

【DESCRIPTION】

【Invention Title】

GAS TREATMENT SYSTEM AND SHIP INCLUDING THE SAME

5 【Technical Field】

[1] The present disclosure relates to a gas treatment system and a ship including the same.

【Background Art】

10 [2] A ship is a means of transportation that moves from a departure to a destination while storing a large amount of cargo, and a form of the ship, an internal structure thereof, and an operating speed thereof are determined depending on the type of cargo.

[3] As an example, when the cargo is a container, a cell guide for mounting
15 the container may be provided in the ship, and when the cargo is minerals or the like, a storage space (hold) for loading a large amount of cargo is provided in the ship.

[4] Alternatively, when the cargo is a fluid material, the ship may be equipped with a tank for storing the cargo. In particular, when the fluid
20 material is a gas material having a boiling point lower than room temperature, the tank is provided as a type for storing the material in a liquefied state.

[5] As an example, the tank may have a barrier and insulation wall

structure to stably store the material liquefied below the boiling point. The barrier/insulation wall structure of the tank may be changed depending on the boiling point of the material.

[6] Examples of materials transported in a liquefied state by the ship
5 include liquefied natural gas, liquefied petroleum gas, ammonia, carbon dioxide (CO₂), and hydrogen, and the ship is classified into a liquefied natural gas carrier, a liquefied petroleum gas carrier, a carbon dioxide carrier, or the like according to the material being transported.

[7] However, there is a problem that a ship built for transporting a specific
10 liquefied material is not suitable for transporting another material having a different boiling point. This is because specifications of devices required for treating gaseous materials naturally evaporated during a transportation process are different, and physical properties, such as a storage temperature of a material to be transported, are different from each other.

15 [8] That is, a conventional liquefied material carrier may not change the material to be transported, and thus, when various types of materials are transported, there is a problem in that enormous operating costs are inevitably consumed.

20 **【Disclosure】**

【Technical Problem】

[9] The present disclosure has been devised to solve the problems of the related art and provides a gas treatment system capable of selectively loading

and transporting liquefied petroleum gas or ammonia and a carbon dioxide in combination and thus securing versatility for loading and transportation of a liquefied material, and a ship including the same.

5 **【Technical Solution】**

[10] A gas treatment system according to an aspect of the present disclosure includes a re-liquefaction part that re-liquefies a gaseous material discharged from a storage tank, wherein the storage tank stores at least one of a first material or a second material, the re-liquefaction part includes a first cooler
10 that cools the first gaseous material using a refrigerant and a second cooler that cools the refrigerant, and the second material is cooled using the second cooler.

[11] In detail, the refrigerant that exchanges heat with the first gaseous material may include the second material.

15 [12] In detail, the re-liquefaction part may further include a first compressor that compresses the first gaseous material and a second compressor that compresses the refrigerant.

[13] In detail, the re-liquefaction part may exchange heat between the refrigerant compressed by the second compressor and cooled by the second
20 cooler and the first material compressed by the first compressor in the first cooler, to re-liquefy the first gaseous material.

[14] In detail, the re-liquefaction part may compress the second material by the second compressor and cool the second material in the second cooler, to

re-liquefy a second gaseous material.

[15] In detail, the re-liquefaction part may block flow of the first compressor when a second gaseous material is re-liquefied.

[16] In detail, the re-liquefaction part may include a circulation flow path
5 connecting the second compressor, the second cooler, and the first cooler in a closed form, a first re-liquefaction flow path connecting the storage tank, the first compressor, the first cooler, and the storage tank in series, and a second re-liquefaction flow path connecting the storage tank, the second compressor, the second cooler, and the storage tank in series.

10 [17] In detail, the second re-liquefaction flow path may branch from the circulation flow path downstream of the second cooler.

[18] In detail, the storage tank may store the first material at a first pressure and store the second material at a second pressure different from the first pressure.

15 [19] In detail, a working pressure of the first compressor may be different from a working pressure of the second compressor.

[20] In detail, a discharge pressure of the first compressor may be relatively higher than a discharge pressure of the second compressor.

[21] In detail, an internal pressure of the first re-liquefaction flow path may
20 be relatively higher than an internal pressure of the second re-liquefaction flow path.

[22] In detail, the first compressor and the second compressor may be provided in parallel, and the re-liquefaction part may further include a third

compressor that is provided in parallel to the first compressor and the second compressor and backs up at least one of the first compressor and the second compressor.

[23] In detail, the first material may include a carbon dioxide, and the
5 second material may include at least one of ammonia and liquefied petroleum gas.

[24] In detail, the gas treatment system may further include a fuel tank that stores liquefied gas, wherein the re-liquefaction part may further include a cold energy recovery device that exchanges heat between the gaseous material
10 and the liquefied gas.

[25] In detail, the cold energy recovery device may be provided on at least one of an upstream side of the first cooler and an upstream side of the second cooler, cool the gaseous material by the liquefied gas, and deliver the heated liquefied gas to a demand site.

15 [26] A ship according to an aspect of the present disclosure has the gas treatment system.

【 Advantageous Effects 】

[27] A gas treatment system according to the present disclosure and a ship
20 including the same may be provided to universally load materials having different storage pressures and may ensure transportation stability by effectively liquefying the materials when the materials are evaporated.

【 Description of Drawings】

[28] FIG. 1 is a conceptual view of a ship according to a first embodiment of the present disclosure.

[29] FIG. 2 is a conceptual view of a gas treatment system according to the
5 first embodiment of the present disclosure.

[30] FIG. 3 is a conceptual view of the gas treatment system according to the first embodiment of the present disclosure.

[31] FIG. 4 is a conceptual view of the gas treatment system according to the first embodiment of the present disclosure.

10 [32] FIG. 5 is a conceptual view of a gas treatment system according to a second embodiment of the present disclosure.

[33] FIG. 6 is a conceptual view of the gas treatment system according to the second embodiment of the present disclosure.

[34] FIG. 7 is a conceptual view of the gas treatment system according to
15 the second embodiment of the present disclosure.

[35] FIG. 8 is a conceptual view of a gas treatment system according to a third embodiment of the present disclosure.

[36] FIG. 9 is a conceptual view of a gas treatment system according to a fourth embodiment of the present disclosure.

20 [37] FIG. 10 is a conceptual view of the gas treatment system according to the fourth embodiment of the present disclosure.

[38] FIG. 11 is a conceptual view of the gas treatment system according to the fourth embodiment of the present disclosure.

[39] FIG. 12 is a conceptual view of a gas treatment system according to a fifth embodiment of the present disclosure.

[40] FIG. 13 is a conceptual view of the gas treatment system according to the fifth embodiment of the present disclosure.

5 [41] FIG. 14 is a conceptual view of the gas treatment system according to the fifth embodiment of the present disclosure.

【 Mode for Invention】

[42] The objectives, specific advantages, and novel features of the present
10 disclosure will become more apparent from the following detailed description and embodiments taken in conjunction with the accompanying drawings. In the specification, it should be noted that, in assigning reference numerals to components of the respective drawings, the same components are denoted by the same reference numerals as much as possible even when the components
15 are illustrated in different drawings. Further, in description of the present disclosure, when it is determined that a detailed description of well-known related technologies may make the subject matter of the present disclosure unnecessarily unclear, the detailed description will be omitted.

[43] In the present disclosure, although not illustrated in the drawings, it is
20 obvious that a pressure sensor PT, a temperature sensor TT, a flow sensor, a block valve, a control valve, a pressure control valve, and the like may be provided at appropriate positions without limitation. Further, measurement values obtained by the respective sensors may be variously used without

limitation for operating components which will be described below, and opening degrees of the valves may be appropriately controlled.

[44] Hereinafter, exemplary embodiments of the present disclosure will be described in detail with reference to the accompanying drawings.

5 [45] FIG. 1 is a conceptual view of a ship according to the present disclosure, and FIGS. 2 to 4 are conceptual views of a gas treatment system according to a first embodiment of the present disclosure.

[46] First, referring to FIG. 1, the present disclosure includes a ship 1 provided with a gas treatment system 10 which will be described below with
10 reference to FIG. 2 and the like. In this case, the ship 1 may be a carrier for loading a material, and the material may include at least cargo among cargo and fuel. Further, in the present disclosure, the ship 1 is a concept that includes not only a merchant ship but also a floating storage and regasification unit (FSRU), a floating production storage and offloading (FPSO), a bunkering
15 vessel, an offshore plant, and the like.

[47] The ship 1 according to the present disclosure includes a storage tank CT for storing a material. The storage tank CT may include at least one cargo tank provided inside a hull. In this case, the cargo tank may be referred to as a cargo tank or the like, and the plurality of cargo tanks may be arranged in a
20 longitudinal direction of the hull. Further, a material stored in the cargo tank may be treated as cargo that should be delivered from a departure to a destination.

[48] The material stored in the storage tank CT may have a boiling point

lower than a room temperature. Thus, at room temperature, the material may be naturally evaporated and converted into a gaseous material. The gaseous material generated in the storage tank CT is discharged to an outside of the storage tank CT and then treated, which will be described in detail below.

5 [49] In the specification, the material may include at least one of a first material and a second material. The first material and the second material may have the same boiling point or different boiling points. Further, the first material and the second material may be materials having different storage pressures. As an example, the first material may include carbon dioxide that
10 should be stored at a relatively high pressure (5 bar or higher) to suppress generation of dry ice, and the second material may include ammonia and liquefied petroleum gas that may be stored at atmospheric pressure.

[50] The ship 1 according to the present disclosure may be the ship 1 that transports at least one of the first material and the second material as cargo.
15 That is, the ship 1 may be used to transport the first material or may be used to transport the second material, and further, may be used to transport the first material and the second material at the same time. This ship 1 may be a carrier that loads both the first material and the second material.

[51] As an example, the ship 1 may be used to operate while the first
20 material is loaded in the storage tank CT, and after the transportation of the first material is fully completed, may be used to transport the second material after the material of the storage tank CT is replaced from the first material with the second material. Alternatively, the ship 1 may transport the first

material and the second material at the same time. As an example, the first material may be loaded in the one storage tank CT and the second material may be loaded in the other storage tank CT.

[52] In the specification, the first material and the second material may have
5 different storage pressures during loading. As an example, a loading pressure of the first material may be higher than a loading pressure of the second material. As described above, the first material may be carbon dioxide, and it is preferable that the carbon dioxide is stored at a high pressure (first pressure) to suppress the generation of dry ice. On the other hand, the second material
10 may be ammonia or the like and may be stored at an atmospheric pressure level (a second pressure relatively lower than the first pressure).

[53] To this end, the storage tank CT according to the present disclosure may be manufactured such that a storage limit pressure of the first material is provided as a design pressure, and accordingly, the storage tank CT may be
15 manufactured with a design pressure having a sufficient margin compared to a storage limit pressure of the second material. That is, the storage tank CT may be used to store the first material at a high pressure and, when necessary, to store the second material at a relatively low pressure, and the storage tank CT storing the second material may have a relatively greater margin for storing
20 the gaseous material than the storage tank CT storing the first material.

[54] The ship 1 according to the present disclosure may further include a fuel tank FT in addition to the storage tank CT. The fuel tank FT stores liquefied gas. In this case, the liquefied gas may be liquefied natural gas or the

like, and may have a boiling point lower than at least that of the material stored in the storage tank CT.

[55] A temperature of the liquefied gas stored in the fuel tank FT should be increased so that the liquefied gas is delivered to a demand site. In
5 consideration of this, a low temperature of the liquefied gas may be recovered by the material in the storage tank CT. This will be described in detail in a second embodiment below.

[56] The ship 1 may use the material stored in the storage tank CT as fuel. The ship 1 may be provided with a propulsion engine, a power generation
10 engine, and the like, and the propulsion engine or the like may generate energy by consuming the material discharged from the storage tank CT. Of course, the propulsion engine or the like may consume the liquefied gas stored in the fuel tank FT in addition to the material stored in the storage tank CT.

[57] The ship 1 is provided with the gas treatment system 10. The gas
15 treatment system 10 will be described in detail below. However, the gas treatment system 10 may further include a fuel supply part (reference numeral is not illustrated) in addition to a re-liquefaction part 100 which will be described below.

[58] The fuel supply part treats at least one of the material stored in the
20 storage tank CT and the liquefied gas stored in the fuel tank FT and supplies the treated material to the demand site. The demand site may be the propulsion engine described above, but the present disclosure is not limited thereto. The fuel supply part treats a liquid-phase or gaseous-phase material into a state

suitable for the demand site, and by way of example, may include a component for increasing a temperature and a pressure of the material.

[59] Hereinafter, the gas treatment system 10 provided in the ship 1 of according to the present disclosure will be described with reference to FIG. 2
5 and the like.

[60] Referring to FIGS. 2 to 4, the gas treatment system 10 according to the first embodiment of the present disclosure includes the re-liquefaction part 100. The gas treatment system 10 may further include the fuel supply part described above in addition to the re-liquefaction part 100 or may not include
10 the fuel supply part.

[61] The re-liquefaction part 100 re-liquefies the gaseous material discharged from the storage tank CT. The first material or the second material may be stored in the storage tank CT, and both the first material and the second material may have boiling points lower than room temperature.

15 [62] Thus, natural evaporation of the material is induced in the storage tank CT due to external heat intrusion. The gaseous material generated in the storage tank CT may be discharged to the outside of the storage tank CT to relieve a pressure of the storage tank CT. The material discharged to the outside of the storage tank CT may be delivered to the demand site and
20 consumed, but may be re-liquefied and recovered by the re-liquefaction part 100.

[63] The re-liquefaction part 100 may include a first compressor 110, a first cooler 120, a second compressor 210, a second cooler 220, and the like. The

first compressor 110 compresses the gaseous material. As an example, the first compressor 110 may compress the gaseous first material. The first compressor 110 may compress the first material to increase the boiling point of the gaseous first material.

5 [64] An operating pressure of the first compressor 110 may be in a range of 5 bar to 40 bar. This is in consideration of a case in which the first material is carbon dioxide, and a discharge pressure of the first compressor 110 may be varied depending on a composition and type of the first material. However, as will be described again below, the discharge pressure of the first compressor
10 110 may be relatively higher than a discharge pressure of the second compressor 210.

[65] The first compressor 110 may be provided in multiple stages and may have a form in which a plurality of compression stages are arranged in series. Further, the first compressor 110 may be provided with a cooler (reference
15 numeral is not illustrated) between the compression stages or downstream of the compression stages, and the cooler included in the first compressor 110 may be referred to as an intercooler or an aftercooler.

[66] The first compressor 110 may be provided on a first re-liquefaction flow path L10 through which the gaseous first material is discharged from the
20 storage tank CT. The first re-liquefaction flow path L10 connects the storage tank CT and the first compressor 110, and delivers the gaseous first material compressed by the first compressor 110 to the first cooler 120. The first re-liquefaction flow path L10 may connect the storage tank CT, the first

compressor 110, the first cooler 120, and the storage tank CT in series.

[67] The first cooler 120 cools the gaseous material using a refrigerant. The first cooler 120 may be provided downstream of the first compressor 110 and may cool the gaseous first material compressed by the first compressor 110
5 through heat exchange with the refrigerant.

[68] The first cooler 120 may have a flow path through which the first material flows and a flow path through which the refrigerant flows. The flow path through which the first material flows in the first cooler 120 may be provided in parallel with the first re-liquefaction flow path L10, and the flow
10 path through which the refrigerant flows in the first cooler 120 may be provided in parallel with a circulation flow path L20 which will be described below.

[69] After the first material is compressed in a sufficient pressure by the first compressor 110, the first material is cooled (liquefied) by the refrigerant in the
15 first cooler 120. Thereafter, the first material may be delivered to the storage tank CT along the first re-liquefaction flow path L10. However, the first material may not be liquefied only by heat exchange in the first cooler 120, and a pressure reducing valve (reference numeral is not illustrated) may be provided downstream of the first cooler 120 so that the first material is
20 sufficiently liquefied through pressure reduction.

[70] The gaseous first material is generated in the storage tank CT that stores the first material in a liquid phase, and the gaseous first material discharged from the storage tank CT is delivered to the first re-liquefaction

flow path L10. The first re-liquefaction flow path L10 may sequentially connect the storage tank CT, the first compressor 110, the first cooler 120, and the pressure reducing valve, and thus the gaseous first material may be liquefied while undergoing compression, cooling, and pressure reduction. The
5 liquefied first material may be recovered to the storage tank CT through the first re-liquefaction flow path L10 connected from the pressure reducing valve to the storage tank CT.

[71] The refrigerant used to cool the first material in the first cooler 120 may be an unlimited material. However, in the present embodiment, by way of
10 example, the refrigerant may include the second material.

[72] When the storage tank CT loads the second material, at least a portion of the second material as the refrigerant may be delivered to a front side and a rear side of the first cooler 120. The flow path through which the refrigerant flows in the first cooler 120 may form a portion of the circulation flow path
15 L20 in a closed state, and the second material may be filled on the circulation flow path L20.

[73] Thereafter, when the storage tank CT is changed to load the first material, the gaseous first material discharged from the storage tank CT may be cooled using the second material filled in the circulation flow path L20 as
20 the refrigerant.

[74] Of course, even when a loading target of the storage tank CT provided in the ship 1 is not changed from the second material to the first material, the second material stored in some of the storage tanks CT may be utilized as the

refrigerant for the first material stored in the other storage tanks CT.

[75] The second compressor 210 compresses the refrigerant used in the first cooler 120. The second compressor 210 may be provided as a multi-stage compressor identical/similar to the first compressor 110, and may have a
5 structure in which a cooler is provided.

[76] The refrigerant compressed by the second compressor 210 may include the second material as described above. To deliver the second material to the second compressor 210, the second compressor 210 may be provided in parallel with the first compressor 110 downstream of the storage tank CT.
10 That is, the gaseous material may be delivered from the storage tank CT to the first compressor 110 or the second compressor 210, the gaseous first material may be delivered to the first compressor 110, and the gaseous second material may be delivered to the second compressor 210.

[77] An working pressure of the second compressor 210 may be different
15 from that of the first compressor 110. That is, a suction pressure of the first compressor 110 may be lower than that of the second compressor 210. Further, the discharge pressure of the second compressor 210 may be relatively lower than that of the first compressor 110. As an example, an operating pressure of the second compressor 210 may be in a range of 0 bar to
20 15 bar.

[78] When the first material is carbon dioxide and the second material is ammonia, an internal pressure of the storage tank CT that stores the first material is set to be higher than an internal pressure of the storage tank CT that

stores the second material. In this case, a pressure of the gaseous first material discharged from the storage tank CT is formed to be relatively higher than that of the gaseous second material discharged from the storage tank CT, and thus the suction pressure of the first compressor 110 is higher than the suction
5 pressure of the second compressor 210.

[79] Further, the discharge pressure of the first compressor 110 may be provided to be relatively higher than the discharge pressure of the second compressor 210. In this case, a pressure difference may be formed between the first material and the refrigerant with respect to the first cooler 120. That is,
10 the gaseous first material compressed by the first compressor 110 and introduced into the first cooler 120 may have a higher pressure than the refrigerant (gaseous second material) compressed by the second compressor 210 (pressure-reduced by the pressure reducing valve), and then introduced into the first cooler 120.

15 [80] The second cooler 220 cools the refrigerant. The second cooler 220 may be provided downstream of the second compressor 210 on the circulation flow path L20, and may cool the refrigerant compressed by the second compressor 210 through heat exchange with a cold source. In this case, the cold source may include fresh water, seawater, and glycol water. Since the
20 refrigerant is sufficiently compressed and heated in the second compressor 210, the second cooler 220 may cool the compressed refrigerant even when seawater having a temperature above 0 degree Celsius is used.

[81] The re-liquefaction part 100 has the circulation flow path L20 through

which the refrigerant continuously circulates. The circulation flow path L20 may have a closed loop and may connect the second compressor 210, the second cooler 220, and the first cooler 120 in series. Thus, the refrigerant is compressed in the second compressor 210, cooled in the second cooler 220, and then heated through heat exchange with the first material in the first cooler 120, and thereafter, the refrigerant is delivered to the second compressor 210 again.

[82] Of course, the pressure reducing valve (reference numeral is not illustrated) may be provided on the circulation flow path L20 in a manner similar to that described in the first re-liquefaction flow path L10, and the pressure reducing valve may be provided between the second cooler 220 and the first cooler 120 to reduce the pressure of the refrigerant and cool the refrigerant.

[83] The refrigerant cooled by the pressure reducing valve may be used to cool the first material in the first cooler 120, and may be heated in the first cooler 120, may be then delivered to the second compressor 210, and may circulate back to the first cooler 120. The circulation flow path L20 that implements this circulation flow may be charged with the refrigerant by injecting the second material as needed.

[84] The re-liquefaction part 100 may cool the second material using the second cooler 220. One or more storage tanks CT may store at least one of the first material and the second material, and the first material may be recovered after compressed by the first compressor 110 and cooled by the refrigerant in

the first cooler 120. On the other hand, the second material may be recovered to the storage tank CT or the like after compressed by the second compressor 210 and cooled by the cold source in the second cooler 220.

[85] Similarly to the first re-liquefaction flow path L10 that connects the storage tank CT, the first compressor 110, the first cooler 120, and the storage tank CT in series, a second re-liquefaction flow path L30 that connects the storage tank CT, the second compressor 210, the second cooler 220, and the storage tank CT may be provided. However, the second re-liquefaction flow path L30 may partially overlap the circulation flow path L20 through which the refrigerant circulates.

[86] The refrigerant used to liquefy the first material flowing along the first re-liquefaction flow path L10 may flow along the circulation flow path L20 that connects the second compressor 210, the second cooler 220, and the first cooler 120 in a closed form. However, as described above, the refrigerant may be the second material, and thus the storage tank CT and the circulation flow path L20 may be connected to each other as needed.

[87] The second re-liquefaction flow path L30 is a component for liquefying the gaseous second material discharged from the storage tank CT that stores the second material but is also a component used to replenish the refrigerant in the circulation flow path L20. That is, the second re-liquefaction flow path L30 may extend from the storage tank CT, may be connected to the circulation flow path L20, and may share portions of the second compressor 210 and the second cooler 220 provided on the circulation flow path L20.

[88] However, the second re-liquefaction flow path L30 may branch from the circulation flow path L20 downstream of the second cooler 220. Thus, when the second material is used as the refrigerant, the second material is delivered to the first cooler 120 along the circulation flow path L20 downstream of the second cooler 220, but when the second material is a re-liquefaction target, the second material may be recovered to the storage tank CT downstream of the second cooler 220. In this case, the pressure reducing valve (reference numeral is not illustrated) may be provided between the second cooler 220 and the storage tank CT, which is similar to the above description.

[89] An internal pressure (from 5 bar to 40 bar) of the first re-liquefaction flow path L10 is relatively higher than an internal pressure (from 0 bar to 15 bar) of the second re-liquefaction flow path L30. This is because a pressure at which the first material is stored in the storage tank CT is higher than a pressure at which the second material is stored in the storage tank CT. Accordingly, a pressure difference between the first material and the second material (refrigerant) may occur in the first cooler 120, as described above.

[90] Hereinafter, a case in which the re-liquefaction part 100 re-liquefies the first material and a case in which the re-liquefaction part 100 re-liquefies the second material will be described with reference to FIGS. 3 and 4.

[91] FIG. 3 illustrates a fluid flow when the re-liquefaction part 100 re-liquefies the gaseous first material discharged from the storage tank CT, and FIG. 4 illustrates a fluid flow when the re-liquefaction part 100 re-liquefies the

gaseous second material discharged from the storage tank CT.

[92] First, referring to FIG. 3, the storage tank CT stores the first material at a first pressure that is a relatively high pressure, and the gaseous first material generated inside the storage tank CT is delivered from the storage tank CT to the first compressor 110 along the first re-liquefaction flow path L10. In this case, the first material may be delivered to the first cooler 120 after compressed by the first compressor 110 and may be recovered to the storage tank CT after cooled by the first cooler 120.

[93] On the other hand, the refrigerant (second material) may flow through the second compressor 210. The refrigerant may be filled in the circulation flow path L20 that connects the second compressor 210, the second cooler 220, and the like in a closed form. The refrigerant is compressed in the second compressor 210, cooled in the second cooler 220, and then delivered to the first cooler 120.

[94] The first cooler 120 cools the first material by heat exchange between the gaseous first material compressed by the first compressor 110 and the refrigerant cooled by the second cooler 220. That is, to re-liquefy the gaseous first material, the re-liquefaction part 100 exchanges heat between the refrigerant compressed by the second compressor 210 and cooled by the second cooler 220 and the first material compressed by the first compressor 110 in the first cooler 120. The first material cooled in the first cooler 120 may return to the storage tank CT while passing through the pressure reducing valve.

[95] On the other hand, referring to FIG. 4, the storage tank CT may store the second material at a second pressure which is a relatively low pressure. In this case, the gaseous second material discharged from the storage tank CT is delivered to the second compressor 210 along the second re-liquefaction flow path L30. The second material compressed by the second compressor 210 may be cooled by the cold source in the second cooler 220, and is recovered to the storage tank CT while passing through the pressure reducing valve.

[96] That is, to re-liquefy the gaseous second material, the re-liquefaction part 100 may compress the second material by the second compressor 210 and cool the second material by the second cooler 220. Further, when re-liquefying the gaseous second material, the re-liquefaction part 100 may block flow of the first compressor 110.

[97] Both the first material and the second material are re-liquefied using compression, heat exchange, and pressure reduction. However, when viewed based on the cold source, liquefaction of the first material may correspond to indirect heat exchange, and liquefaction of the second material may correspond to direct heat exchange.

[98] As described above, in the present embodiment, the second re-liquefaction flow path L30 forms a portion of the circulation flow path L20 of the refrigerant used for re-liquefying the first material, and the refrigerant that cools the first material includes the second material. In this case, even when a single system is used, stable re-liquefaction for the first material and the second material having different storage pressures may be ensured.

[99] As an example, the present embodiment may be used as an ammonia carrier that transports ammonia as the second material, and may be converted into a carbon dioxide carrier that transports carbon dioxide as the first material as needed. When the cargo of the ship 1 of the present disclosure is changed
5 from ammonia to carbon dioxide, an ammonia re-liquefaction line and equipment may be utilized for re-liquefying carbon dioxide, and ammonia may be used as the refrigerant for carbon dioxide.

[100] Thus, the ship 1 according to the present embodiment may cover all cases in which a system operating pressure varies in a state in which a single
10 system (line, equipment, etc.) is provided, and thus may be used as a dual-purpose ship for two materials having different transportation pressures.

[101] FIGS. 5 to 7 are conceptual views of the gas treatment system according to the second embodiment of the present disclosure. For reference, FIG. 6 illustrates a fluid flow when the re-liquefaction part 100 re-liquefies the
15 gaseous first material discharged from the storage tank CT, and FIG. 7 illustrates a fluid flow when the re-liquefaction part 100 re-liquefies the gaseous second material discharged from the storage tank CT.

[102] Referring to FIGS. 5 to 7, the gas treatment system 10 according to the second embodiment of the present disclosure may utilize the fuel tank FT. The
20 liquefied gas such as the liquefied natural gas is stored as fuel in the fuel tank FT, and the liquefied gas discharged from the fuel tank FT undergoes heating such that the liquefied gas is supplied to the demand site.

[103] However, the material stored in the storage tank CT may have a boiling

point lower than that of the liquefied gas stored in the fuel tank FT or the gaseous material discharged from the storage tank CT may have a temperature higher than that of the liquefied gas discharged from the fuel tank FT and directed to the demand site.

5 [104] The present embodiment may utilize this state of the liquefied gas for cooling the material. As an example, the present embodiment further includes a cold energy recovery device 300 that performs direct or indirect heat exchange between the gaseous material and the liquefied gas.

[105] The cold energy recovery device 300 may exchange heat between the
10 gaseous first material and the liquefied gas. To this end, the cold energy recovery device 300 is provided on the first re-liquefaction flow path L10. In detail, the cold energy recovery device 300 may be provided downstream of the first compressor 110 to cool the compressed first material and may be provided upstream of the first cooler 120 to cool the first material in advance
15 before liquefaction.

[106] Alternatively, when the re-liquefaction part 100 operates to liquefy the first material, the cold energy recovery device 300 may exchange heat between the refrigerant and the liquefied gas. This cold energy recovery device 300 may be provided on the circulation flow path L20 through which
20 the refrigerant circulates. As an example, the cold energy recovery device 300 may be provided downstream of the second compressor 210. The cold energy recovery device 300 is disposed downstream of the second compressor 210 and upstream of the second cooler 220 to implement previous cooling of the

refrigerant.

[107] Alternatively, the cold energy recovery device 300 may be provided on the circulation flow path L20 and may be disposed downstream of the second cooler 220. In this case, the refrigerant may be cooled in the second cooler 220
5 and then additionally cooled by the liquefied gas in the cold energy recovery device 300.

[108] Of course, the cold energy recovery device 300 provided on at least one of an upstream side and a downstream side of the second cooler 220 on the circulation flow path L20 may exchange heat between the refrigerant and the
10 liquefied gas as well as between the second material and the liquefied gas.

[109] The second re-liquefaction flow path L30 through which the second material flows may be provided to pass through the second compressor 210 and the second cooler 220, and the cold energy recovery device 300 provided upstream or downstream of the second cooler 220 may be disposed on the
15 second re-liquefaction flow path L30.

[110] Alternatively, the cold energy recovery device 300 may be provided to exchange heat between the cold source and the liquefied gas. That is, the cold energy recovery device 300 may be provided on a flow path through which the cold source flows in the second cooler 220, and as an example, may be
20 provided upstream of the second cooler 220 on a flow path of the cold source. Thus, the cold source cooled by the liquefied gas is introduced into the second cooler 220.

[111] One or more cold energy recovery devices 300 may be provided as

illustrated in FIG. 5 and the like and may be appropriately arranged on the first re-liquefaction flow path L10, the circulation flow path L20, the second re-liquefaction flow path L30, the cold source flow path, and the like.

[112] Further, in the cold energy recovery device 300 illustrated in the drawings, inlets A, B, C, and D and outlets A', B', C', and D' may be connected to each other in series or provided in parallel with each other. The liquefied gas discharged from the fuel tank FT may be delivered to the demand site, and as an example, the low-temperature liquefied gas may be introduced into the inlet D of the one cold energy recovery device 300, discharged through the outlet D', introduced into the inlet A of another cold energy recovery device 300, and then discharged through the outlet A'. Alternatively, the low-temperature liquefied gas discharged from the fuel tank FT may be divided and supplied to the inlets A and B of the two or more cold energy recovery devices 300 and may be discharged through the outlets A' and B' of the cold energy recovery devices 300. That is, the plurality of cold energy recovery devices 300 may be connected to each other based on at least one of series connection and parallel connection.

[113] Referring to FIG. 6, when the first material is re-liquefied, the first material moves along the first re-liquefaction flow path L10, the refrigerant circulates along the circulation flow path L20, and the cold source is delivered to the second cooler 220. In this case, all the cold energy recovery devices 300 illustrated in the drawings may be utilized.

[114] On the other hand, referring to FIG. 7, when the second material is re-

liquefied, the second material moves along the second re-liquefaction flow path L30, and flow before and after the first compressor 110 on the first re-liquefaction flow path L10 is blocked. Thus, among the cold energy recovery devices 300 illustrated in the drawings, at least the cold energy recovery device 300 provided on the first re-liquefaction flow path L10 may not be utilized.

[115] FIG. 8 is a conceptual view of a gas treatment system according to a third embodiment of the present disclosure.

[116] Referring to FIG. 8, in the gas treatment system 10 according to the third embodiment of the present disclosure, the first compressor 110 and the second compressor 210 may be provided in parallel. Of course, there may be no case in which both the first compressor 110 and the second compressor 210 compress the same material, but when a flow path through which a material may flow is examined regardless of actual flow of the material, it may be considered that the first compressor 110 and the second compressor 210 are provided in parallel.

[117] However, the compressor may need to stop operation when an unexpected situation occurs, and when the compressor stops the operation, overall operation of re-liquefaction becomes impossible. To prepare for this, the compressor should always be provided in a form capable of backup. Thus, a backup compressor may be added to the compressor although not illustrated in the drawings.

[118] However, when the backup compressor is provided in each of the first

compressor 110 and the second compressor 210 based on to FIG. 1, at least four compressors should be provided. This causes an increase in installation and operation costs.

[119] In order to resolve this disadvantages, in the present embodiment, the first compressor 110 and the second compressor 210 may be provided to be capable of backing up each other. That is, the first compressor 110 may be provided on the first re-liquefaction flow path L10, and further a backup flow path (reference numeral is not illustrated) that may connect an upstream side and a downstream side of the first compressor 110 on the first re-liquefaction flow path L10 and may pass through the second compressor 210 may be provided.

[120] Further, in contrast, the second compressor 210 may be provided on the second re-liquefaction flow path L30 or the circulation flow path L20, and a backup flow path (reference numeral is not illustrated) that may connect an upstream side and a downstream side of the second compressor 210 on the second re-liquefaction flow path L30 or the like and may pass through the first compressor 110 may be provided.

[121] Therefore, in the present embodiment, the first compressor 110 and the second compressor 210 may be provided to be backed up to each other. When the re-liquefaction part 100 re-liquefies the second material, the second compressor 210 operates, and the first compressor 110 that does not operate may back up the second compressor 210. However, when the re-liquefaction part 100 re-liquefies the first material, the first compressor 110 compresses the

first material and the second compressor 210 compresses the refrigerant, and thus another compressor waiting for operation is additionally required.

[122] Thus, the present embodiment further includes a third compressor 400 provided in parallel with the first compressor 110 and the second compressor 210. The third compressor 400 may back up at least one of the first compressor 110 and the second compressor 210.

[123] That is, when the re-liquefaction part 100 re-liquefies the first material, the first compressor 110 compresses the first material, the second compressor 210 compresses the refrigerant, and the third compressor 400 waits for operation. Further, when the re-liquefaction part 100 re-liquefies the second material, the second compressor 210 may compress the second material, and the first compressor 110 and the third compressor 400 may wait for operation.

[124] In order for the third compressor 400 to back up the first compressor 110 and the second compressor 210, backup flow paths may be provided on the first re-liquefaction flow path L10 and the circulation flow path L20, and the backup flow paths may be provided to pass through the third compressor 400. Thus, when a problem occurs in the first compressor 110 or the like while the first material is re-liquefied, the second compressor 210 may continuously compress the refrigerant, the third compressor 400 may back up the first compressor 110, and thus re-liquefaction of the first material may be ensured.

[125] FIGS. 9 to 11 are conceptual views of a gas treatment system according to a fourth embodiment of the present disclosure. For reference, FIG. 10 illustrates a fluid flow when the re-liquefaction part 100 re-liquefies the

gaseous first material discharged from the storage tank CT, and FIG. 11 illustrates a fluid flow when the re-liquefaction part 100 re-liquefies the gaseous second material discharged from the storage tank CT.

[126] Referring to FIGS. 9 to 11, the gas treatment system 10 according to the fourth embodiment of the present disclosure further includes a gas-liquid separator 230 and an intercooler 240 as compared with the first embodiment.

[127] The gas-liquid separator 230 separates the refrigerant into a gaseous phase and a liquid phase. The gas-liquid separator 230 may be provided upstream of the second compressor 210. Only the gaseous refrigerant separated by the gas-liquid separator 230 may be introduced into the second compressor 210, and the liquid refrigerant separated by the gas-liquid separator 230 may remain in the gas-liquid separator 230. Therefore, inflow of the liquid into the second compressor 210 is suppressed.

[128] The present embodiment provides the gas-liquid separator 230 to prepare for a possibility that at least a portion of the refrigerant exists in a liquid phase on the circulation flow path L20. As an example, when the refrigerant is a mixed refrigerant MR or liquefied petroleum gas, the gas-liquid separator 230 may prevent the liquid phase that may be included in the refrigerant from being introduced into the second compressor 210 and may deliver only the gaseous refrigerant to the second compressor 210.

[129] As illustrated in FIG. 10, the gas-liquid separator 230 is provided to separate the refrigerant into the gaseous phase and the liquid phase. However, as illustrated in FIG. 11, the second material may also pass through the gas-

liquid separator 230. In this case, the gas-liquid separator 230 may separate the second material into a gaseous phase and a liquid phase and may allow only the gaseous second material to be delivered to the second compressor 210.

[130] The intercooler 240 exchanges heat between refrigerants of which at least one of pressures and temperatures is different. The intercooler 240 may be provided downstream of the second cooler 220 and may exchange heat between the refrigerants discharged from the second cooler 220 and then separated into a first flow and a second flow.

[131] As an example, the intercooler 240 may exchange heat between a portion of the refrigerant cooled by the second cooler 220 and the other portion of the refrigerant cooled by the second cooler 220. In this case, the portion of the refrigerant is delivered to the first cooler 120 after passing through the intercooler 240, and a temperature of the other portion of the refrigerant is reduced while a pressure thereof is reduced by the pressure reducing valve (reference numeral is not illustrated) before the other portion of the refrigerant introduced into the intercooler 240. Thus, the intercooler 240 may implement a function of cooling the refrigerant delivered from the second cooler 220 to the first cooler 120.

[132] The other portion of the refrigerant that branches downstream of the second cooler 220, is pressure-reduced by the pressure reducing valve, and exchanges heat in the intercooler 240 may be delivered to the second compressor 210 along a branch flow path L40. The other portion of the refrigerant discharged from the intercooler 240 may be delivered to an inlet or

an intermediate end of the second compressor 210, which may be changed depending on a degree of pressure reduction of the pressure reducing valve.

[133] The intercooler 240 may be provided in a form of a heat exchanger in which two streams flow sequentially or may be provided in a form of a drum
5 in which at least one stream is temporarily stored.

[134] As described above, the circulation flow path L20 may allow the refrigerant to be separated into the gaseous phase and the liquid phase in the gas-liquid separator 230, may allow the gaseous phase to be delivered to the second compressor 210, and may connect the second cooler 220, the
10 intercooler 240, and the first cooler 120 in series. Further, the branch flow path L40 may be provided between the second cooler 220 and the intercooler 240 on the circulation flow path L20, and the branch flow path L40 may be provided with the pressure reducing valve upstream of the intercooler 240.

[135] Further, in the present embodiment, as illustrated in FIG. 11, the
15 intercooler 240 may be used when liquefying the second material. That is, the second material compressed by the second compressor 210 may be cooled in the second cooler 220 and then divided into a portion of the second material and the other portion of the second material upstream of the intercooler 240. In this case, the other portion of the second material may be pressure-reduced by
20 the pressure reducing valve and may be used to cool the portion of the second material in the intercooler 240.

[136] FIGS. 12 to 14 are conceptual views of a gas treatment system according to a fifth embodiment of the present disclosure. For reference, FIG.

13 illustrates a fluid flow when the re-liquefaction part 100 re-liquefies the gaseous first material discharged from the storage tank CT, and FIG. 14 illustrates a fluid flow when the re-liquefaction part 100 re-liquefies the gaseous second material discharged from the storage tank CT.

5 [137] Referring to FIGS. 12 to 14, the gas treatment system 10 according to the fifth embodiment of the present disclosure may further include an accumulator 250 as compared with the fourth embodiment described above, and a cooling flow path L21 may be added in addition to the circulation flow path L20.

10 [138] The accumulator 250 accumulates the refrigerant. The accumulator 250 may be a component similar to that of the gas-liquid separator 230 described in the above fourth embodiment, and function to deliver the refrigerant to the first cooler 120 in addition to delivering the gaseous refrigerant to the second compressor 210.

15 [139] In the above embodiments, the refrigerant sequentially may circulate through the gas-liquid separator 230, the second compressor 210, the second cooler 220, the intercooler 240, and the first cooler 120 along the circulation flow path L20, but in the present embodiment, the circulation flow path L20 may connect the gas-liquid separator 230, the second compressor 210, the
20 second cooler 220, and the intercooler 240 and may not connect the first cooler 120. That is, the refrigerant flowing along the circulation flow path L20 is not introduced into the first cooler 120.

[140] Instead, in the present embodiment, the refrigerant provided in the

accumulator 250 may be delivered to the first cooler 120, and the cooling flow path L21 in a closed circuit form may be provided between the accumulator 250 and the first cooler 120. That is, the refrigerant may be cooled through the second cooler 220 and the like along the circulation flow path L20, and the cooled refrigerant may be stored in the accumulator 250. In this case, the accumulator 250 may deliver the low-temperature refrigerant to the first cooler 120. Thus, in the present embodiment, the refrigerant cooled by the second cooler 220 and the refrigerant transferred to the first cooler 120 may be different from each other.

[141] Further, in the present embodiment, the cooling of the refrigerant by the second cooler 220 and the delivery of the refrigerant to the first cooler 120 may be performed at different times. That is, the refrigerant may be cooled through the second cooler 220, stored in the accumulator 250 in a low-temperature state, and delivered to the first cooler 120 as needed. Thus, the accumulator 250 may be interpreted not only as a component that accumulates a flow rate of the refrigerant, but also as a component that accumulates low-temperature energy of the refrigerant.

[142] The present disclosure includes not only the embodiments described above but also combinations of the embodiments and embodiments generated by combinations of at least one of the embodiments and widely known technologies.

[143] Although the present disclosure has been described above in detail through the specific embodiments, the above description is merely intended to

describe the present disclosure in detail, and thus the present disclosure is not limited thereto. Further, it is obvious that those skilled in the art may derive changes or modifications thereof without departing from the technical spirit of the present disclosure.

- 5 [144] All simple modifications or changes of the present disclosure belong to the scope of the present disclosure, and the detailed scope of the present disclosure will be made clear by the appended claims.

【CLAIMS】

【 Claim 1 】 A gas treatment system comprising a re-liquefaction part configured to re-liquefy a gaseous material discharged from a storage tank,

wherein the storage tank stores at least one of a first material or a
5 second material,

wherein the re-liquefaction part includes:

a first cooler configured to cool a first gaseous material using a
refrigerant including the second material; and

a second cooler configured to cool the refrigerant, and

10 wherein the second material is cooled using the second cooler.

【Claim 2】 The gas treatment system of claim 1, wherein the first material includes a carbon dioxide, and

wherein the second material includes at least one of ammonia and
15 liquefied petroleum gas.

【Claim 3】 The gas treatment system of claim 1, wherein the re-liquefaction part further includes:

a first compressor configured to compress the first gaseous material;

20 and

a second compressor configured to compress the refrigerant.

【Claim 4】 The gas treatment system of claim 3, wherein the re-liquefaction

part exchanges heat between the refrigerant compressed by the second compressor and cooled by the second cooler and the first material compressed by the first compressor in the first cooler, to re-liquefy the first gaseous material.

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【Claim 5】 The gas treatment system of claim 3, wherein the re-liquefaction part compresses the second material by the second compressor and cools the second material in the second cooler, to re-liquefy a second gaseous material.

10 【Claim 6】 The gas treatment system of claim 3, wherein the re-liquefaction part blocks flow of the first compressor when a second gaseous material is re-liquefied.

15 【Claim 7】 The gas treatment system of claim 3, wherein the re-liquefaction part includes:

 a circulation flow path connecting the second compressor, the second cooler, and the first cooler in a closed form;

 a first re-liquefaction flow path connecting the storage tank, the first compressor, the first cooler, and the storage tank in series; and

20 a second re-liquefaction flow path connecting the storage tank, the second compressor, the second cooler, and the storage tank in series.

【Claim 8】 The gas treatment system of claim 7, wherein the second re-

liquefaction flow path branches from the circulation flow path downstream of the second cooler.

5 **【Claim 9】** The gas treatment system of claim 1, wherein the storage tank is configured to:

store the first material at a first pressure; and

store the second material at a second pressure different from the first pressure.

10 **【Claim 10】** The gas treatment system of claim 3, wherein a working pressure of the first compressor is different from a working pressure of the second compressor.

15 **【Claim 11】** The gas treatment system of claim 3, wherein a discharge pressure of the first compressor is relatively higher than a discharge pressure of the second compressor.

20 **【Claim 12】** The gas treatment system of claim 8, wherein an internal pressure of the first re-liquefaction flow path is relatively higher than an internal pressure of the second re-liquefaction flow path.

【Claim 13】 The gas treatment system of claim 4, wherein the first compressor and the second compressor are provided in parallel, and

wherein the re-liquefaction part further includes:

a third compressor provided in parallel to the first compressor and the second compressor and configured to back up at least one of the first compressor and the second compressor.

5

【Claim 14】 The gas treatment system of claim 1, further comprising:

a fuel tank configured to store liquefied gas,

wherein the re-liquefaction part further includes a cold energy recovery device configured to exchange heat between the gaseous material and the
10 liquefied gas, and is provided on at least one of an upstream side of the first cooler and an upstream side of the second cooler, cools the gaseous material by the liquefied gas, and delivers the heated liquefied gas to a demand site.