

DESCRIPTION

Title of Invention: SHIP

Technical Field

[0001] The present invention relates to a ship including a propulsion engine that uses LPG as fuel.

Background Art

[0002] Typically, fuel of propulsion engines of conventional ships is fuel oil (such as heavy oil or light oil) or LNG (Liquefied Natural Gas). In recent years, it has been proposed that LPG (Liquefied Petroleum Gas) is used as the fuel of the propulsion engines.

[0003] For example, a ship disclosed in PTL 1 includes: a light oil storage tank configured to store light oil; and a deck tank configured to store LPG. The light oil or the LPG can be selectively supplied as the fuel to a propulsion engine. The deck tank is connected to the engine through a fuel transfer pipe, and a pump and a cutoff valve are provided on the fuel transfer pipe.

[0004] While the light oil is being used, the pump stops, and the cutoff valve closes. When switching the fuel from the light oil to the LPG, the pump operates, and the cutoff valve opens. With this, the supply of the LPG to the engine starts.

Citation List

Patent Literature

[0005] PTL 1: Korean Laid-Open Patent Application Publication No. 2012-0113398

Summary of Invention

Technical Problem

[0006] In order to inject fuel in an engine, the pressure of the fuel supplied to the engine needs to be ensured at a fixed value or more. In a case where the pump operates when the supply of the LPG starts as above, the pressure of the LPG in the fuel transfer pipe may not reach pressure required in the engine, and therefore, the engine may not operate smoothly. It should be noted that this problem at the time of the start of the supply of the LPG may occur not only in a dual fuel engine disclosed in PTL 1 but also in engines that uses only the LPG as the fuel.

[0007] An object of the present invention is to provide a ship including a propulsion engine that can smoothly operate at the time of start of supply of LPG.

Solution to Problem

[0008] A ship according to one aspect of the present invention includes: a fuel tank configured to store LPG; a propulsion engine configured to use the LPG as fuel; a fuel supply line through which the LPG is supplied from the fuel tank to the engine; a pump provided on the fuel supply line; a shutoff valve provided on the fuel supply line so as to be located downstream of the pump; a fuel recovery line through which unconsumed LPG is recovered from the engine to the fuel tank; a bypass line branching from the fuel supply line extending between the pump and the shutoff valve, the bypass line being connected to the fuel recovery line or the fuel tank; a flow control valve provided on the bypass line; a pressure gauge provided on the fuel supply line so as to be located downstream of the pump and upstream of the shutoff valve, the pressure gauge being configured to detect pressure of the LPG supplied from the pump; a flow meter configured to detect a supply flow rate of the LPG flowing into the engine through the fuel line or a recovery flow rate of the LPG flowing out from the engine through the fuel recovery line; and a controller configured to control a rotational frequency of the pump and the flow control valve. When the shutoff valve is being closed, and supply of the LPG to the engine is being stopped, the controller controls the rotational frequency of the pump and/or the flow control valve such that the pressure of the LPG detected by the pressure gauge is maintained at required pressure required for operating the engine. When the shutoff valve is opened, and the LPG is supplied to the engine, the controller controls the rotational frequency of the pump and the flow control valve such that the flow rate detected by the flow meter becomes a predetermined value corresponding to a fuel consumption of the engine.

[0009] According to the above configuration, the bypass line is provided, and the rotational frequency of the pump and the flow control valve are controlled such that the flow rate of the LPG is adjusted in accordance with the fuel consumption. Therefore, excessive supply of the LPG to the engine can be suppressed, and excessive temperature increase of the LPG in the fuel tank can be suppressed in the ship including the fuel recovery line.

[0010] The pump and the flow control valve are used in the flow rate control while the LPG is being supplied, and the pump and the flow control valve are used in the adjustment of the pressure of the LPG in the fuel supply line when the shutoff valve is being closed and the supply of the LPG is being stopped. As above, since the rotational frequency of the pump and the flow control valve are also used in the pressure control, and the supply pressure of the LPG is maintained at the required pressure required for operating the engine, the engine can be smoothly operated at the time of the start of the supply of the LPG.

[0011] The ship may further include a pressure regulating valve provided on the fuel

recovery line so as to be located upstream of a meeting point where the bypass line meets the fuel recovery line. When the shutoff valve is opened, and the LPG is supplied to the engine, the controller may operate the pressure regulating valve to control the pressure of the LPG supplied to the engine. According to the above configuration, when the LPG is being supplied, the pressure control of the LPG supplied to the engine can be realized while using the flow control valve and the rotational frequency of the pump in the flow rate control.

Advantageous Effects of Invention

[0012] The present invention can provide the ship including the propulsion engine that can smoothly operate at the time of the start of the supply of the LPG.

Brief Description of Drawings

[0013] FIG. 1 is a diagram showing the schematic configuration of a ship according to an embodiment.

FIG. 2 is a diagram showing the schematic configuration of a ship according to Modified Example.

Description of Embodiments

[0014] Hereinafter, an embodiment will be described with reference to the drawings. In the drawings, the same reference signs are used for the same or corresponding components, and a repetition of the same explanation is avoided.

[0015] A ship 1 shown in FIG. 1 is a LPG fuel propulsion ship. The ship 1 includes a fuel tank 2 and a propulsion engine 11. The fuel tank 2 stores LPG, and the propulsion engine 11 uses the LPG as fuel. A major component of the LPG may be propane (propane gas) or butane (butane gas).

[0016] In the present embodiment, the fuel tank 2 is constituted by a storage tank 21 and a service tank 22. The storage tank 21 has a relatively large volume, and the service tank 22 has a relatively small volume. The storage tank 21 and the service tank 22 are pressure vessels each having withstand pressure that is higher than atmospheric pressure. The storage tank 21 and the service tank 22 are connected to each other through an interconnection line 26.

[0017] The LPG is introduced from a LPG supply source through a fuel introducing line 23 into the storage tank 21. The LPG supply source may be a cargo tank mounted on the ship 1, a land LPG supply facility, or a LPG fuel supply ship.

[0018] In the present embodiment, a means (for example, a heat insulating member) for

maintaining the LPG at low temperature is not provided at the storage tank 21, and the temperature of the LPG in the storage tank 21 changes so as to follow air temperature. When the major component of the LPG introduced from the LPG supply source is the propane gas, the temperature of the LPG is about -42°C in many cases. Therefore, a heater 24 is provided on the fuel introducing line 23. The heater 24 heats the LPG to, for example, temperature in a range from -5°C to the air temperature. It should be noted that the heater 24 is unnecessary if the land LPG supply facility or the LPG fuel supply ship as the LPG supply source is equipped with a heater, and the temperature of the LPG supplied to the ship 1 is -5°C or more.

[0019] When components of a gaseous layer in the storage tank 21 are only evaporated PG, the pressure of the gaseous layer in the storage tank 21 is saturated steam pressure of the LPG. For example, when the temperature in the storage tank 21 is 25°C , the pressure (saturated steam pressure) of the gaseous layer in the storage tank 21 is about 0.9 MPa gage pressure. Hereinafter, pressure is shown as gage pressure. It should be noted that since the saturated steam pressure of the LPG is about 1.7 MPa at 50°C , the storage tank 21 is configured to be able to withstand, for example, 1.8 MPa. For reference, the saturated steam pressure of the LPG is about 0.4 MPa at 0°C .

[0020] A pump 25 is provided in the storage tank 21. The number of pumps 25 may be one or plural. An upstream end of the interconnection line 26 is connected to the pump 25. A downstream end of the interconnection line 26 is open in the service tank 22. The LPG is supplied by the pump 25 from the storage tank 21 through the interconnection line 26 to the service tank 22. It should be noted that the pump 25 may be provided outside the storage tank 21 and on a portion of the interconnection line 26.

[0021] As with the storage tank 21, a means for maintaining the LPG at low temperature is not provided at the service tank 22, and the temperature of the LPG in the service tank 22 changes so as to follow the air temperature. When components of a gaseous layer in the service tank 22 are only evaporated PG, the pressure of the gaseous layer in the service tank 22 is the saturated steam pressure of the LPG.

[0022] When the LPG circulates between the engine 11 and the service tank 22 as described below, the temperature of the LPG in the service tank 22 may be higher than the air temperature. For example, when the temperature of the LPG in the service tank 22 is 60°C , the pressure (saturated steam pressure) of the gaseous layer in the service tank 22 is about 2.1 MPa. It should be noted that the service tank 22 is configured to be able to withstand, for example, 2.2 MPa.

[0023] The service tank 22 is connected to the propulsion engine 11 through a fuel supply line 31 and a fuel recovery line 41. The LPG is supplied from the service tank 22 through the fuel supply line 31 to the engine 11, and unconsumed LPG is recovered from the engine 11 through the fuel recovery line 41 to the service tank 22. In other words, the LPG circulates between the service tank 22 and the engine 11 through the fuel supply line 31 and the fuel recovery line 41.

[0024] An upstream end of the fuel supply line 31 is connected to a lower portion of the service tank 22. A downstream end of the fuel recovery line 41 is open in the service tank 22.

[0025] The engine 11 is, for example, a diesel cycle or otto cycle reciprocating engine. Although not shown, the engine 11 includes a main passage and a plurality of fuel injection valves. The main passage connects a downstream end of the fuel supply line 31 and an upstream end of the fuel recovery line 41, and the plurality of fuel injection valves are connected to the main passage in parallel.

[0026] A pump 32, a heater 33, and a shutoff valve 34 are provided on the fuel supply line 31 in this order from an upstream side.

[0027] A heater 27 is provided on the interconnection line 26. The heater 27 heats the LPG supplied from the storage tank 21 to the service tank 22. The heater 33 heats the LPG to required temperature (for example, 45°C) of the engine 11. While the LPG is being supplied to the engine 11, the LPG is supplied from the storage tank 21 to the service tank 22 at an amount corresponding to a fuel consumption Q_e of the engine 11. The heater 27 is used when it is difficult to heat the LPG to the required temperature of the engine 11 only by the heater 33. It should be noted that the heater 27 may be omitted.

[0028] A first pressure regulating valve 42, a shutoff valve 43, a cooler 44, and a second pressure regulating valve 45 are provided on the fuel recovery line 41 in this order from the upstream side. The cooler 44 cools the LPG to predetermined temperature (for example, 40°C). It should be noted that the cooler 44 may be omitted.

[0029] The fuel supply line 31 and the fuel recovery line 41 are connected to each other through a first bypass line 51. The first bypass line 51 branches from the fuel supply line 31 extending between the pump 32 and the shutoff valve 34, more specifically, between the heater 33 and the shutoff valve 34, and is connected to the fuel recovery line 41 extending between the shutoff valve 43 and the cooler 44. A flow control valve 52 is provided on the first bypass line 51.

[0030] Further, the present embodiment adopts a second bypass line 53. The second

bypass line 53 branches from the fuel supply line 31 extending between the pump 32 and the heater 33 and is connected to the service tank 22. A flow control valve 54 is provided on the second bypass line 53. It should be noted that one of the first bypass line 51 and the second bypass line 53 may be omitted.

[0031] The pump 32, the shutoff valves 34 and 43, the pressure regulating valves 42 and 45, and the flow control valves 52 and 54 are controlled by a controller 6. It should be noted that only some of signal wires are shown in FIG. 1 for simplicity. The controller 6 is, for example, a computer including memories (a ROM, a RAM, etc.) and a CPU, and programs stored in the ROM are executed by the CPU. The controller 6 may be a single device or may be divided into a plurality of devices (for example, an engine controller and a fuel supply controller).

[0032] The controller 6 is electrically connected to a first supply pressure gauge 72, a second supply pressure gauge 73, a recovery pressure gauge 74, and a flow meter 81. The flow meter 81 is used for control of the pump 32 and the flow control valve 52, especially for control of the flow rate of the LPG while the LPG is being supplied to the engine 11. The first supply pressure gauge 72 is used for control of the pump 32 and the flow control valve 52, especially for control of the pressure of the LPG while the supply of the LPG to the engine 11 is being stopped. The second supply pressure gauge 73 is used for control of the first pressure regulating valve 42, and the recovery pressure gauge 74 is used for control of the second pressure regulating valve 45.

[0033] The flow meter 81 is provided on the fuel supply line 31 so as to be located downstream of a branch point where the first bypass line 51 branches from the fuel supply line 31. The flow meter 81 detects a supply flow rate Q_i of the LPG flowing into the engine 11 through the fuel supply line 31.

[0034] The first supply pressure gauge 72 is provided on the fuel supply line 31 so as to be located downstream of the pump 32 (more specifically, downstream of the heater 33). The first supply pressure gauge 72 detects the pressure of the LPG supplied from the pump 32. The second supply pressure gauge 73 is provided on the fuel supply line 31 so as to be located downstream of the shutoff valve 34. The second supply pressure gauge 73 detects the pressure of the LPG supplied to the engine 11 through the shutoff valve 34.

[0035] The recovery pressure gauge 74 is provided on the fuel recovery line 41 so as to be located between the shutoff valve 43 and the second pressure regulating valve 45. The recovery pressure gauge 74 detects the pressure of the LPG which has been reduced in pressure by the first pressure regulating valve 42. In the present embodiment, the recovery pressure gauge 74 is located upstream of the cooler 44. However, the recovery pressure gauge 74 may be located

downstream of the cooler 44.

[0036] The engine 11 may be an engine that uses only the LPG as the fuel or may be a dual fuel engine that uses the LPG and fuel oil (such as heavy oil or light oil) as the fuel. In the case of the engine that uses only the LPG as the fuel, a timing at which the supply of the LPG to the engine 11 starts corresponds to a timing at which the operation of the engine 11 starts. A period in which the supply of the LPG to the engine 11 is being stopped corresponds to a period in which the engine 11 is being stopped. In the case of the dual fuel engine, as a timing at which the supply of the LPG to the engine 11 starts, there are a timing at which the operation of the engine 11 starts and a timing at which the engine 11 is operating, and the fuel supplied to the engine 11 is switched from the fuel oil to the LPG. As a period in which the supply of the LPG to the engine 11 is being stopped, there are a period in which the engine 11 is being stopped and a period in which the engine 11 is operating by using the fuel oil as the fuel.

[0037] In a period in which the supply of the LPG to the engine 11 is being stopped, the controller 6 closes the shutoff valves 34 and 43. In a period in which the LPG is being supplied to the engine 11, the controller 6 opens the shutoff valves 34 and 43. While the engine 11 is being stopped, the passages between the shutoff valves 34 and 43 (i.e., a downstream portion of the fuel supply line 31, the main passage of the engine 11, and an upstream portion of the fuel recovery line 41) are purged with inactive gas.

[0038] While the LPG is being supplied to the engine 11, pressure control, flow rate control, and temperature management of the LPG are executed.

[0039] Regarding the flow rate control of the LPG while the LPG is being supplied to the engine, the controller 6 controls a rotational frequency of the pump 32 such that the supply flow rate Q_i detected by the flow meter 81 becomes a predetermined value V corresponding to the fuel consumption Q_e of the engine 11. In the present embodiment, the predetermined value V is a value obtained by multiplying the fuel consumption Q_e of the engine 11 by a coefficient C ($V = Q_e \times C$). For example, the coefficient C is typically 1.1 to 1.50. The coefficient C may be a fixed value set within this numerical range or may be set variably within this numerical range.

[0040] For example, the controller 6 may determine the fuel consumption Q_e of the engine 11 based on an operation amount of a telegraph lever operated by a ship operator. Or, when the controller 6 is divided into the engine controller configured to control the engine 11 and the fuel supply controller configured to control the pump 32 and various valves, the fuel supply controller may determine the fuel consumption Q_e of the engine 11 based on a value which is

calculated by the engine controller and related to the fuel consumption.

[0041] When the rotational frequency of the pump 32 becomes a lowest rotational frequency as a result of the control of the rotational frequency of the pump 32 based on the supply flow rate Q_i detected by the flow meter 81, the controller 6 controls one of the flow control valves 52 and 54 such that the supply flow rate Q_i detected by the flow meter 81 becomes the above-described predetermined value V . Specifically, as the fuel consumption Q_e of the engine 11 decreases, the controller 6 increases an opening degree of one of the flow control valves 52 and 54 to decrease the flow rate of the LPG supplied to the engine 11.

[0042] Since the rotational frequency of the pump 32 and the flow control valve 52 are controlled such that the flow rate of the LPG is adjusted in accordance with the fuel consumption, excessive supply of the LPG to the engine 11 can be suppressed. The temperature of the LPG increases by heat input from the engine 11 to the LPG when the LPG flows through the engine 11. Since the bypass lines 51 and 53 are provided, excessive temperature increase of the LPG in the fuel tank 2 (service tank 22) can be suppressed in the ship 1 including the fuel recovery line 41.

[0043] The temperature of the LPG slightly increases (for example, 55°C) when the LPG flows through the engine 11. Therefore, in order to prevent the LPG, which has been reduced in pressure by the first pressure regulating valve 42, from evaporating, the controller 6 controls the second pressure regulating valve 45 such that the pressure detected by the recovery pressure gauge 74 becomes a set value (for example, 2.0 MPa) higher than the saturated steam pressure at assumed highest temperature.

[0044] Regarding the pressure control of the LPG while the LPG is being supplied to the engine, the controller 6 controls the first pressure regulating valve 42 such that the pressure detected by the second supply pressure gauge 73 becomes required pressure (for example, 5.0 to 6.0 MPa) of the engine 11. The required pressure is pressure required to properly inject the fuel, i.e., to smoothly operate the engine 11.

[0045] The pressure control of the LPG is executed even when the supply of the LPG to the engine 11 is being stopped. It should be noted that the pressure control is not executed at all times while the supply of the LPG is being stopped. In the case of the dual fuel engine, the pressure control is executed while the light oil is being used, for example. At this time, in preparation for the start of the supply of the LPG to the engine 11, the LPG may be filled in the engine main passage for LPG. In the case of the engine that uses only the LPG as the fuel, the pressure control is executed in a standby period, for example. It should be noted that in the

engine that uses only the LPG as the fuel, purging with the inactive gas may be performed in this standby period.

[0046] Regarding the pressure control of the LPG in a period in which the shutoff valves 34 and 43 are being closed and the supply of the LPG is being stopped, the controller 6 operates the pump 32 and opens the flow control valve 52 and/or the flow control valve 54. With this, the LPG in the storage tank 21 is made to return to the storage tank 21 through the fuel supply line 31, the first bypass line 51, and the fuel recovery line 41 without flowing through the engine 11, and/or the LPG in the storage tank 21 is made to return to the storage tank 21 through the fuel supply line 31 and the second bypass line 53 without flowing through the engine 11. The controller 6 controls the rotational frequency of the pump 32 and the flow control valves 52 and 54 such that the supply pressure of the LPG detected by the first supply pressure gauge 72 is maintained at the required pressure (for example, 5.0 to 6.0 MPa). It should be noted that since the first supply pressure gauge 72 is provided on the fuel supply line 31 so as to be located downstream of the pump 32 and upstream of the shutoff valve 34, and the branch point of the first bypass line 51 is also located upstream of the shutoff valve 34, the first supply pressure gauge 72 can detect the pressure of the circulating LPG.

[0047] As one example, the rotational frequency of the pump 32 is maintained at a lowest rotational frequency, and the flow control valve 52 increases the opening degree when the detected pressure is higher than the required pressure and decreases the opening degree when the detected pressure is lower than the required pressure.

[0048] When the shutoff valves 34 and 43 are switched from a closed state to an open state under such a situation that the above pressure control is being executed, the supply pressure of the LPG at an upstream side of the shutoff valve 34 has already reached the required pressure immediately after this switching. Therefore, after that, only the pressure increase at a downstream side of the shutoff valve 34 (especially between the shutoff valves 34 and 43) is necessary, and the pressure supplied to the engine 11 can be stabilized quickly after the shutoff valves 34 and 43 are opened. After the pressure is stabilized, the operation can be switched to the operation using the LPG, and therefore, the operation using the LPG can be started smoothly and quickly.

[0049] The rotational frequency of the pump 32 and the opening degrees of the flow control valves 52 and 54 are used for the pressure control when the LPG is not being supplied and are used for the flow rate control when the LPG is being supplied. The controller 6 operates the first pressure regulating valve 42 to control the pressure supplied to the engine 11. Therefore, while using the flow control valves 52 and 54 and the rotational frequency of the pump 32 for

the flow rate control, the controller 6 can also realize the control of the supply pressure.

[0050] **Modified Example**

The present invention is not limited to the above-described embodiment, and various modifications may be made within the scope of the present invention.

[0051] For example, as shown in FIG. 2, the flow meter 81 may be provided on the fuel recovery line 41 so as to be located upstream of the shutoff valve 43 and detect a recovery flow rate Q_o of the LPG flowing out from the engine 11 through the fuel recovery line 41. To be specific, the controller 6 may control the pump 32 and the flow control valve 52 such that the recovery flow rate Q_o detected by the flow meter 81 becomes a predetermined value V' corresponding to the fuel consumption Q_e of the engine 11. In this case, the predetermined value V' is, for example, a value obtained by multiplying the fuel consumption Q_e of the engine 11 by the coefficient C that is typically 0.1 to 0.50.

[0052] Further, the predetermined values V and V' do not necessarily have to be fixed. The controller 6 may increase the predetermined values V and V' when the rotational frequency of the pump 32 has become the lowest rotational frequency. For example, in the configuration shown in FIG. 1, the predetermined value V may be increased to a flow rate that falls within a range from $1.1 \times Q_e$ to $11.0 \times Q_e$. In the configuration shown in FIG. 2, the predetermined value V' may be increased to a flow rate that falls within a range from $0.1 \times Q_e$ to $10.0 \times Q_e$.

[0053] In a case where the predetermined value V or V' is fixed and the flow control valve 54 provided on the second bypass line 53 is opened when the rotational frequency of the pump 32 has become the lowest rotational frequency, the LPG is made to return to the service tank 22 through the second bypass line 53 at an excess flow rate that is a flow rate obtained by subtracting the predetermined value V or V' from a discharge flow rate Q of the pump 32. Since the LPG corresponding to the excess flow rate has received heat at the pump 32, the temperature of the LPG in the service tank 22 increases. On the other hand, in a case where the predetermined value V or V' is increased when the rotational frequency of the pump 32 has become the lowest rotational frequency, the amount of LPG that is made to return to the service tank 22 through the second bypass line 53 can be reduced. On the other hand, by the increase of the predetermined value V or V' , the amount of LPG that flows through the engine 11 also increases, and this increased portion of the LPG is cooled by the cooler 44 provided on the fuel recovery line 41. Therefore, the increase in the temperature of the LPG in the service tank 22 can be suppressed.

[0054] Further, as shown in FIG. 2, the second supply pressure gauge 73 may be omitted.

In this case, the first pressure regulating valve 42 is controlled by using the pressure detected by the first supply pressure gauge 72.

[0055] In the above embodiment, in the pressure control while the supply of the LPG is being stopped, the rotational frequency of the pump 32 is controlled to be a fixed value that is the lowest rotational frequency. However, the rotational frequency of the pump 32 may be controlled to be a different fixed value or may be set variably in accordance with the pressure of the gaseous layer in the fuel tank 2 or temperature.

[0056] In the above embodiment, the fuel tank 2 is constituted by the storage tank 21 and the service tank 22. However, the storage tank 21 may be omitted, and the fuel tank 2 may be constituted only by the service tank 22. To be specific, the LPG may be directly introduced to the service tank 22 from the LPG supply source. However, according to the configuration of the above embodiment, the fuel tank 2 can be divided into the storage tank 21 for the introduction of the LPG and the service tank 22 for the circulation of the LPG.

Reference Signs List

[0057]	1	ship
	2	fuel tank
	6	controller
	11	propulsion engine
	31	fuel supply line
	32	pump
	34	shutoff valve
	41	fuel recovery line
	42	first pressure regulating valve
	43	shutoff valve
	51	first bypass line
	52	flow control valve
	53	second bypass line
	54	flow control valve
	72	first supply pressure gauge
	81	flow meter
	Qe	fuel consumption
	Qi	inflow rate
	Qo	outflow rate

CLAIMS

1. A ship comprising:
 - a fuel tank configured to store LPG;
 - a propulsion engine configured to use the LPG as fuel;
 - a fuel supply line through which the LPG is supplied from the fuel tank to the engine;
 - a pump provided on the fuel supply line;
 - a shutoff valve provided on the fuel supply line so as to be located downstream of the pump;
 - a fuel recovery line through which unconsumed LPG is recovered from the engine to the fuel tank;
 - a bypass line branching from the fuel supply line extending between the pump and the shutoff valve, the bypass line being connected to the fuel recovery line or the fuel tank;
 - a flow control valve provided on the bypass line;
 - a pressure gauge provided on the fuel supply line so as to be located downstream of the pump and upstream of the shutoff valve, the pressure gauge being configured to detect pressure of the LPG supplied from the pump;
 - a flow meter configured to detect a supply flow rate of the LPG flowing into the engine through the fuel line or a recovery flow rate of the LPG flowing out from the engine through the fuel recovery line; and
 - a controller configured to control a rotational frequency of the pump and the flow control valve, wherein:
 - when the shutoff valve is being closed, and supply of the LPG to the engine is being stopped, the controller controls the rotational frequency of the pump and/or the flow control valve such that the pressure of the LPG detected by the pressure gauge is maintained at required pressure required for operating the engine; and
 - when the shutoff valve is opened, and the LPG is supplied to the engine, the controller controls the rotational frequency of the pump and the flow control valve such that the flow rate detected by the flow meter becomes a predetermined value corresponding to a fuel consumption of the engine.

2. The ship according to claim 1, further comprising a pressure regulating valve provided on the fuel recovery line so as to be located upstream of a meeting point where the bypass line meets the fuel recovery line, wherein

when the shutoff valve is opened, and the LPG is supplied to the engine, the controller operates the pressure regulating valve to control the pressure of the LPG supplied to the engine.