GAS DISCHARGING SYSTEM FOR VESSEL, METHOD FOR DISCHARGING GAS, AND METHOD FOR RECYCLING DISCHARGED GAS

TECHNICAL FIELD

[1] The present invention relates to a gas discharge system for vessels, which discharges remaining fuel gas from an engine configured to use natural gas as fuel and a gas valve unit (GVU) upon occurrence of a problem with gas supply in the engine or upon interruption of engine operation.

BACKGROUND ART

[2] In general, various vessels, such as bulk cargo ships, container ships, passenger ships, and the like, employ a diesel engine using marine gas oil (MGO) or heavy fuel oil (HFO), such as bunker fuel oil C, and the like.

[3] Upon combustion of heavy oil and the like used as fuel in a fuel supply system of the diesel engine, there is a problem of environmental pollution caused by greenhouse gases and various harmful substances of exhaust gases. With increasing global demand for preventing environmental pollution, regulations on propulsion systems using heavy oil as fuel are also being tightened.

[4] In addition, when oil prices rise due to depletion of fossil fuels or unstable international situations, ships using heavy oil as fuel also suffer from problems with ship operation, such as rapid increase in fuel cost and the like.

[5] Thus, the use of other fuels for propulsion of ships, for example, the use of clean fuels, such as liquefied natural gas (LNG) or compressed natural gas (CNG), and the development of an engine configured to use different types of fuels are attempted in the art.

[6] A dual fuel engine, also known as the Honso engine in Korea, is a kind of hybrid engine that uses both gas and oil at the same time, and is an eco-friendly engine that can remarkably reduce fuel consumption, carbon emission and operating costs. Since liquefied natural gas contains less sulfur than heavy oil, the use of liquefied natural gas as fuel can reduce air pollution.

[7]

[8] FIG. 1 is a view of a ship including a conventional DF engine gas discharge

system.

[9] Referring to FIG. 1, a DF engine 1 is disposed within an engine room (E/R) and a gas valve unit (GVU) 2 configured to control the flux of boil-off gas or liquefied gas is disposed in a separate gas valve unit room (G/R).

[10] The gas valve unit room (G/R) is arranged rearward from the engine room (E/R) to the stern side of a vessel and is configured to allow ventilation at any time for system security in consideration of an explosion risk due to gas leakage.

[11] On the other hand, when the DF engine suffers from a problem with gas supply or when the DF engine is not operated for a long period of time or requires overhaul of the interior of the system, there is a need for removal of remaining fuel gas from the DF engine 1 and the gas valve unit 2.

[12] Since the remaining combustible fuel gas in the system can provide an explosion risk, the remaining fuel gas is removed for safety of the system.

[13] Conventionally, an exhaust line 4 for discharging the remaining fuel gas from the DF engine 1 and the gas valve unit 2, extend to a vent mast 3 disposed on a cargo tank, such that the remaining fuel gas can be discharged through the vent mast 3.

[14] In this case, even with a structure wherein the exhaust line 4 is connected to the vent mast 3 on the cargo tank disposed closest to the engine room E/R, a pipe constituting the exhaust line 4 extending from the engine room E/R and the gas valve unit room (G/R) to the vent mast 3 approaches a length of about 150m, thereby causing problems as follows.

[15] In order to allow the remaining fuel gas to be discharged through the pipe having a length of 150m without accumulation of liquid in the middle of the exhaust line, it is necessary to apply substantial pressure and to arrange the pipe so as not to generate an adverse pressure gradient.

[16] In addition, the pipe of the exhaust line 4 is generally prepared using stainless steel and the use of the pipe for constructing the exhaust line 4 to a length of 150 m causes increase in manufacturing cost due to increase in the amount of material, and butt welding generally performed for installation of the exhaust line 4 makes installation of the exhaust line 4 more difficult and requires more time and more labor for installation of the exhaust line 4 with increasing length of the exhaust line 4.

[17] Nevertheless, the vessel including the conventional DF engine gas discharge

system generally has the arrangement as shown in FIG. 1, in which the remaining fuel gas in the engine 1 and the gas valve unit 2 is forced to be sent to and discharged through the vent mast 3 separated a predetermined distance from the engine room in order to secure safety in discharge of the combustible fuel gas.

DISCLOSURE

【Technical Problem】

[18] An engine room is provided at a rear side thereof with a space that a person cannot access and, despite discussions about arrangement of gas exhaust lines in the space, arrangement of a gas discharge pipe near the engine room is considered to be dangerous and is not applied in practice and ship owners are extremely reluctant to employ this arrangement.

[19] In order to address such problems in the art, embodiments of the present invention are aimed at solving a fundamental cause of exclusion of such arrangement, that is, a safety problem, while achieving significant reduction in length of a pipe line through arrangement of a gas exhaust line at the rear side of the engine room.

[20] In addition, embodiments of the present invention provide a method of reusing a gas discharged through a gas discharge system according to embodiments of the present invention.

【Technical Solution】

[21] In accordance with one embodiment of the present invention, a gas discharge system for vessels includes: an engine using natural gas as fuel; a gas valve unit (GVU) controlling a flux of natural gas supplied to the engine; an exhaust line connected to the engine and the gas valve unit to discharge fuel gas from the engine and the gas valve unit; and an ejector disposed on the exhaust line, wherein the exhaust line extends to a space placed at the stern side from an engine room to allow the fuel gas discharged through the exhaust line to be discharged from the stern to sea water or the atmosphere.

[22] A gas valve unit room receiving the gas valve unit therein may be disposed

at the stern side from the engine room to be isolated from the engine room receiving the engine therein.

[23] The exhaust line may include a first exhaust line through which the fuel gas remaining in the engine is discharged; a second exhaust line through which the fuel gas remaining in the gas valve unit is discharged; and a third exhaust line to which the first exhaust line and the second exhaust line are joined such that the fuel gas transferred along the first exhaust line and the second exhaust line is discharged from the vessel through the third exhaust line, and the ejector may be disposed on the third exhaust line.

[24] A drive gas supply line may be connected to one side of the ejector to supply an inert gas g1 to the ejector, the inert gas g1 supplied to the ejector through the drive gas supply line may act as a drive fluid driving the ejector, and the ejector may generate a pressure for discharging a gas through the exhaust line.

[25] A first purging line may be connected to the engine to supply an inert gas g2 to the engine and a second purging line may be connected to the gas valve unit to supply the inert gas g2 to the gas valve unit such that the inert gas g2 is supplied to the engine and the gas valve unit through the first purging line and the second purging line, respectively, to generate an additional pressure for discharging a gas through the exhaust line in addition to the pressure generated by the ejector.

[26] The inert gas g1 supplied to the ejector and the inert gas g2 supplied to the engine and the gas valve unit may be nitrogen (N_2) gas.

[27] In accordance with another embodiment of the present invention, a gas discharge method of a gas discharge system for vessels includes: a blow-off step in which an exhaust line connected to an engine and a gas valve unit is opened to discharge remaining fuel gas in the engine and the gas valve unit to an outside of the vessel; and a purging step in which the remaining fuel gas is discharged from the engine and the gas valve unit through substitution with an inert gas g2 by supplying the inert gas g2 to the engine and the gas valve unit to generate a pressure for discharging the remaining fuel gas from the vessel through the exhaust line, wherein the exhaust line extends to a space placed at the stern side from an engine room to allow the fuel gas discharged through the exhaust line to be discharged from the stern to sea water or the atmosphere.

[28] In the blow-off step, an ejector disposed on the exhaust line may be driven to generate a pressure for discharging the remaining fuel gas through the exhaust line.

[29] In the purging step, the ejector disposed on the exhaust line may be driven to generate a pressure for discharging the inert gas g2 or a mixture of the remaining fuel gas and the inert gas g2 through the exhaust line.

[30]

[31] In accordance with a further embodiment of the present invention, a gas discharge system for vessels includes: an engine using a gas as fuel; a gas supply unit supplying fuel gas to the engine; a gas valve unit (GVU) disposed on a gas supply line, through which the fuel gas is supplied from the gas supply unit to the engine, to control a flux of the fuel gas supplied to the engine; an exhaust line connected to the engine and the gas valve unit to discharge a gas from the engine and the gas valve unit; and a fuel gas discharge line branched off from the exhaust line and connected to the gas supply unit to transfer the fuel gas discharged from the engine and the gas valve unit to the gas supply unit, wherein the fuel gas remaining in the engine and the gas valve unit is transferred to the gas supply unit through the exhaust line and the fuel gas discharge line to be reused.

[32] The gas discharge system may further include: a second ejector disposed on the fuel gas discharge line and operated to generate a pressure for transferring the fuel gas to the gas supply unit through the exhaust line and the fuel gas discharge line upon discharge of the remaining fuel gas from the engine or the gas valve unit.

[33] The gas discharge system may further includes: a three-way valve disposed at a branch point, at which the fuel gas discharge line is branched off from the exhaust line, and selectively controlling opening and closing of a pipe toward the exhaust line or the fuel gas discharge line; an inert gas separator disposed on the exhaust line downstream of the three-way valve and separating a mixture of the fuel gas and an inert gas into the fuel gas and the inert gas; a branch-off line through which the fuel gas separated by the inert gas separator is sent to the fuel gas discharge line; an inert gas discharge line through which the inert gas separated by the inert gas separator is discharged; and an inert gas supply unit storing the inert gas discharged through the inert gas discharge line.

[34] The gas discharge system may further include a first ejector disposed on the

inert gas discharge line, wherein, upon discharge of the remaining fuel gas from the engine or the gas valve unit through purging with the inert gas, only a pipe extending from the exhaust line to the inert gas discharge line is opened by the three-way valve and the first ejector is operated to generate a pressure for transferring the mixture of the fuel gas and the inert gas to the inert gas separator through the exhaust line and a pressure for transferring the inert gas separated by the inert gas separator to the inert gas supply unit through the inert gas discharge line.

[35] The gas discharge system may further include a second ejector disposed on the fuel gas discharge line to generate a pressure for transferring the fuel gas separated by the inert gas separator to the gas supply unit through the branch-off line and the fuel gas discharge line.

[36] A drive gas g1 for driving the first ejector may be supplied from the inert gas supply unit and a drive gas for driving the second ejector may be supplied through a drive gas line branched off from the gas supply line through which the fuel gas is supplied from the gas supply unit to the engine.

[37] A first purging line may be connected to the engine to supply an inert gas g2 to the engine and a second purging line may be connected to the gas valve unit to supply the inert gas g2 to the gas valve unit such that the inert gas g2 is supplied to the engine and the gas valve unit through the first purging line and the second purging line, respectively, to generate an additional pressure for discharging a gas through the exhaust line in addition to the pressure generated by the first ejector upon discharge of the remaining fuel gas from the engine or the gas valve unit through purging with the inert gas.

[38] The inert gas g1 supplied to the ejector and the inert gas g2 supplied to the engine and the gas valve unit may be nitrogen (N_2) gas.

[39] In accordance with yet another embodiment of the present invention, a discharged gas reuse method of a gas discharge system for vessels includes: a blow-off step in which an exhaust line connected to an engine and a gas valve unit is opened to discharge remaining fuel gas from the engine and the gas valve unit to an outside of a vessel; and a purging step in which the remaining fuel gas is discharged from the engine and the gas valve unit through substitution with an inert gas g2 by supplying the inert gas g2 to the engine and the gas valve unit to generate a pressure for

discharging the remaining fuel gas from the vessel through the exhaust line.

[40] In the blow-off step, only a fuel gas discharge line branched off from the exhaust line and connected to a gas supply unit may be opened to transfer the remaining fuel gas in the engine and the gas valve unit to the gas supply unit through the exhaust line and the fuel gas discharge line, and in the purging step, only a pipe extending from the exhaust line to an inert gas discharge line may be opened to separate a mixture of the fuel gas and the inert gas discharged from the engine and the gas valve unit into the fuel gas and the inert gas using an inert gas separator disposed on the exhaust line such that the separated fuel gas is sent to the fuel gas discharge line through a branch-off line to be transferred to the gas supply unit and the separated inert gas is transferred to an inert gas supply unit through the inert gas discharge line.

[41] The gas discharge system may include: a first ejector disposed on the inert gas discharge line and generating a pressure for transferring a gas; and a second ejector disposed on the fuel gas discharge line and generating a pressure for transferring the gas, in which the second ejector is operated in the blow-off step and both the first ejector and the second ejector are operated in the purging step.

【Advantageous Effects】

[42] In a gas discharge system according to embodiments of the present invention, an exhaust line extends to a space at the rear side of an engine room such that fuel gas can be directly discharged at the stern of a vessel to eliminate a need for extension of the exhaust line to a vent mast, thereby enabling substantial reduction in length of the exhaust line, as compared with a typical gas discharge system in the art.

[43] In addition, an ejector is disposed on the exhaust line to generate a high discharge pressure such that fuel gas can be more rapidly discharged through the exhaust line and a vacuum is generated, thereby enabling complete removal of the remaining fuel gas from an engine and a gas valve unit while achieving discharge of the fuel gas through the exhaust line with a sufficient pressure even when an adverse pressure gradient is generated in the exhaust line.

[44] Further, the gas discharge system allows the remaining fuel gas discharged through the exhaust line to have a sufficient pressure through mixing with the inert

gas, whereby the remaining fuel gas can be discharged toward sea water at the stern.

[45] Further, according to one embodiment of the invention, the fuel gas discharged through the gas discharge system can be reused instead of being discharged from the vessel.

DESCRIPTION OF DRAWINGS

[46] FIG. 1 is a view of a vessel including a typical DF engine gas discharge system.

[47] FIG. 2 is a view of a gas discharge system according to a first embodiment of the present invention.

[48] FIG. 3 is a view of a gas discharge system according to a second embodiment of the present invention.

BEST MODE

[49] The above and other aspects and advantages of the present invention will become apparent from the detailed description with reference to the accompanying drawings. Like components will be denoted by like reference numerals throughout the accompanying drawings.

[50] Hereinafter, exemplary embodiments of the present invention will be described 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.

[51] A gas discharge system according to the present invention may be applied to a vessel provided with an engine using natural gas as fuel, for example, a liquefied natural gas carrier (LNGC) using LNG as a propulsion fuel.

[52]

[53] FIG. 2 is a view of a gas discharge system according to a first embodiment of the present invention.

[54] Referring to FIG. 2, the gas discharge system according to the first embodiment includes: an engine room 100 receiving an engine 10 therein; a gas valve unit room 200 disposed at the stern behind the engine room 100 and receiving a gas valve unit (GVU) 20 therein; an exhaust line 30 through which fuel gas remaining in

the engine 10 and the gas valve unit 20 is discharged; and an ejector 40 disposed on the exhaust line 30, wherein the exhaust line 30 extends from the engine 10 and the gas valve unit 20 to a space behind the engine room 100 at the stern, to discharge the remaining fuel gas from the stern side to sea water or a stable zone at a side surface of a vessel body.

[55] The engine 10 disposed in the engine room 100 may be a dual fuel engine which uses a dual fuel. However, it should be understood that the engine 10 is not limited to a particular type of engine and the present invention is applicable to any engines, such as an ME-GI engine, an X-DF engine, and the like, which use natural gas as fuel.

[56] The gas valve unit 20 is disposed on a fuel supply line for supplying boil-off gas or natural gas to the engine 10 to control the flux of the boil-off gas or the natural gas supplied to the engine 10, and is received in the gas valve unit room 200 independent of the engine room 100.

[57] The gas valve unit room 200 is arranged rearward from the engine room 100 to the stern side of a vessel to be isolated from the engine room 100. In addition, the gas valve unit room 200 may be provided with an exhaust fan 210 to allow continuous ventilation.

[58] The exhaust line 30 extends from the engine 10 or the gas valve unit 20 to a space behind the engine room 100 at the stern, to discharge the remaining fuel gas in the engine 10 and the gas valve unit 20 from the stern side to sea water or a stable zone at the side surface of the vessel body.

[59] With the structure wherein the exhaust line 30 extends to the space behind the engine room 100 at the stern such that the fuel gas can be directly discharged from the stern side, the gas discharge system according to this embodiment can significantly reduce the length of the exhaust line 30, as compared with a gas discharge system in the art. This is because the gas discharge system according to this embodiment does not require extension of the exhaust line to the vent mast unlike the gas discharge system in the art.

[60] The exhaust line 30 may include a first exhaust line 31 through which the remaining fuel gas in the engine 10 is discharged; a second exhaust line 32 through which the remaining fuel gas in the gas valve unit 20 is discharged; and a third exhaust

line 33 to which the first exhaust line 31 and the second exhaust line 32 are joined.

[61] The remaining fuel gas in the engine 10 discharged through the first exhaust line 31 merges with the remaining fuel gas in the gas valve unit 20 discharged through the second exhaust line 32 to be discharged from the vessel along the third exhaust line 33.

[62] A first exhaust valve 11 may be disposed on the first exhaust line 31 to open or close the first exhaust line 31 and a second exhaust valve 21 may be disposed on the second exhaust line 32 to open or close the second exhaust line 32.

[63] The first exhaust valve 11 and the second exhaust valve 21 may be controlled to discharge the remaining fuel gas from the engine 10 and the gas valve unit 20, respectively, by a controller 60.

[64] On the other hand, in order to further reduce the length of the exhaust line 30 as compared with the related art, it is necessary to control the remaining fuel gas in the engine 10 and the gas valve unit 20 to be discharged near the engine room 100. Thus, it is necessary to ensure stability by eliminating the risk of explosion of the remaining fuel gas discharged through the exhaust line 30.

[65] According to the first embodiment, the gas discharge system may include the ejector 40 disposed on the exhaust line 30 to remove the risk of explosion of the remaining fuel gas discharged through the exhaust line 30.

[66] The ejector 40 is preferably disposed on the third exhaust line 33 to which the first and second exhaust lines 31, 32 are joined.

[67] According to the present invention, since a well-known ejector is used as the ejector 40, description on constitution and operation of the ejector 40 will be briefly given or omitted and the following description will focus on components related to the present invention.

[68] The ejector 40 is a kind of pump based on the Venturi effect and is configured to generate a vacuum using pressure energy of a drive fluid having high pressure, so as to allow an inlet fluid to be easily discharged by high discharge pressure.

[69] According to this embodiment, a drive gas supplied to the ejector 40 through a drive gas supply line 41 acts as the drive fluid and the fuel gas discharged through the exhaust line 30 acts as the inlet fluid.

[70] According to the present invention, an inexplosive inert gas g1 is preferably

used as the drive gas. In particular, nitrogen (N_2) gas inevitably generated in an LNGC vessel is preferably used.

[71] The drive gas supply line 41 may be connected to one side of the ejector 40 to supply the drive gas to the ejector 40, and a drive gas control valve 42 may be disposed on the drive gas supply line 41 to control supply of the drive gas.

[72] When the drive gas control valve 42 is opened to supply the inert gas g1 to the ejector 40 through the drive gas supply line 41, the ejector 40 is operated to allow the inert gas g1 to be supplied to the exhaust line 30 through the ejector 40.

[73] Accordingly, the remaining fuel gas discharged from the engine 10 and the gas valve unit 20 is mixed with a large amount of the inert gas g1 supplied through the ejector 40 to become inexplosive, whereby the mixture of the remaining fuel gas and the inert gas g1 can be discharged through the exhaust line 30 near the engine room 100 instead of being supplied to the vent mast.

[74] In addition, the remaining fuel gas discharged through the exhaust line 30 has a sufficient pressure in the course of being mixed with the inert gas g1 and thus can be discharged to sea water at the stern side.

[75] The ejector 40 acts not only to supply the inert gas g1 to the exhaust line 30 but also to generate a discharge pressure through an ejector effect, thereby assisting in more rapid discharge of the fuel gas through the exhaust line 30, while enabling more complete removal of the remaining fuel gas from the engine 10 and the gas valve unit 20 through generation of a vacuum.

[76] The ejector 40 neither exhibits electric properties nor requires substantial maintenance and repair, and thus has very good stability in application to the gas discharge system according to the present invention.

[77]

[78] On the other hand, the gas discharge system according to the first embodiment may perform purging in order to achieve more complete removal of the remaining fuel gas from the engine 10 and the gas valve unit 20, after discharging the remaining fuel gas from the engine 10 and the gas valve unit 20 through the exhaust line 30.

[79] The gas discharge system according to the first embodiment may further include a first purging line 51 connected to one side of the engine 10 to supply a

purging gas to the engine 10; and a second purging line 52 connected to one side of the gas valve unit 20 to supply the purging gas to the gas valve unit 20.

[80] According to the present invention, an inexplosive inert gas g2 such as nitrogen (N_2) gas is preferably used as the purging gas, like the drive gas. The inert gas g1 used as the drive gas of the ejector 40 and the inert gas g2 used as the purging gas may be nitrogen (N_2) gas, which may be supplied from a nitrogen (N_2) gas generator (not shown) in the vessel.

[81] Upon purging, the inert gas g2 is supplied to the engine 10 and the gas valve unit 20 through the first purging line 51 and the second purging line 52 such that the remaining fuel gas is pushed by the inert gas g2 to be discharged through the exhaust line 30.

[82] Supply of the inert gas g2 to the engine 10 and the gas valve unit 20 through the first and second purging lines 51, 52 generates an additional pressure for discharge of the fuel gas from the vessel to the outside.

[83] The ejector 40 may also be operated upon purging, whereby more rapid purging can be performed through generation of a discharge pressure, and the inert gas g2 supplied to the engine 10 and the gas valve unit 20 can be completely discharged through the first and second purging lines 51, 52 through the exhaust line 30 by generating a vacuum.

[84] According to the first embodiment, the gas discharge system may further include the controller 60. When there is a problem with gas supply to the engine 10, the controller 60 performs control to allow the remaining fuel gas in the engine 10 and the gas valve unit 20 to be discharged.

[85] Accordingly, the controller controls opening/closing of the first exhaust valve 11 and the second exhaust valve 21, operation of the ejector 40 through opening/closing of the drive gas control valve 42, and supply of the inert gas g2 to the engine 10 and the gas valve unit 20 through the first and second purging lines 51, 52.

[86]

[87] Next, referring to FIG. 2, a gas discharge method according to the first embodiment will be described.

[88] When there is a problem with gas supply to the engine 10, such as tripping of the engine 10, when the engine 10 is not operated for a long period of time, or when

there is a need to overhaul the interior of the gas discharge system, a process of discharging the remaining fuel gas from the engine 10 and the gas valve unit 20 is performed. Here, the process of discharging the remaining fuel gas can be generally divided into two steps, that is, a blow-off step and a purging step.

[89] In the blow-off step, the remaining fuel gas in the engine 10 and the gas valve unit 20 is discharged as is by atmospheric pressure.

[90] In the blow-off step, the first exhaust valve 11 and the second exhaust valve 21 are opened to discharge the fuel gas remaining in the engine 10 and the gas valve unit 20 to the outside of the vessel along the exhaust line 30. The first exhaust valve 11 and the second exhaust valve 21 may be opened by the controller 60.

[91] In the blow-off step, the ejector 40 may be operated to assist in discharge of the fuel gas. When the drive gas control valve 42 is opened to operate the ejector 40, an inert gas g1 may be supplied from the drive gas supply line 41 to the exhaust line 30, and the fuel gas discharged along the exhaust line 30 may be mixed with a large amount of the inert gas g1 to be discharged from the vessel in a state that the fuel gas becomes inexplosive.

[92] The blow-off step may be performed in a time-delay manner. By way of example, the first and second exhaust valves 11, 21 may be opened to start discharge of the fuel gas through the exhaust line 30 and may be automatically closed after a preset time t.

[93] In the purging step, the fuel gas remaining in the engine 10 and the gas valve unit 20 is more completely removed therefrom through substitution with an inert gas.

[94] In the purging step, an inert gas g2 may be supplied to the engine 10 and the gas valve unit 20 through the first and second purging lines 51, 52, respectively.

[95] The inert gas g2 supplied to the engine 10 and the gas valve unit 20 through the first and second purging lines 51, 52 generates an additional pressure for discharging the remaining fuel gas from the engine 10 and the gas valve unit 20 to the outside of the vessel, whereby the remaining fuel gas can be completely pushed through the exhaust line 30, thereby securing efficient purging.

[96] In the purging step, the ejector 40 may also be operated to generate a discharge pressure, thereby enabling more rapid purging.

[97] When the remaining fuel gas is completely discharged from the engine 10

and the gas valve unit 20, the fuel gas in the engine 10 and the gas valve unit 20 is completely substituted with the inert gas g2, and supply of the inert gas g2 to the engine 10 and the gas valve unit 20 through the first and second purging lines 51, 52 is stopped.

[98] Accordingly, the inert gas g2 is present in the engine 10 and the gas valve unit 20 and may be discharged from the vessel by the discharge pressure generated by the ejector 40 as in the blow-off step, thereby completing the purging step.

[99] Like the blow-off step, the purging step may be performed in a time-delay manner. Alternatively, a gas detector (not shown) may be provided to the engine 10 or the gas valve unit 20, and the purging step may be performed until the remaining fuel gas is not detected by the gas detector.

[100] The ejector 40 may be used in all processes of generating a gas discharge pressure and may be maintained in an operating step from the blow-off step until the purging step is completed.

[101]

[102] FIG. 3 is a view of a gas discharge system according to a second embodiment of the present invention.

[103] The gas discharge system according to the second embodiment shown in FIG. 3 has the same configuration for gas discharge as the gas discharge system according to the first embodiment shown in FIG. 2 and further includes a configuration for reusing a discharged gas.

[104] Accordingly, the following description will focus on additional components of the second embodiment not included in the gas discharge system according to the first embodiment and detailed description of the same components as the gas discharge system according to the first embodiment will be omitted.

[105] In addition, the ejector 40 according to the first embodiment will be referred to as the first ejector 40 in the second embodiment for convenience of description.

[106] Referring to FIG. 3, the gas discharge system according to the second embodiment includes all of the components of the gas discharge system according to the first embodiment and further includes a fuel gas discharge line 310 branched off from the exhaust line 30 and connected to a gas supply unit 300; and a three-way valve 320 disposed at a branch point at which the fuel gas discharge line 310 is branched

off from the exhaust line 30.

[107] In addition, the gas discharge system according to the second embodiment further includes an inert gas separator 410 disposed on the exhaust line 30 downstream of the three-way valve 320 to separate a mixture of fuel gas and an inert gas into the fuel gas and the inert gas; an inert gas discharge line 420 through which the inert gas separated by inert gas separator 410 is discharged; a branch-off line 430 through which the fuel gas separated by the inert gas separator 410 is sent to the fuel gas discharge line 310; and an inert gas supply unit 400 storing the inert gas discharged through the inert gas discharge line 420.

[108]

[109] The gas supply unit 300 supplies fuel gas to the engine 10. The fuel gas is supplied from the gas supply unit 300 to the engine 10 through the gas valve unit 20 along a gas supply line 330.

[110] The fuel gas discharge line 310 is branched off from the exhaust line 30 and connected to the gas supply unit 300. The fuel gas discharge line 310 may be provided with a second ejector 311 to generate a pressure for transferring the gas from the exhaust line 30 and the fuel gas discharge line 310 to the gas supply unit 300.

[111] The second ejector 311 generates the pressure for transferring a gas through a pipe using the principle of the ejector described in the first embodiment of the present invention.

[112] A drive gas for driving the second ejector 311 may be supplied from a drive gas line 331 branched from the gas supply line 330 which the fuel gas is supplied from the gas supply unit 300 to the engine 10.

[113] An air separator 312 may be disposed on the fuel gas discharge line 310 upstream of the gas supply unit 300. Since the remaining fuel gas discharged in an initial stage can be mixed with air in the pipe during transfer of the remaining fuel gas to the gas supply unit 300, the air is removed and sent to the gas supply unit 300 by the air separator 312.

[114] The three-way valve 320 is disposed at a branch point at which the fuel gas discharge line 310 is branched off from the exhaust line 30. Supply of the gas transferred from the engine 10 and the gas valve unit 20 to the fuel gas discharge line 310 or the inert gas separator 410 may be determined by the three-way valve 320. The

three-way valve 320 may be controlled by the controller 60.

[115] The inert gas separator 410 is disposed on the exhaust line 30 downstream of the three-way valve 320. The inert gas separator 410 separates the mixture of the fuel gas and the inert gas into the fuel gas and the inert gas such that the separated inert gas is discharged through the inert gas discharge line 420 and the separated fuel gas is sent to the fuel gas discharge line 310 through the branch-off line 430 to be transferred to the gas supply unit 300.

[116] The inert gas separator 410 may be one of a membrane filter, a cyclone, a gas centrifuge, and a vortex tube.

[117] The first ejector 40 may be disposed on the inert gas discharge line 420 to generate a pressure for transferring the gas from the exhaust line 30 and the inert gas discharge line 420 to the inert gas supply unit 400.

[118] The first ejector 40 generates the pressure for transferring the gas through a pipe using the principle of the ejector described in the first embodiment.

[119] The inert gas supply unit 400 stores an inert gas discharged through the inert gas discharge line 420. The inert gas stored in the inert gas supply unit 400 may be used as a drive gas g1 of the first ejector 40 or a purging gas g2 to be supplied to the engine 10 and the gas valve unit 20, or may be used by a demand site in the vessel.

[120] That is, according to the second embodiment of the invention, the remaining fuel gas in the engine 10 and the gas valve unit 20 is transferred to the gas supply unit 300 through the fuel gas discharge line 310 and stored in the gas supply unit 300 to be reused. In addition, the inert gas used for purging the remaining fuel gas in the engine 10 and the gas valve unit 20 is separated from the fuel gas by the inert gas separator 410 and transferred to the inert gas supply unit 400 to be reused.

[121]

[122] Next, referring to FIG. 3, a method of reusing a discharged gas according to the second embodiment will be described.

[123] The gas discharge system discharges the remaining fuel gas from the engine 10 and the gas valve unit 20 by the same method as in the first embodiment of the invention.

[124] According to the second embodiment, instead of discharging the remaining fuel gas through the exhaust line 30, the discharged gas may be reused through the

additional components of the second embodiment.

[125] The method of reusing a discharged gas according to the second embodiment may differ depending upon the blow-off step and the purging step.

[126] In the blow-off step, the first exhaust valve 11 and the second exhaust valve 21 are opened to discharge the remaining fuel gas from the engine 10 and the gas valve unit 20, in which only the fuel gas is transferred through the exhaust line 30.

[127] Here, the pipe extending from the exhaust line 30 and connected to the inert gas separator 410 is closed and only the pipe extending therefrom and connected to the fuel gas discharge line 310 is opened by the three-way valve 320. Accordingly, all of the remaining fuel gas in the engine 10 and the gas valve unit 20 is transferred to the fuel gas discharge line 310 through the exhaust line 30.

[128] At this time, the second ejector 311 disposed on the fuel gas discharge line 310 is driven to generate a vacuum, thereby providing a pressure to force the fuel gas remaining in the engine 10 and the gas valve unit 20 to be easily transferred to the gas supply unit 300 through the exhaust line 30 and the fuel gas discharge line 30.

[129] The fuel gas transferred to the gas supply unit 300 through the fuel gas discharge line 310 may be stored in the gas supply unit 300 after complete removal of air using the air separator 312 disposed upstream of the gas supply unit 300.

[130]

[131] In the purging step, since the fuel gas remaining in the engine 10 and the gas valve unit 20 is removed through substitution with an inert gas, a mixture of the fuel gas and the inert gas discharged from the engine 10 and the gas valve unit 20 is transferred through the exhaust line 30.

[132] Here, the pipe connected to the fuel gas discharge line 310 is closed and the pipe connected to the inert gas separator 410 is opened by the three-way valve 320, thereby allowing the mixture of the fuel gas and the inert gas to be transferred to the inert gas separator 410.

[133] The mixture is separated into the fuel gas and the inert gas by the inert gas separator 410 such that the separated inert gas is transferred to the inert gas supply unit 400 and stored therein, and the separated fuel gas is sent to the fuel gas discharge line 310 through the branch-off line 430 and transferred to the gas supply unit 300.

[134] A check valve 431 may be disposed on the branch-off line 430 to force the

fuel gas separated by the inert gas separator 410 to flow only in the direction from the inert gas separator 410 toward the fuel gas discharge line 310.

[135] The fuel gas and the inert gas may be transferred to and stored in the gas supply unit 300 and the inert gas supply unit 400, respectively, to be reused.

[136] Here, the pressure for transferring the fuel gas and the inert gas through the exhaust line 30 and the pressure for transferring the fuel gas and the inert gas through the inert gas discharge line 420 may be provided by the first ejector 40, and the pressure for transferring the fuel gas through the fuel gas discharge line 310 may be provided by the second ejector 311.

[137]

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

CLAIMS

【Claim 1】

A gas discharge system for vessels, comprising:

an engine using natural gas as fuel;

a gas valve unit (GVU) controlling a flux of natural gas supplied to the engine;

an exhaust line connected to the engine and the gas valve unit to discharge fuel gas from the engine and the gas valve unit; and

an ejector disposed on the exhaust line,

wherein the exhaust line extends to a space placed behind an engine room at the stern side, to allow the fuel gas discharged through the exhaust line to be discharged from the stern to sea water or the atmosphere.

【Claim 2】

The gas discharge system for vessels according to claim 1, wherein a gas valve unit room receiving the gas valve unit therein is arranged rearward from the engine room to the stern side of a vessel to be isolated from the engine room receiving the engine therein.

【Claim 3】

The gas discharge system for vessels according to claim 1, wherein the exhaust line comprises:

a first exhaust line through which the fuel gas remaining in the engine is discharged;

a second exhaust line through which the fuel gas remaining in the gas valve unit is discharged; and

a third exhaust line to which the first exhaust line and the second exhaust line are joined such that the fuel gas transferred along the first exhaust line and the second

exhaust line is discharged from the vessel through the third exhaust line, and

the ejector is disposed on the third exhaust line.

【Claim 4】

The gas discharge system for vessels according to claim 1, wherein a drive gas supply line is connected to one side of the ejector to supply an inert gas g1 to the ejector, the inert gas g1 supplied to the ejector through the drive gas supply line acts as a drive fluid driving the ejector, and the ejector generates a pressure for discharging a gas through the exhaust line.

【Claim 5】

The gas discharge system for vessels according to claim 4, wherein a first purging line is connected to the engine to supply an inert gas g2 to the engine and a second purging line is connected to the gas valve unit to supply the inert gas g2 to the gas valve unit such that the inert gas g2 is supplied to the engine and the gas valve unit through the first purging line and the second purging line, respectively, to generate an additional pressure for discharging a gas through the exhaust line in addition to the pressure generated by the ejector.

【Claim 6】

The gas discharge system for vessels according to claim 5, wherein the inert gas g1 supplied to the ejector and the inert gas g2 supplied to the engine and the gas valve unit are nitrogen (N_2) gas.

【Claim 7】

A gas discharge method of a vessel, comprising:

a blow-off step in which an exhaust line connected to an engine and a gas valve unit is opened to discharge remaining fuel gas in the engine and the gas valve unit to an outside of the vessel; and

a purging step in which the remaining fuel gas is discharged from the engine and the gas valve unit through substitution with an inert gas g2 by supplying the inert gas g2 to the engine and the gas valve unit to generate a pressure for discharging the remaining fuel gas from the vessel through the exhaust line,

wherein the exhaust line extends to a space placed at the stern of the vessel behind an engine room to allow the fuel gas discharged through the exhaust line to be discharged from the stern to sea water or the atmosphere.

【Claim 8】

The gas discharge method according to claim 7, wherein, in the blow-off step, an ejector disposed on the exhaust line is driven to generate a pressure for discharging the remaining fuel gas through the exhaust line.

【Claim 9】

The gas discharge method according to claim 7, wherein, in the purging step, the ejector disposed on the exhaust line is driven to generate a pressure for discharging the inert gas g2 or a mixture of the remaining fuel gas and the inert gas g2 through the exhaust line.

【Claim 10】

A gas discharge system for vessels, comprising:

an engine using a gas as fuel;

a gas supply unit supplying fuel gas to the engine;

a gas valve unit (GVU) disposed on a gas supply line, through which the fuel gas is supplied from the gas supply unit to the engine, to control a flux of the fuel gas supplied to the engine;

an exhaust line connected to the engine and the gas valve unit to discharge a gas from the engine and the gas valve unit; and

a fuel gas discharge line branched off from the exhaust line and connected to

the gas supply unit to transfer the fuel gas discharged from the engine and the gas valve unit to the gas supply unit,

wherein the fuel gas remaining in the engine and the gas valve unit is transferred to the gas supply unit through the exhaust line and the fuel gas discharge line to be reused.

【Claim 11】

The gas discharge system for vessels according to claim 10, further comprising:

a second ejector disposed on the fuel gas discharge line and operated to generate a pressure for transferring the fuel gas to the gas supply unit through the exhaust line and the fuel gas discharge line upon discharge of the remaining fuel gas from the engine or the gas valve unit.

【Claim 12】

The gas discharge system for vessels according to claim 10, further comprising:

a three-way valve disposed at a branch point, at which the fuel gas discharge line is branched off from the exhaust line, and selectively controlling opening and closing of a pipe toward the exhaust line or the fuel gas discharge line;

an inert gas separator disposed on the exhaust line downstream of the three-way valve and separating a mixture of the fuel gas and an inert gas into the fuel gas and the inert gas;

a branch-off line through which the fuel gas separated by the inert gas separator is sent to the fuel gas discharge line;

an inert gas discharge line through which the inert gas separated by the inert gas separator is discharged; and

an inert gas supply unit storing the inert gas discharged through the inert gas discharge line.

【Claim 13】

The gas discharge system for vessels according to claim 12, further comprising:

a first ejector disposed on the inert gas discharge line,

wherein, upon discharge of the remaining fuel gas from the engine or the gas valve unit through purging with the inert gas, only a pipe extending from the exhaust line to the inert gas discharge line is opened by the three-way valve and the first ejector is operated to generate a pressure for transferring the mixture of the fuel gas and the inert gas to the inert gas separator through the exhaust line and a pressure for transferring the inert gas separated by the inert gas separator to the inert gas supply unit through the inert gas discharge line.

【Claim 14】

The gas discharge system for vessels according to claim 13, further comprising:

a second ejector disposed on the fuel gas discharge line to generate a pressure for transferring the fuel gas separated by the inert gas separator to the gas supply unit through the branch-off line and the fuel gas discharge line.

【Claim 15】

The gas discharge system for vessels according to claim 14, wherein a drive gas g1 for driving the first ejector is supplied from the inert gas supply unit and a drive gas for driving the second ejector is supplied through a drive gas line branched off from the gas supply line through which the fuel gas is supplied from the gas supply unit to the engine.

【Claim 16】

The gas discharge system for vessels according to claim 13, wherein a first purging line is connected to the engine to supply an inert gas g2 to the engine and a

second purging line is connected to the gas valve unit to supply the inert gas g2 to the gas valve unit such that the inert gas g2 is supplied to the engine and the gas valve unit through the first purging line and the second purging line, respectively, to generate an additional pressure for discharging a gas through the exhaust line in addition to the pressure generated by the first ejector upon discharge of the remaining fuel gas from the engine or the gas valve unit through purging with the inert gas.

【Claim 17】

The gas discharge system for vessels according to claim 16, wherein the inert gas g1 supplied to the ejector and the inert gas g2 supplied to the engine and the gas valve unit are nitrogen (N_2) gas.

【Claim 18】

A discharged gas reuse method of a gas discharge system for vessels, the method comprising:

a blow-off step in which an exhaust line connected to an engine and a gas valve unit is opened to discharge remaining fuel gas from the engine and the gas valve unit to an outside of a ship; and

a purging step in which the remaining fuel gas is discharged from the engine and the gas valve unit through substitution with an inert gas g2 by supplying the inert gas g2 to the engine and the gas valve unit to generate a pressure for discharging the remaining fuel gas from a vessel through the exhaust line,

wherein:

in the blow-off step, only a fuel gas discharge line branched off from the exhaust line and connected to the gas supply unit is opened to transfer the remaining fuel gas in the engine and the gas valve unit to the gas supply unit through the exhaust line and the fuel gas discharge line, and

in the purging step, only a pipe extending from the exhaust line to an inert gas discharge line is opened to separate a mixture of the fuel gas and the inert gas discharged from the engine and the gas valve unit into the fuel gas and the inert gas

using an inert gas separator disposed on the exhaust line such that the separated fuel gas is sent to the fuel gas discharge line through a branch-off line to be transferred to the gas supply unit and the separated inert gas is transferred to an inert gas supply unit through the inert gas discharge line.

【Claim 19】

The discharged gas reuse method according to claim 18, wherein the gas discharge system comprises:

a first ejector disposed on the inert gas discharge line and generating a pressure for transferring a gas; and

a second ejector disposed on the fuel gas discharge line and generating a pressure for transferring the gas,

the second ejector being operated in the blow-off step,

both the first ejector and the second ejector being operated in the purging step.