pressure from the second compression unit 420 without installation of an additional compression means.

[84] According to this embodiment, the first valve 710 prevents the cooling water

from flowing backward due to reduction in pressure of the cooling water supplied from the engine E to the first heater 110 when the second compression unit 420 is stopped.

[85] The fuel gas supply system according to this embodiment may further include a second heater 150 that heats the cooling water discharged from the fresh water generator 120 to be supplied to the engine E. According to this embodiment, the second heater 150 heats the cooling water through heat exchange between steam and the cooling water. A third valve 730 may be disposed on a line along which steam is supplied, and the amount of steam may be regulated by regulating the degree of opening of the third valve 730, thereby enabling regulation of the degree of heating the cooling water.

[86] According to this embodiment, the second heater 150 serves to heat the cooling water to a predetermined temperature or more such that the heated cooling water can be supplied to the engine E in order to prevent low temperature corrosion of the engine E when the engine E is not operated during anchorage of the ship. According to this embodiment, generally, the cooler 130 is not operated during operation of the second heater 150.

[87] In the structure wherein the fuel gas supply system according to this embodiment includes the second heater 150, the fresh water generator 120 can be 100% operated even when the cooling water to be used has low quantity of heat due to low load of the engine E. Conventionally, when the engine E has low load, since 100% operation of the fresh water generator 120 causes the cooling water supplied to the engine E to have too a low temperature to prevent low temperature corrosion of the engine E, the fresh water generator 120 cannot be 100% operated. According to the present invention, however, even when the engine E has low load, the cooling water is heated to a temperature capable of preventing low temperature corrosion of the engine E by the second heater 150 after the fresh water generator 120 is 100% operated, the fuel gas supply system can be more efficiently operated.

[88] In the structure wherein the fuel gas supply system according to this embodiment includes the second heater 150, the cooling water discharged from the fresh water generator 120 may be divided into two flows such that some of the cooling

water (line L60) is sent to the second heater 150 and the remaining cooling water (line L62) bypasses the second heater 150. The cooling water (line L62) having bypassed the second heater 150 may merge with the cooling water (L60) having passed through the second heater 150 to be sent to the engine E and a fourth valve 740 may be disposed on a line L62 along which the cooling water having bypassed the second heater 150 flows. According to this embodiment, the amount of the cooling water to be sent to the second heater 150 may be regulated by regulating the degree of opening of the fourth valve 740, thereby enabling regulation of the degree of heating the cooling water by the second heater 150.

[89] In the structure wherein the fuel gas supply system according to this embodiment includes all of the cooler 130, the air discharge tank 140, the second compression unit 420, and the second heater 150, the cooler 130 may be disposed downstream of the fresh water generator 120, the air discharge tank 140 may be disposed downstream of the cooler 130, the second compression unit 420 may be disposed downstream of the air discharge tank 140, the second heater 150 may be disposed downstream of the second compression unit 420, and the engine E may be disposed downstream of the second heater 150.

[90] In the embodiment wherein the fuel gas supply system further includes at least one of the first three-way valve 810, the second three-way valve 820, the third three-way valve 830, the third valve 730, the first temperature regulation sensor 210, the second temperature regulation sensor 220, and the third temperature regulation sensor 230, operation of each of the first three-way valve 810, the second three-way valve 820, the third three-way valve 830, the third valve 730, the first temperature regulation sensor 210, the second temperature regulation sensor 220, and the third temperature regulation sensor 230 may be controlled by a control board C.

[91] According to this embodiment, the control board C controls each of the devices through overall analysis of operating conditions of the system based on information obtained by each of the devices connected to the control board C and a state of each of the devices.

[92] In the fuel gas supply system according to this embodiment, a pipe (indicated by a double dotted line in FIG. 1) through which the cooling water flows may be

subjected to thermal insulation treatment in order to use the heat of the cooling water discharged from the engine E as much as possible without loss.

[93] FIG. 2 is a schematic diagram of a system for supplying fuel gas for a ship in accordance with a second embodiment of the present invention.

[94] The fuel gas supply system according to the second embodiment shown in FIG. 2 is different from the fuel gas supply system according to the first embodiment shown in FIG. 1 in that the fuel gas supply system according to the second embodiment includes a first heater 110 disposed above an expansion tank 170 and further includes a third compression unit 190, and the following description will focus on the different features of the fuel gas supply system according to the second embodiment. Detailed description of the same components as those of the fuel gas supply system according to the first embodiment will be omitted.

[95] Referring to FIG. 2, the fuel gas supply system according to this embodiment includes a first heater 110, a vaporizer 180, and a fresh water generator 120, as in the first embodiment.

[96] As in the first embodiment, examples of an engine E to which fuel is supplied by the fuel gas supply system according to this embodiment may include an ME-GI engine, an X-DF engine, a DF engine, and the like, which use natural gas as fuel, and the fuel gas supply system according to this embodiment may be applied to other combustion devices, such as a gas turbine and the like, which use natural gas as fuel. As in the first embodiment, the fuel gas supply system according to this embodiment is preferably applied to an ME-GI engine used as a main propulsion engine. According to this embodiment, the engine E is disposed in an engine room, as in the first embodiment.

[97] As in the first embodiment, the first heater 110 according to this embodiment exchanges heat between cooling water (line L10) discharged from the engine E and a fluid (line L3) used as a heating medium in the vaporizer 180. That is, as in the first embodiment, the first heater 110 according to this embodiment supplies some of heat, which is obtained by the cooling water while cooling the engine E, to the fluid (line L3) used as the heating medium in the vaporizer 180 to heat the fluid (line L3) used as the heating medium in the vaporizer 180.

[98] On the line L10 along which the cooling water is supplied from the engine E to the first heater 110, a first temperature regulation sensor 210 may be disposed to regulate the temperature of the cooling water discharged from the engine E to be supplied to the first heater 110, as in the first embodiment. According to this embodiment, the first temperature regulation sensor 210 may regulate the temperature of the cooling water discharged from the engine E to about 85°C, as in the first embodiment.

[99] According to this embodiment, the temperature of the cooling water discharged from the engine E is regulated to about 85°C and the temperature of the cooling water supplied to the engine E varies depending upon the load of the engine E, as in the first embodiment. That is, in order to prevent low temperature corrosion of the engine E with decreasing load of the engine E, the temperature of the cooling water supplied to the engine E is increased.

[100] According to this embodiment, the vaporizer 180 vaporizes liquefied natural gas through heat exchange between the heating medium (line L4) heated by the first heater 110 and the liquefied natural gas, as in the first embodiment. That is, the vaporizer 180 uses some of the heat, which is obtained by the cooling water while cooling the engine E, to vaporize the liquefied natural gas via the heating medium, as in the first embodiment. Natural gas (line L1) obtained through vaporization of the liquefied natural gas by the vaporizer 180 is supplied to the engine E to be used as fuel, as in the first embodiment. The fluid used as the heating medium in the vaporizer 180 may be glycol water, as in the first embodiment.

[101] According to this embodiment, the fresh water generator 120 generates fresh water by heating sea water using some or the entirety of the heat obtained by the cooling water (line L20) discharged from the engine E and having passed through the first heater 110, as in the first embodiment.

[102] As in the first embodiment, when A indicates the load of the engine E, x indicates the maximum quantity of heat transferred to the fluid used as the heating medium in the vaporizer 180, B indicates the load of the fresh water generator 120, y indicates the maximum quantity of heat obtained by the cooling water while cooling the engine E, and z indicates the quantity of heat required when the load of the fresh

water generator 120 is 100%, the following equation is established.

[103] $Ax + Bz = Ay$

[104] Thus, the load of the fresh water generator is represented by Equation: $B = (y-x)A/z$ and the quantity of heat obtained by the cooling water while cooling the engine E may be suitably distributed to the vaporizer 180 and the fresh water generator 120 by regulating the load of the fresh water generator 120 according to this equation.

[105] According to this embodiment, the heat obtained by the cooling water while cooling the engine E is primarily used by the first heater 110 and the remaining heat is used by the fresh water generator 120, as in the first embodiment.

[106] As in the first embodiment, the cooling water (line L10) discharged from the engine E may be divided into two flows such that some of the cooling water (line L10) is sent to the first heater 110 and the remaining cooling water (line L12) bypasses the first heater 110. The cooling water (line L12) having bypassed the first heater 110 may merge with the cooling water (line L20) having passed through the first heater 110 to be sent to the fresh water generator 120 and a first three-way valve 810 may be disposed where the cooling water (line L12) having bypassed the first heater 110 merges with the cooling water (line L20) having passed through the first heater 110, as in the first embodiment. According to this embodiment, the amount of the cooling water to be sent to the first heater 110 may be regulated by regulating the degree of opening of the first three-way valve 810, thereby enabling regulation of the quantity of heat transferred from the cooling water to the first heater 110, as in the first embodiment.

[107] On the line L4 along which the heating medium is sent from the first heater 110 to the vaporizer 180, a temperature sensor (not shown) may be disposed to allow the degree of opening of the first three-way valve 810 to be regulated depending upon the temperature detected thereby, as in the first embodiment.

[108] In addition, the fuel gas supply system according to this embodiment may be operated to maintain the heating medium flowing along the line L4 at a constant temperature, as in the first embodiment.

[109] A second valve 720 for regulating the flow rate of the fluid and the degree of opening may be disposed on the line L4 along which the heating medium is sent from

the first heater 110 to the vaporizer 180, as in the first embodiment.

[110] The fuel gas supply system according to this embodiment may further include an air separator 330 disposed on the line L20 along which the cooling water discharged from the engine E and having passed through the first heater 110 is sent to the fresh water generator 120, as in the first embodiment. The air separator 330 according to this embodiment removes air from the cooling water sent from the first heater 110 to the fresh water generator 120, thereby preventing failure of various devices included in the system according to this embodiment, as in the first embodiment.

[111] As in the first embodiment, the cooling water (line L20) discharged from the engine E and having passed through the first heater 110 may be divided into two flows such that some of the cooling water (line L20) is sent to the fresh water generator 120 and the remaining cooling water (line L22) bypasses the fresh water generator 120. As in the first embodiment, the cooling water (line L22) having bypassed the fresh water generator 120 may merge with the cooling water (line L30) having passed through the fresh water generator 120 to be sent to the engine E and a second three-way valve 820 may be disposed where the cooling water (line L22) having bypassed the fresh water generator 120 merges with the cooling water (line L30) having passed through the fresh water generator 120. According to this embodiment, the amount of the cooling water to be sent to the fresh water generator 120 may be regulated by regulating the degree of opening of the second three-way valve 810, thereby enabling regulation of the quantity of heat transferred from the cooling water to the fresh water generator 120, as in the first embodiment.

[112] On the line L30 along which the cooling water discharged from the fresh water generator 120 is sent to the engine E, a second temperature regulation sensor 220 may be disposed to regulate the temperature of the cooling water, as in the first embodiment. According to this embodiment, a preset value of the second temperature regulation sensor 220 decreases with increasing load of the engine E, as in the first embodiment.

[113] The fuel gas supply system according to this embodiment may further include a cooler 130 that reduces the temperature of the cooling water discharged from

the engine E and having passed through the first heater 110 and the fresh water generator 120, as in the first embodiment. The cooler 130 according to this embodiment reduces the temperature of the cooling water so as to allow the cooling water to cool the engine E to a predetermined temperature, when the temperature of the cooling water is not sufficiently reduced even after the cooling water obtaining the quantity of heat while cooling the engine E supplies some of the heat to the first heater 110 and the fresh water generator 120, as in the first embodiment.

[114] In the structure wherein the fuel gas supply system according to this embodiment includes the cooler 130, the cooling water (line L30) discharged from the fresh water generator 120 may be divided into two flows such that some of the cooling water (line L30) is sent to the cooler 130 and the remaining cooling water (line L32) bypasses the cooler 130, as in the first embodiment. The cooling water (line L32) having bypassed the cooler 130 may merge with the cooling water (L40) having passed through the cooler 130 to be sent to the engine E and a third three-way valve 830 may be disposed where the cooling water (line L32) having bypassed the cooler 130 merges with the cooling water (line L40) having passed through the cooler 130, as in the first embodiment. According to this embodiment, the amount of the cooling water to be sent to the cooler 130 may be regulated by regulating the degree of opening of the third three-way valve 830, thereby enabling regulation of the degree of cooling the cooling water by the cooler 130, as in the first embodiment.

[115] The fuel gas supply system according to this embodiment can reduce the capacity of the cooler 130 and energy for operation of the cooler 130, as in the first embodiment.

[116] In the structure wherein the fuel gas supply system according to this embodiment includes the cooler 130, the heat obtained by the cooling water while cooling the engine E is primarily used by the first heater 110 and secondarily used by the fresh water generator 120, and the heat remaining after being used by the fresh water generator 120 is cooled by the cooler 130, as in the first embodiment.

[117] In the structure wherein the fuel gas supply system according to this embodiment includes the cooler 130, a third temperature regulation sensor 230 may be disposed on the line L40, along which the cooling water discharged from the cooler

130 is sent to the engine E, to regulate the temperature of the cooling water, as in the first embodiment. According to this embodiment, a preset value of the third temperature regulation sensor 230 decreases with increasing load of the engine E, as in the first embodiment.

[118] The fuel gas supply system according to this embodiment may further include at least one of a storage tank 160, an expansion tank 170, and an air discharge tank 140.

[119] The storage tank 160 according to this embodiment stores the cooling water not sent to the first heater 110 among the cooling water used to cool the engine E and some of the cooling water stored in the storage tank 160 may be sent to the expansion tank 170 (line L50), as in the first embodiment. According to this embodiment, the fuel gas supply system can minimize consumption of cooling water to be subjected to chemical treatment, as in the first embodiment.

[120] According to this embodiment, the expansion tank 170 serves to improve stability of the system by absorbing volume change due to expansion or shrinkage of the cooling water and to apply pressure for circulation of the cooling water, as in the first embodiment. The expansion tank 170 receives the cooling water supplied from the storage tank 160 and air discharged from the air discharge tank 140, as in the first embodiment. When the internal pressure of the expansion tank 170 excessively increases, the gas may be discharged from the expansion tank 170 along a gas discharge line L2, as in the first embodiment.

[121] According to this embodiment, the expansion tank 170 may be installed at a distance of about 20 m to 25 m above the engine room in which the engine E is disposed, as in the first embodiment.

[122] Unlike the first embodiment, the fuel gas supply system according to this embodiment may further include a third compression unit 190 disposed on the line along which the cooling water discharged from the engine E is supplied to the first heater 110. The third compression unit 190 according to this embodiment is provided to a structure wherein the first heater 110 is installed at a high height to obstruct efficient supply of the cooling water to the first heater 110, particularly, to a structure wherein the second compression unit 420 provides insufficient pressure to supply the

cooling water to the first heater 110.

[123] The air discharge tank 140 according to this embodiment discharges air, which is obtained from the cooling water sent from the fresh water generator 120 to the engine E, to the expansion tank 170, and serves to relieve influence of rapid volume change due to temperature change of the fluid, as in the first embodiment. The cooling water sent from the fresh water generator 120 to the engine E may be sent to the engine E after being temporarily stored in the air discharge tank 140, as in the first embodiment.

[124] The fuel gas supply system according to this embodiment may further include a first compression unit 410 disposed on the line L50 along which the cooling water discharged from the storage tank 160 is supplied to the expansion tank 170, as in the first embodiment.

[125] The first compression unit 410 according to this embodiment may be operated in association with a first level regulator 310 adapted to regulate a water level of the storage tank 160 and a second level regulator 320 adapted to regulate a water level of the expansion tank 170, as in the first embodiment. That is, according to this embodiment, the first compression unit 410 is operated to send the cooling water of the storage tank 160 to the expansion tank 170 when the water level of the storage tank 160 reaches a predetermined value or more or when the water level of the expansion tank 170 reaches a predetermined value or less, as in the first embodiment.

[126] The fuel gas supply system according to this embodiment may further include at least one of a second compression unit 420 which compresses the cooling water discharged from the fresh water generator 120 to supply the compressed cooling water to the engine E; and a first valve 710 disposed on the line L10 along which the cooling water is supplied from the engine E to the first heater 110 to prevent backward flow of the cooling water, as in the first embodiment.

[127] According to this embodiment, the second compression unit 420 may be provided in plural to be connected in parallel and may compress the cooling water under a pressure of about 3 bar, as in the first embodiment. According to this embodiment, the second compression unit 420 may compress the cooling water to satisfy both the pressure for circulation of the cooling water and the pressure required

by the engine E, as in the first embodiment.

[128] In the structure wherein the fuel gas supply system according to this embodiment includes the second compression unit 420, it is desirable that the devices disposed on the line along which the cooling water discharged from the engine E is supplied again to the engine E be connected to one another in series in order to allow the cooling water to be circulated only with the pressure from the second compression unit 420 without installation of an additional compression mean, as in the first embodiment.

[129] According to this embodiment, the first valve 710 prevents the cooling water from flowing backward due to reduction in pressure of the cooling water supplied from the engine E to the first heater 110 when the second compression unit 420 is stopped, as in the first embodiment.

[130] The fuel gas supply system according to this embodiment may further include a second heater 150 that heats the cooling water discharged from the fresh water generator 120 to be supplied to the engine E, as in the first embodiment. According to this embodiment, the second heater 150 heats the cooling water through heat exchange between steam and the cooling water, as in the first embodiment. A third valve 730 may be disposed on a line along which steam is supplied, and the amount of steam may be regulated by regulating the degree of opening of the third valve 730, thereby enabling regulation of the degree of heating the cooling water, as in the first embodiment.

[131] According to this embodiment, the second heater 150 serves to heat the cooling water to a predetermined temperature or more such that the heated cooling water can be supplied to the engine E in order to prevent low temperature corrosion of the engine E when the engine E is not operated during anchorage of the ship, as in the first embodiment. According to this embodiment, generally, the cooler 130 is not operated during operation of the second heater 150.

[132] In the structure wherein the fuel gas supply system according to this embodiment includes the second heater 150, the fresh water generator 120 can be 100% operated even when the cooling water to be used has low quantity of heat due to low load of the engine E, as in the first embodiment. According to the present invention,

even when the engine E has low load, the cooling water is heated to a temperature capable of preventing low temperature corrosion of the engine E by the second heater 150 after the fresh water generator 120 is 100% operated, the fuel gas supply system can be more efficiently operated, as in the first embodiment.

[133] In the structure wherein the fuel gas supply system according to this embodiment includes the second heater 150, the cooling water discharged from the fresh water generator 120 may be divided into two flows such that some of the cooling water (line L60) is sent to the second heater 150 and the remaining cooling water (line L62) bypasses the second heater 150, as in the first embodiment. The cooling water (line L62) having bypassed the second heater 150 may merge with the cooling water (L60) having passed through the second heater 150 to be sent to the engine E and a fourth valve 740 may be disposed on a line L62 along which the cooling water having bypassed the second heater 150 flows, as in the first embodiment. According to this embodiment, the amount of the cooling water to be sent to the second heater 150 may be regulated by regulating the degree of opening of the fourth valve 740, thereby enabling regulation of the degree of heating the cooling water by the second heater 150, as in the first embodiment.

[134] In the structure wherein the fuel gas supply system according to this embodiment includes the expansion tank 170, the first heater 110 is installed at a higher location than the expansion tank 170, unlike the first embodiment. Often, it is difficult to install the first heater 110 in the engine room and the first heater is necessarily disposed at a higher location than the expansion tank 170 in actual arrangement of components of the fuel gas supply system according to this embodiment in a ship.

[135] Further, in the structure wherein the fuel gas supply system according to this embodiment includes both the expansion tank 170 and the first three-way valve 810, the first three-way valve 810 may be placed at a lower location than the expansion tank 170.

[136] According to this embodiment, when the second compression unit 420 is stopped, a valve portion (upper-side valve portion in FIG. 2) of the first three-way valve 810 directed toward the first heater 110 may be closed and valve portions (left

and lower-side valve portions in FIG. 2) of the first three-way valve 810 directed toward the line L12 and the fresh water generator 120 may be kept open.

[137] According to this embodiment, when the valve portion (upper-side valve portion in FIG. 2) of the first three-way valve 810 directed toward the first heater 110 is closed, it is possible to prevent loss of the cooling water and the pressure inside a pipe (line L20) between the first heater 110 and the first three-way valve 810 disposed at a lower location than the expansion tank 170 even when the pressure for circulation of the cooling water is reduced by stopping the second compression unit 420.

[138] In addition, when the valve portions (left and lower-side valve portions in FIG. 2) of the first three-way valve 810 directed toward the line L12 and the fresh water generator 120 are kept open, the first valve 710 can prevent the cooling water from flow backward to the engine E (in the structure wherein the fuel gas supply system according to this embodiment includes the third compression unit 190, backward flow of the cooling water toward the third compression unit 190 is also blocked), even when the second compression unit 420 is stopped to allow the cooling water supplied from the engine E to the first heater 110 to flow backward. The cooling water flowing backward from the first heater 110 is sent to the fresh water generator 120 through the line L12 and the first three-way valve 810.

[139] If the first three-way valve 810 is placed at a higher location than the expansion tank 170, failure of the second compression unit 420 can cause reduction in pressure near to vapor pressure and generation of bubbles in the cooling water due to generation of a vacuum in the pipe, thereby having an adverse influence on rigidity of the pipe, even when the valve portion (upper-side valve portion in FIG. 2) of the first three-way valve 810 directed toward the first heater 110 is closed. In addition, the pressure or the flow rate of the cooling water can be rapidly reduced and water hammering can be generated.

[140] If the first heater 110 can be disposed below the expansion tank 170, there is no concern about generation of a vacuum in the pipe (line L20) between the first heater 110 and the first three-way valve 810 even upon failure of the second compression unit 420. However, in the structure wherein the first heater is inevitably disposed above the expansion tank in the ship, the first three-way valve 810 is disposed below

the expansion tank to prevent generation of a vacuum in the pipe (line L20) between the first heater 110 and the first three-way valve 810 upon failure of the second compression unit 420.

[141] As a result, the fuel gas supply system according to this embodiment can prevent water hammering and failure of devices due to backward flow of the cooling water.

[142] In the structure wherein the fuel gas supply system according to this embodiment includes all of the cooler 130, the air discharge tank 140, the second compression unit 420, and the second heater 150, the cooler 130 may be disposed downstream of the fresh water generator 120, the air discharge tank 140 may be disposed downstream of the cooler 130, the second compression unit 420 may be disposed downstream of the air discharge tank 140, the second heater 150 may be disposed downstream of the second compression unit 420, and the engine E may be disposed downstream of the second heater 150, as in the first embodiment.

[143] In the embodiment wherein the fuel gas supply system further includes at least one of the first three-way valve 810, the second three-way valve 820, the third three-way valve 830, the third valve 730, the first temperature regulation sensor 210, the second temperature regulation sensor 220, and the third temperature regulation sensor 230, operation of each of the first three-way valve 810, the second three-way valve 820, the third three-way valve 830, the third valve 730, the first temperature regulation sensor 210, the second temperature regulation sensor 220, and the third temperature regulation sensor 230 may be controlled by a control board C, as in the first embodiment.

[144] According to this embodiment, the control board C controls each of the devices through overall analysis of operating conditions of the system based on information obtained by each of the devices connected to the control board C and a state of each of the devices, as in the first embodiment.

[145] In particular, according to this embodiment, an algorithm of the fuel gas supply system is established to close the valve portion (upper side valve portion in FIG. 2) of the first three-way valve 810 directed toward the first heater 110 when the second compression unit 420 is stopped, thereby enabling automatic coping with

failure or the like of the second compression unit 420 through the control board C.

[146] In the fuel gas supply system according to this embodiment, the pipe (indicated by a double dotted line in FIG. 1) through which the cooling water flows may be subjected to thermal insulation treatment in order to use the heat of the cooling water discharged from the engine E as much as possible without loss.

[147]

[148] It will be apparent to those skilled in the art that the present invention is not limited to the embodiments described above and that various modifications, changes, alterations, and equivalent embodiments can be made without departing from the spirit and scope of the present invention.

【CLAIMS】

【Claim 1】

A system for supplying fuel gas for a ship, comprising:

a vaporizer vaporizing liquefied natural gas to supply the liquefied natural gas to an engine;

a first heater heating a fluid used as a heating medium in the vaporizer through heat exchange between cooling water discharged from the engine after cooling the engine and the heating medium; and

a fresh water generator generating fresh water by heating sea water with some or the entirety of a heat source of the cooling water having passed through the first heater after being discharged from the engine,

wherein the vaporizer vaporizes the liquefied natural gas by heat exchanging between the heating medium heated by the first heater and the liquefied natural gas.

【Claim 2】

The system for supplying fuel gas for a ship according to claim 1, further comprising: an expansion tank absorbing volume change caused by expansion or shrinkage of the cooling water.

【Claim 3】

The system for supplying fuel gas for a ship according to claim 2, wherein the engine is disposed in an engine room and the expansion tank is disposed at a distance of 20 m to 25 m above the engine room.

【Claim 4】

The system for supplying fuel gas for a ship according to claim 2, wherein the first heater is disposed at a higher location than the expansion tank.

【Claim 5】

The system for supplying fuel gas for a ship according to claim 1, further

comprising: a second heater heating the cooling water discharged from the fresh water generator to be supplied to the engine.

【Claim 6】

The system for supplying fuel gas for a ship according to claim 2, wherein the cooling water discharged from the engine is divided into two flows such that some of the cooling water is supplied to the first heater and the remaining cooling water bypasses the first heater,

the system further comprising:

a first three-way valve disposed where the cooling water having bypassed the first heater merges with the cooling water having passed through the first heater.

【Claim 7】

The system for supplying fuel gas for a ship according to claim 6, wherein the first three-way valve is disposed at a lower location than the expansion tank.

【Claim 8】

The system for supplying fuel gas for a ship according to claim 1, further comprising: a cooler cooling the cooling water having passed through the first heater and the fresh water generator after being discharged from the engine.

【Claim 9】

The system for supplying fuel gas for a ship according to claim 8, further comprising:

a third temperature regulation sensor disposed on a line along which the cooling water discharged from the cooler is supplied to the engine to regulate temperature of the cooling water,

wherein a preset value of the third temperature regulation sensor decreases with increasing load of the engine.

【Claim 10】

The system for supplying fuel gas for a ship according to claim 8, wherein the heat source obtained by the cooling water while cooling the engine is primarily used by the first heater and secondarily used by the fresh water generator and the heat remaining after being used by the fresh water generator is cooled by the cooler.

【Claim 11】

The system for supplying fuel gas for a ship according to claim 2, further comprising: a storage tank storing the remaining cooling water not sent to the first heater among the cooling water used to cool the engine.

【Claim 12】

The system for supplying fuel gas for a ship according to claim 11, further comprising:

a first compression unit disposed on a line along which the cooling water discharged from the storage tank is supplied to the expansion tank,

the first compression unit being operated when a liquid level of the storage tank reaches a predetermined value or more or when a liquid level of the expansion tank reaches a predetermined value or less.

【Claim 13】

The system for supplying fuel gas for a ship according to claim 1, further comprising: a second compression unit compressing the cooling water discharged from the fresh water generator to supply the compressed cooling water to the engine.

【Claim 14】

The system for supplying fuel gas for a ship according to claim 13, further comprising: a first valve preventing the cooling water supplied from the engine to the first heater from flowing backward when the second compression unit is stopped.

【Claim 15】

The system for supplying fuel gas for a ship according to claim 13, wherein

the vaporizer, the first heater, the fresh water generator, and the second compression unit are connected to one another in series to allow the cooling water to be circulated only by the second compression unit.

【Claim 16】

The system for supplying fuel gas for a ship according to any one of claims 1 to 15, further comprising: a third compression unit disposed on a line along which the cooling water discharged from the engine is supplied to the first heater.

【Claim 17】

The system for supplying fuel gas for a ship according to any one of claims 1 to 15, wherein the fresh water generator has a load represented by Equation: $B = (y-x)A/z$, where A indicates a load of the engine, x indicates the maximum quantity of heat transferred to the fluid used as the heating medium in the vaporizer, B indicates a load of the fresh water generator, y indicates the maximum quantity of heat obtained by the cooling water while cooling the engine, and z indicates quantity of heat required when the load of the fresh water generator is 100%.

【Claim 18】

The system for supplying fuel gas for a ship according to any one of claims 1 to 15, further comprising:

at least one of a first temperature regulation sensor disposed on a line along which the cooling water discharged from the engine is supplied to the first heater to maintain the cooling water at a constant temperature and a second temperature regulation sensor disposed on a line along which the cooling water discharged from the fresh water generator is supplied to the engine to regulate the temperature of the cooling water,

wherein a preset value of the second temperature regulation sensor decreases with increasing load of the engine.

【Claim 19】

The system for supplying fuel gas for a ship according to any one of claims 1 to 15, further comprising: an air separator disposed on a line along which the cooling water discharged from the engine and having passed through the first heater is supplied to the fresh water generator to remove air from the cooling water.

【Claim 20】

The system for supplying fuel gas for a ship according to any one of claims 1 to 15, further comprising: an air discharge tank discharging air from the cooling water sent from the fresh water generator to the engine.

【Claim 21】

The system for supplying fuel gas for a ship according to any one of claims 1 to 15, wherein a part or the entirety of a pipe through which cooling water flows is subjected to heat insulation treatment.

【Claim 22】

A method for supplying fuel gas for a ship, comprising:

1) heating, by a first heater, a heating medium through heat exchange between cooling water discharged from an engine after cooling the engine and the heating medium;

2) vaporizing liquefied natural gas through heat exchange between the heating medium heated by heat exchange in Step 1) and the liquefied natural gas;

3) supplying natural gas vaporized in Step 2) to the engine; and

4) generating, by a fresh water generator, fresh water by heating sea water using some or the entirety of a heat source obtained by the cooling water used for heat exchange of the heating medium in Step 1).

【Claim 23】

The method according to claim 22, further comprising: 5) heating the cooling water used in the fresh water generator in Step 4).

【Claim 24】

The method according to claim 23, wherein, in Step 5), the cooling water is heated to a temperature or more at which low temperature corrosion of the engine can be prevented, when the engine is not operated.

【Claim 25】

The method according to claim 23, wherein, when it is judged that the temperature of the cooling water is decreased below a temperature at which low temperature corrosion of the engine can be prevented upon 100% operation of the fresh water generator in Step 4), the cooling water is heated to a temperature or more at which low temperature corrosion of the engine can be prevented, after 100% operation of the fresh water generator, in Step 5).

【Claim 26】

The method according to claim 22, further comprising: 5) compressing, by a second compression unit, the cooling water discharged from the fresh water generator to supply the compressed cooling water to the engine.

【Claim 27】

The method according to claim 26, wherein the cooling water discharged from the engine is divided into two flows such that some of the cooling water is supplied to the first heater and the remaining cooling water bypasses the first heater, and a first three-way valve may be disposed where the cooling water having bypassed the first heater merges with the cooling water having passed through the first heater.

【Claim 28】

The method according to claim 27, wherein, when the second compression unit is stopped, a valve portion of the first three-way valve directed toward the first heater is closed and remaining valve portions thereof are kept in an open state.

【Claim 29】

The method according to claim 28, wherein an algorithm is constituted to allow the valve portion of the first three-way valve directed toward the first heater to be automatically closed by a control board when the second compression unit is stopped.

【Claim 30】

An arrangement method, wherein an engine is disposed in an engine room, an expansion tank adapted to buffer volume change due to expansion or shrinkage of cooling water is disposed at a distance of 20 m to 25 m above the engine room, a first heater heating a heating medium for vaporization of liquefied natural gas is disposed at a higher location than the expansion tank, and a first three-way valve is disposed where the cooling water having bypassed the first heater merges with the cooling water having passed through the first heater to be disposed at a lower location than the expansion tank.

【Claim 31】

A method of distributing quantity of heat obtained by cooling water to a vaporizer and a fresh water generator while cooling an engine in accordance with Equation: $B = (y-x)A/z$, where A indicates a load of the engine, x indicates the maximum quantity of heat transferred to a fluid used as a heating medium in the vaporizer, B indicates a load of the fresh water generator, y indicates the maximum quantity of heat obtained by the cooling water while cooling the engine, and z indicates quantity of heat required when the load of the fresh water generator is 100%.