【DESCRIPTION】

【Invention Title】

EXHAUST GAS TREATMENT SYSTEM, AND SHIP COMPRISING SAME

【Technical Field】

[0001] The present disclosure relates to an exhaust gas treatment system for treating exhaust gas emitted from an exhaust gas emission device such as an engine, and a ship including the same.

【Background Art】

[0002] Ships include exhaust gas emission devices from which exhaust gas, such as an engine or a boiler, is discharged.

[0003] Among the exhaust gas emission devices is an exhaust gas emission device in which a gas such as low sulfur oil or LNG, as fuel, is burned to emit exhaust gas in which sulfur oxide are less than a predetermined treatment standard amount. In this case, the exhaust gas may be discharged to the outside without treating the sulfur oxide in the exhaust gas through an exhaust gas treatment system such as a scrubber or the like provided in a ship and connected to an exhaust gas emission device.

[0004] Meanwhile, carbon dioxide is designated as a greenhouse gas (GHG) causing global warming, and because it

accounts for 80% of the total greenhouse gas emissions, IMO (International Maritime Organization) under the UN has policies toward regulating the emission of carbon dioxide. Due to this, IMO finally decided to introduce an Energy Efficiency Design Index (EEDI) for new ships to be built in the future, and accordingly, GHG such as carbon dioxide is to be reduced by 30% compared to the existing amount, by 2025.

[0005] Therefore, there is a need to remove carbon dioxide even when exhaust gas in which sulfur oxide are less than the predetermined treatment standard amount is discharged from the exhaust gas emission device as described above.

[0006] In addition, in the case of an exhaust gas emission device using high sulfur oil as a fuel, the exhaust gas treatment system such as a scrubber or the like should remove carbon dioxide from the exhaust gas after removing sulfur oxide from the exhaust gas.

[0007] For example, a very large crude oil carrier (VLCC) using heavy fuel oil (HFO) as fuel produces about 70,000 tons of carbon dioxide per year, and in order to meet the EEDI phase 2 (20% reduction), various additional facilities such as a waste heat recovery system (WHRS) or an energy storage system (ESS) are required.

[0008] Meanwhile, it is possible to recover heat from exhaust gas by a heat recovery unit such as an economizer.

Heat recovered by the heat recovery unit is used for heating room or heating fuel by producing steam. In the related art, a temperature difference between the exhaust gases before and after heat is recovered by the heat recovery unit is not so large, so that heat of the exhaust gas recovered by the heat recovery unit is not much large.

【Disclosure】

【Technical Problem】

[0009] The present disclosure has been made upon recognition of at least one of demands or problems arising in the related art as described above.

[0010] An aspect of the present disclosure is to remove carbon dioxide from exhaust gas.

[0011] Another aspect of the present disclosure is to drain regulated gas-rich absorbent, which is a cooling liquid or aqueous absorbent used to remove carbon dioxide from exhaust gas or to recover regulated gas-rich absorbent and separate the aqueous absorbent from the regulated gas-rich absorbent.

[0012] Another aspect of the present disclosure is to increase heat of exhaust gas recovered by a heat recovery unit.

[0013] Another aspect of the present disclosure is to make an aqueous absorbent to be sprayed into exhaust gas by mixing seawater and an alkaline agent in order to remove

carbon dioxide from the exhaust gas.

【Technical Solution】

[0014] An exhaust gas treatment system and a ship including the same related to an embodiment for realizing at least one of the above problems may include the following features.

[0015] An exhaust gas treatment system according to an embodiment of the present disclosure includes: a reactor into which exhaust gas is introduced; and a treatment unit provided inside the reactor and spraying a cooling liquid and an aqueous absorbent (regulated gas-lean absorbent), or an aqueous absorbent, to exhaust gas to remove carbon dioxide from the exhaust gas, wherein the aqueous absorbent is an aqueous alkaline solution which chemically adsorbs carbon dioxide contained in the exhaust gas, thereby removing carbon dioxide from the exhaust gas, and regulated gas-rich absorbent, which is the cooling liquid or the aqueous absorbent sprayed to the exhaust gas and used to remove carbon dioxide from the exhaust gas, is drained or recovered so that the aqueous absorbent is separated from the regulated gas-rich absorbent.

[0016] In this case, the exhaust gas may be cooled to 100°C or lower before the exhaust gas is introduced into the reactor or before the aqueous absorbent is sprayed inside the reactor.

[0017] In addition, the exhaust gas treatment system may further include: a heat recovery unit recovering heat from the exhaust gas before the exhaust gas is introduced into the reactor, to cool the exhaust gas.

[0018] In addition, the treatment unit may include: a first spraying unit spraying the cooling liquid or the aqueous absorbent into the exhaust gas; a second spraying unit spraying the aqueous absorbent into the exhaust gas; and an aqueous absorbent tank storing the aqueous absorbent and connected to the first spraying unit and the second spraying unit to supply the aqueous absorbent thereto.

[0019] In addition, the cooling liquid may be seawater.

[0020] In addition, the reactor may include an exhaust gas inlet through which the exhaust gas is introduced, and at least a portion of the first spraying unit may be provided in a portion inside the reactor next to the exhaust gas inlet in a flow direction of the exhaust gas, and at least a portion of the second spraying unit may be provided in a portion inside the reactor next to the first spraying unit in the flow direction of the exhaust gas.

[0021] In addition, the reactor may include a regulated gas-rich absorbent drain port through which regulated gas-rich absorbent is drained, and a regulated gas-rich absorbent drainage line and a regulated gas-rich absorbent recovery line connected to the aqueous absorbent tank may

be connected to the regulated gas-rich absorbent drain port.

[0022] In addition, the regulated gas-rich absorbent drainage line may include a regulated gas-rich absorbent drainage valve, and the regulated gas-rich absorbent recovery line may include a regulated gas-rich absorbent recovery valve and a regulated gas-rich absorbent recovery pump.

[0023] In addition, the treatment unit may further include a third spraying unit spraying an aqueous absorbent into the exhaust gas, at least a portion thereof being provided in a portion inside the reactor next to the second spraying unit in the flow direction of the exhaust gas.

[0024] The first, second, and third spraying units may include first, second, and third supply pipes in which at least portions of one sides are provided inside the reactor and the other sides are connected to the aqueous absorbent tank, respectively, and a seawater spray supply line connected to a seawater source may be connected to the first supply pipe.

[0025] In addition, the seawater spray supply line may include a seawater spray supply valve and a seawater spray supply pump, the first, second, and third supply pipes may include first, second, and third aqueous absorbent supply valves, respectively, an aqueous absorbent supply line including an aqueous absorbent supply pump may be connected

to the aqueous absorbent tank, and the other sides of the first, second, and third supply pipes may be connected to the aqueous absorbent supply line.

[0026] In addition, the first, second, and third spraying units may further include first, second, and third spray nozzles respectively provided in portions of the first, second, and third supply pipes provided inside the reactor.

[0027] In addition, the regulated gas-rich absorbent recovery valve may be closed and the regulated gas-rich absorbent drainage valve may be opened to enter an open loop state, or the regulated gas-rich absorbent drainage valve may be closed and the regulated gas-rich absorbent recovery valve may be opened to enter a closed loop state.

[0028] In addition, in the open loop state, the first aqueous absorbent supply valve may be closed, the seawater spray supply valve and the second and third aqueous absorbent supply valves may be opened, the seawater spray supply pump and the aqueous absorbent supply pump may be operated so that seawater is sprayed from the first spray nozzle, the aqueous absorbent may be sprayed from the second and third spray nozzles, and regulated gas-rich absorbent may be discharged through the regulated gas-rich absorbent drainage line.

[0029] In addition, in the closed loop state, the seawater spray supply valve may be closed, at least one of the first,

second, and third aqueous absorbent supply valves may be opened, and the aqueous absorbent supply pump and the regulated gas-rich absorbent recovery pump may be operated, so that the aqueous absorbent may be sprayed from at least one of the first, second, and third spray nozzles, and regulated gas-rich absorbent may be recovered through the regulated gas-rich absorbent recovery line.

[0030] In addition, the first aqueous absorbent supply valve may be closed, the seawater spray supply valve may be opened, and the seawater spray supply pump may be operated, as necessary, so that seawater may be sprayed through the first spray nozzle.

[0031] In addition, the treatment unit may further include an aqueous absorbent preparing unit connected to the aqueous absorbent tank, preparing an aqueous absorbent, and supplying the aqueous absorbent to the aqueous absorbent tank.

[0032] In addition, the aqueous absorbent preparing unit may prepare an aqueous alkaline solution as an aqueous absorbent by mixing at least one of seawater and fresh water with an alkaline agent.

[0033]

[0034] An exhaust gas treatment system according to another embodiment of the present disclosure includes: a reactor into which exhaust gas is introduced; and a heat

recovery unit recovering heat from the exhaust gas before the exhaust gas is introduced into the reactor, wherein the exhaust gas may be cooled to 100°C or lower by the heat recovery unit.

[0035]

[0036] An exhaust gas treatment system according to another embodiment of the present disclosure includes: a reactor into which exhaust gas is introduced; and a treatment unit provided inside the reactor and spraying an aqueous absorbent into the exhaust gas to remove carbon dioxide from the exhaust gas, wherein the treatment unit includes an aqueous absorbent preparing unit preparing and supplying the aqueous absorbent, and the aqueous absorbent preparing unit may prepare an aqueous absorbent by mixing seawater with an alkaline agent.

[0037]

[0038] An exhaust gas treatment system according to another embodiment of the present disclosure includes: a reactor into which exhaust gas is introduced; and a treatment unit provided inside the reactor and spraying an aqueous absorbent into the exhaust gas to remove carbon dioxide from the exhaust gas, wherein the treatment unit includes an aqueous absorbent preparing unit preparing and supplying the aqueous absorbent, the aqueous absorbent preparing unit prepares the aqueous absorbent by mixing

seawater with an alkaline agent, the aqueous absorbent preparing unit includes a seawater tank in which seawater is stored, and the seawater tank may receive seawater from a seawater source and store the seawater.

[0039]

[0040] A ship according to an embodiment of the present disclosure includes: a hull; and the exhaust gas treatment system described above provided in the hull.

【Advantageous Effects】

[0041] According to the embodiment of the present disclosure as described above, it is possible to remove carbon dioxide from exhaust gas.

[0042] In addition, according to an embodiment of the present disclosure, regulated gas-rich absorbent, which is a cooling liquid or an aqueous absorbent, used to remove carbon dioxide from exhaust gas, may be drained, or regulated gas-rich absorbent may be recovered and an aqueous absorbent may be separated from regulated gas-rich absorbent.

[0043] In addition, according to an embodiment of the present disclosure, heat of exhaust gas recovered by the heat recovery unit may increase.

[0044] Further, according to an embodiment of the present disclosure, in order to remove carbon dioxide from exhaust gas, an aqueous absorbent to be sprayed to the exhaust gas

may be produced by mixing seawater with an alkaline agent.

【Description of Drawings】

[0045] FIG. 1 is a view illustrating a first embodiment of an exhaust gas treatment system according to the present disclosure.

[0046] FIG. 2 is a view illustrating an aqueous absorbent preparing unit and related components of the first embodiment of the exhaust gas treatment system according to the present disclosure.

[0047] FIG. 3 is a view illustrating a first embodiment of a ship according to the present disclosure.

[0048] FIG. 4 is an enlarged view of a portion of the first embodiment of the ship according to the present disclosure provided with the first embodiment of the exhaust gas treatment system according to the present disclosure.

[0049] FIG. 5 is a graph illustrating a rate of removing carbon dioxide from exhaust gas by an aqueous absorbent prepared by mixing fresh water with an alkaline agent and a rate of removing carbon dioxide from exhaust gas by an aqueous absorbent prepared by mixing seawater with an alkaline agent.

[0050] FIG. 6 is a view illustrating a second embodiment of an exhaust gas treatment system according to the present disclosure.

[0051] FIG. 7 is an enlarged view, like FIG. 4, illustrating a second embodiment of a ship according to the present disclosure.

[0052] FIG. 8 is a view illustrating a third embodiment of an exhaust gas treatment system according to the present disclosure.

[0053] FIG. 9 is an enlarged view, like FIG. 4, illustrating a third embodiment of a ship according to the present disclosure.

[0054] FIG. 10 is a view illustrating a fourth embodiment of an exhaust gas treatment system according to the present disclosure.

[0055] FIG. 11 is an enlarged view, like FIG. 4, illustrating a fourth embodiment of a ship according to the present disclosure.

【Mode for Invention】

[0056] Hereinafter, in order to help understand the features of the present disclosure as described above, an exhaust gas treatment system and a ship including the same according to embodiments of the present disclosure will be described in detail.

[0057] Hereinafter, embodiments most appropriate to help in understanding of the technical features of the present disclosure will be described, and the technical features of the present disclosure are not limited by the described

embodiments but merely illustrate implementation of the present disclosure through the embodiments described hereinafter. Therefore, the present disclosure may be variably modified within the scope of the present disclosure through the embodiments described below, and such modifications are within the scope of the present disclosure. In order to help understand the embodiments described hereinafter, the like or similar reference numerals are used for relevant components among the components having the same function in the respective embodiments in the accompanying drawings.

[0058]

[0059] First embodiment of exhaust gas treatment system and ship

[0060] Hereinafter, a first embodiment of an exhaust gas treatment system and a ship according to the present disclosure will be described with reference to FIGS. 1 to 5.

[0061] FIG. 1 is a view illustrating a first embodiment of an exhaust gas treatment system according to the present disclosure, FIG. 2 is a view illustrating an aqueous absorbent preparing unit and related components of the first embodiment of the exhaust gas treatment system according to the present disclosure, FIG. 3 is a view illustrating a first embodiment of a ship according to the present disclosure, FIG. 4 is an enlarged view of a portion

of the first embodiment of the ship according to the present disclosure provided with the first embodiment of the exhaust gas treatment system according to the present disclosure, and FIG. 5 is a graph illustrating a rate of removing carbon dioxide from exhaust gas by an aqueous absorbent prepared by mixing fresh water with an alkaline agent and a rate of removing carbon dioxide from exhaust gas by an aqueous absorbent prepared by mixing seawater with an alkaline agent.

[0062]

[0063] [Exhaust gas treatment system]

[0064] The first embodiment of an exhaust gas treatment system 100 according to the present disclosure may include a reactor 200 and a treatment unit 300.

[0065] The reactor 200 may be connected to an exhaust gas emission device 30 such as an engine 31 such as a main engine 31a or an engine 31b for power generation or a boiler 32 as shown in FIG. 4. Accordingly, exhaust gas emitted from the exhaust gas emission device 30 may be introduced into the reactor 200.

[0066] As shown in FIG. 1, the reactor 200 may include an exhaust gas inlet 210. In addition, the exhaust gas inlet 210 may be connected to an exhaust pipe PG connected to the exhaust gas emission device 30. As illustrated in FIG. 4, a flow path switching valve VR may be provided in a portion

in which the exhaust gas inlet 210 is connected to the exhaust pipe PG. When the flow path switching valve VR is switched to the exhaust gas inlet 210 side, the exhaust gas emitted from the exhaust gas emission device 30 may flow through the exhaust pipe PG, etc., and may be introduced into the reactor 200 through the exhaust gas inlet 210.

[0067] The exhaust gas inlet 210 may be provided in a lower portion of the reactor 200 as shown in FIG. 1. However, a portion of the reactor 200 in which the exhaust gas inlet 210 is provided is not particularly limited, and the exhaust gas inlet 210 may be provided in any portion of the reactor 200 in which the exhaust gas inlet 210 is connected to the exhaust gas emission device 30 and through which the exhaust gas emitted from the exhaust gas emission device 30 is introduced into the reactor 200.

[0068] Meanwhile, a heat recovery unit 400 may be provided between the exhaust gas emission device 30 and the reactor 200. For example, as shown in FIGS. 3 and 4, the heat recovery unit 400 may be provided in the exhaust pipe PG to which the exhaust gas inlet 210 is connected.

[0069] Heat of the exhaust gas flowing from the exhaust gas emission device 30 to the reactor 200 may be recovered by the heat recovery unit 400. Accordingly, the exhaust gas flowing into the reactor 200 may be cooled to have a predetermined desired temperature or lower. In addition,

heat recovered by the heat recovery unit 400 may produce steam so as to be used for heating room or the like or heating fuel. Accordingly, thermal efficiency may be improved.

[0070] The heat recovery unit 400 may be, for example, a heat exchanger, an economizer, or a thermoelectric module. However, the heat recovery unit 400 is not particularly limited, and any known heat recovery unit may be used as long as it is provided between the exhaust gas emission device 30 and the reactor 200 to recover heat from the exhaust gas.

[0071] The exhaust gas may be cooled to, for example, 100°C or lower by the heat recovery unit 400. In the case of an economizer, which is a conventional heat recovery unit, a temperature of the exhaust gas after cooling is 160°C to 180°C due to formation of sulfuric acid and plugging of ash and heavy metals, but the exhaust gas treatment system 100 according to the present disclosure does not cause the aforementioned problem, and thus, a temperature of the exhaust gas after cooling may be made to be 100°C or lower. For example, in order to cool the exhaust gas by receiving heat from the exhaust gas, a flow rate of water flowing through the heat recovery unit 400 may be increased to cool the exhaust gas to have a temperature of 100°C or lower.

[0072] As described above, when the temperature of the exhaust gas is cooled to 100°C or lower by the heat recovery unit 400, a difference between temperature of the exhaust gas before being cooled by the heat recovery unit 400 and a temperature of the exhaust gas after being cooled by the heat recovery unit 400 may be relatively significant. The difference from the temperature of the exhaust gas may be relatively large. Accordingly, heat recovered by the heat recovery unit 400 may be relatively large. In addition, a temperature of the exhaust gas flowing into the reactor 200 through the exhaust gas inlet 210 may be an optimal condition in which carbon dioxide is removed by an aqueous absorbent (regulated gas-lean absorbent) to be described later.

[0073] The reactor 200 may include an exhaust gas outlet 220. An exhaust gas treated by the treatment unit 300, while flowing inside the reactor 200, for example, from which carbon dioxide is removed, may be discharged through the exhaust gas outlet 220. The exhaust gas outlet 220 may be provided above the reactor 200. However, a portion of the reactor 200 in which the exhaust gas outlet 220 is provided is not particularly limited, and the exhaust gas outlet 220 may be provided in any portion of the reactor 200 as long as the exhaust gas treated by the treatment unit 300 can be discharged therethrough.

[0074] The reactor 200 may include a regulated gas-rich absorbent drain port 230. Regulated gas-rich absorbent, which is a cooling liquid which has been sprayed into the reactor 200 by the treatment unit 300 to cool the exhaust or an aqueous absorbent which has treated the exhaust gas, for example, which has removed carbon dioxide or the like from the exhaust gas, may be drained through the regulated gas-rich absorbent drain port 230.

[0075] As shown in FIG. 1, a regulated gas-rich absorbent drainage line LD may be connected to the regulated gas-rich absorbent drain port 230, and the regulated gas-rich absorbent drainage line LD may be connected to a regulated gas-rich absorbent purification unit (not shown). In addition, the regulated gas-rich absorbent drained from the regulated gas-rich absorbent drain port 230 is supplied to the regulated gas-rich absorbent purification unit through the regulated gas-rich absorbent drainage line LD, purified in the regulated gas-rich absorbent purification unit, and then drained to the outside, for example, to the outside of the ship 10. The regulated gas-rich absorbent drain port 230 may be provided in a lower portion of the reactor 200. However, the portion of the reactor 200 in which the regulated gas-rich absorbent drain port 230 is provided is not particularly limited, and regulated gas-rich absorbent drain port 230 may be provided in any portion of the

reactor 200 as long as regulated gas-rich absorbent may be drained therefrom.

[0076] As shown in FIG. 1, a porous plate PH may be provided in a portion next to the exhaust gas inlet 210 in the exhaust gas flow direction inside the reactor 200. Accordingly, the exhaust gas introduced into the reactor 200 through the exhaust gas inlet 210 may pass through the porous plate PH. A distribution of a flow rate of the exhaust gas in the reactor 200 may be relatively uniform due to the porous plate PH. Accordingly, the exhaust gas may be smoothly treated by the treatment unit 300.

[0077] A first spraying unit 310 and a second spraying unit 320, which will be described later, included in the treatment unit 300, may be provided in a portion next to the porous plate PH in the flow direction of the exhaust gas in the reactor 200. A packing PC may be provided in a portion of the reactor 200 between the first spraying unit 310 and the second spraying unit 320. Due to the packing PC, a contact region and a contact time of the aqueous absorbent sprayed from the second spraying unit 320 and the exhaust gas may be increased to improve a rate of removing carbon dioxide from the exhaust gas based on the aqueous absorbent.

[0078]

[0079] The treatment unit 300 may be provided inside the

reactor 200 to remove carbon dioxide and the like from the exhaust gas flowing inside the reactor 200. For example, the treatment unit 300 may remove carbon dioxide from the exhaust gas by spraying an aqueous absorbent capable of chemically adsorbing carbon dioxide contained in the exhaust gas into the reactor 200. The aqueous absorbent may be, for example, an aqueous alkaline solution. For example, fresh water and sodium hydroxide (NaOH) as an alkaline agent may be mixed to prepare an aqueous sodium hydroxide solution as an aqueous alkaline solution. When the aqueous sodium hydroxide solution is used as an aqueous absorbent for removing carbon dioxide from the exhaust gas, a chemical reaction formula in which carbon dioxide is chemically adsorbed to the aqueous absorbent and removed from the exhaust gas is as follows.

[0080] [Chemical Reaction Formula]

[0081] $CO_2 + H_2O \leftrightarrow CO_3^{2-} + 2H^+$

[0082] $NaOH \leftrightarrow Na^+ + OH^-$

[0083] $CO_3^{2-} + 2Na^+ \leftrightarrow Na_2CO_3$

[0084] $2CO_3^{2-} + 2Na^+ + 2H^+ \leftrightarrow 2NaHCO_3$

[0085]

[0086] However, the aqueous alkaline solution serving as an aqueous absorbent is not limited to the aqueous sodium hydroxide solution, and any aqueous alkaline solution may be used. In addition, the aqueous absorbent is not limited

to the aqueous alkaline solution, and any known solution may be used as long as it is sprayed to exhaust gas to remove carbon dioxide from the exhaust gas.

[0087]

[0088] The treatment unit 300 may include a first spraying unit 310, a second spraying unit 320, and an aqueous absorbent tank 340, as shown in FIG. 1.

[0089] At least a portion of the first spraying unit 310 may be provided in a portion next to the exhaust gas inlet 210 in the flow direction of the exhaust gas inside the reactor 200. For example, the first spraying unit 310 may be provided in a portion between the porous plate PH and the packing PC inside the reactor 200.

[0090] The first spraying unit 310 may spray a cooling liquid into the exhaust gas. Accordingly, a temperature of the exhaust gas introduced into and flowing in the reactor 200 may be cooled to a temperature below a temperature at which carbon dioxide is chemically adsorbed to the aqueous absorbent and removed from the exhaust gas. For example, a temperature of the exhaust gas introduced into the reactor 200 through the exhaust gas inlet 210 and flowing therein may be cooled to 100°C or lower by the cooling liquid sprayed from the first spraying unit 310. Meanwhile, as described above, when the exhaust gas is cooled by the heat recovery unit 400 and a temperature of the exhaust gas is

lowered to, for example, 100°C or lower before flowing into the reactor 200, the first spraying unit 310 may not spray the cooling liquid.

[0091] The cooling liquid sprayed from the first spraying unit 310 may be seawater, for example. However, the cooling liquid sprayed from the first spraying unit 310 is not particularly limited, and any known cooling liquid may be used as long as it can be sprayed to the exhaust gas so that a temperature of the exhaust gas is lowered to a temperature at which carbon dioxide is chemically adsorbed to the aqueous absorbent so as to be removed from the exhaust gas.

[0092] The first spraying unit 310 may include a first supply pipe 311 and a first spray nozzle 312.

[0093] At least a portion of one side of the first supply pipe 311 may be provided inside the reactor 200. In addition, the other side of the first supply pipe 311 may be connected to a cooling liquid source (not shown). In addition, a pump P and a valve V may be provided in the first supply pipe 311 as shown in FIG. 1. Accordingly, when the valve V is opened and the pump P is driven, the cooling liquid of the cooling liquid source, for example, seawater, may flow through the first supply pipe 311.

[0094] The first spray nozzle 312 may be provided in a portion of the first supply pipe 311 provided inside the

reactor 200. Accordingly, the cooling liquid flowing through the first supply pipe 311, for example, seawater, may be sprayed into the reactor 200 through the first spray nozzle 312. The cooling liquid may be sprayed into the reactor 200 in a direction opposite to the flow direction of the exhaust gas through the first spray nozzle 312. However, the cooling liquid may be sprayed into the reactor 200 in the exhaust gas flow direction through the first spray nozzle 312 or may be sprayed into the reactor 200 in a direction perpendicular to the exhaust gas flow direction to prevent channeling. That is, the cooling liquid may be sprayed into the reactor 200 in any direction.

[0095] At least a portion of the second spraying unit 320 may be provided in a portion next to the first spraying unit 310 inside the reactor 200. For example, the second spraying unit 320 may be provided in a portion next to the packing PC inside the reactor 200 as shown in FIG. 1. The second spraying unit 320 may include a second supply pipe 321 and a second spray nozzle 322.

[0096] At least a portion of one side of the second supply pipe 321 may be provided inside the reactor 200. In addition, the other side of the second supply pipe 321 may be connected to the aqueous absorbent tank 340 (to be described later) in which the aqueous absorbent is stored. In addition, the second supply pipe 321 may include a pump

P and a valve V. Accordingly, when the valve V is opened and the pump P is driven, the aqueous absorbent stored in the aqueous absorbent tank 340 may flow through the second supply pipe 321.

[0097] The second spray nozzle 322 may be provided in a portion of the second supply pipe 321 provided in the reactor 200. Accordingly, the aqueous absorbent flowing through the second supply pipe 321 may be sprayed into the reactor 200 through the second spray nozzle 322. The aqueous absorbent may be sprayed into the reactor 200 in a direction opposite to the flow direction of the exhaust gas through the second spray nozzle 322. However, the aqueous absorbent may be sprayed into the reactor 200 in the exhaust gas flow direction through the second spray nozzle 322 or may be sprayed into the reactor 200 in a direction perpendicular to the exhaust gas flow direction to prevent channeling. That is, the aqueous absorbent may be sprayed into the reactor 200 in any direction.

[0098] The aqueous absorbent tank 340 may store an aqueous absorbent. In addition, the other side of the second supply pipe 321 of the second spraying unit 320 may be connected to the aqueous absorbent tank 340. The aqueous absorbent tank 340 may include an aqueous absorbent component detection sensor 341 capable of detecting a component of the aqueous absorbent. When a component of

the aqueous absorbent detected by the aqueous absorbent component detection sensor 341 does not satisfy a predetermined desired component, at least a portion of the aqueous absorbent in the aqueous absorbent tank 340 may be sent to an aqueous absorbent preparing unit 350 to be described later or an aqueous absorbent prepared by the aqueous absorbent preparing unit 350 may be supplied to the aqueous absorbent tank 340.

[0099] The treatment unit 300 may further include the aqueous absorbent preparing unit 350. The aqueous absorbent preparing unit 350 may be connected to the aqueous absorbent tank 340 and may produce an aqueous absorbent and supply the aqueous absorbent to the aqueous absorbent tank 340. To this end, the aqueous absorbent preparing unit 350 may be connected to the aqueous absorbent tank 340 by an aqueous absorbent supply line LP as shown in FIG. 1. A valve V and a pump P may be provided in the aqueous absorbent supply line LP. Accordingly, when the valve V is opened and the pump P is driven, the aqueous absorbent prepared by the aqueous absorbent preparing unit 350 may be supplied to the aqueous absorbent tank 340 through the aqueous absorbent supply line LP.

[00100] The aqueous absorbent preparing unit 350 may recover at least a portion of the aqueous absorbent from the aqueous absorbent tank 340. For example, as described

above, when the component of the aqueous absorbent of the aqueous absorbent tank 340 detected by the aqueous absorbent component detection sensor 341 does not satisfy a predetermined desired component, at least a portion of the aqueous absorbent of the aqueous absorbent tank 340 may be recovered to the aqueous absorbent preparing unit 350.

[00101] To this end, the aqueous absorbent preparing unit 350 may be connected to the aqueous absorbent tank 340 by an aqueous absorbent recovery line LR. In addition, a valve V and a pump P may be provided in the aqueous absorbent recovery line LR. Accordingly, when the valve V is opened and the pump P is driven, at least a portion of the aqueous absorbent in the aqueous absorbent tank 340 may be recovered to the aqueous absorbent preparing unit 350.

[00102] In the aqueous absorbent preparing unit 350, at least one of seawater and fresh water may be mixed with an alkaline agent to prepare an aqueous alkaline solution as an aqueous absorbent.

[00103] As can be seen from the graph shown in FIG. 5, an aqueous alkaline solution, which is an aqueous absorbent made by mixing fresh water with an alkaline agent, has a higher rate of removing carbon dioxide from exhaust gas than an aqueous alkaline solution, which is an aqueous absorbent made by mixing seawater with an alkaline agent. However, in the case of mixing fresh water with an alkaline

agent to prepare an aqueous alkaline solution as an aqueous absorbent, more cost and equipment are required than the case of making an aqueous alkaline solution as an aqueous absorbent by mixing seawater with an alkaline agent. Therefore, the aqueous absorbent preparing unit 350 may prepare an aqueous alkaline solution as an aqueous absorbent in consideration of this relationship.

[00104] The aqueous absorbent preparing unit 350 may include a seawater tank 351, a fresh water tank 352, an alkaline agent tank 353, and a mixing tank 355, as shown in FIG. 2.

[00105] The mixing tank 355 may be connected to the seawater tank 351, the fresh water tank 352, and the alkaline agent tank 353, by connection lines LC. In addition, the mixing tank 355 receives seawater from the seawater tank 351, fresh water from the fresh water tank 352, and an alkaline agent such as sodium hydroxide (NaOH) from the alkaline agent tank 353. Accordingly, in the mixing tank 355, at least one of seawater and fresh water may be mixed with an alkaline agent to prepare an aqueous alkaline solution as an aqueous absorbent.

[00106] In this case, the seawater tank 351 may be connected to a seawater supply line LS connected to a seawater source (not shown) such as the ocean, for example, as shown in FIG. 2. A pump P may be provided in the

seawater supply line LS, and seawater may be supplied to the seawater tank 351 through the seawater supply line LS from the seawater source by driving the pump P of the seawater supply line LS.

[00107] A heater HE may be provided in the seawater supply line LS. By the heater HE, a temperature of seawater supplied to the seawater tank 351 through the seawater supply line LS may be equal to or higher than a predetermined temperature. For example, seawater supplied to the seawater tank 351 through the seawater supply line LS may be heated to 20°C or higher by the heater HE. As a result, it is possible to more easily prepare the aqueous absorbent in the mixing tank 355. If the temperature of the seawater supplied to the seawater tank 351 is lower than 20°C, even if seawater and the alkaline agent are mixed, the alkaline agent is difficult to dissolve in the seawater, and thus an aqueous alkaline solution as an aqueous absorbent is difficult to be produced. Therefore, when the seawater supplied to the seawater tank 351 is heated to 20°C or higher by the heater HE, the alkaline agent may be easily dissolved in the seawater, and thus, an aqueous alkaline, which is an aqueous absorbent, may be easily prepared by mixing seawater with the alkaline

[00108] The heater HE provided in the seawater supply line LS is not particularly limited, and any known heater

HE may be used as long as it is provided in the seawater supply line LS to heat seawater supplied to the seawater tank 351 through the seawater supply line LS to a predetermined temperature or higher.

[00109] The aqueous absorbent preparing unit 350 may further include an auxiliary agent tank 354. The auxiliary agent tank 354 may also be connected to the mixing tank 355 by a connection line LC.

[00110] In the auxiliary agent tank 354, an aqueous absorbent creation auxiliary agent that helps seawater and an alkaline agent to be mixed to become an aqueous absorbent may be stored. The auxiliary agent tank 354 may supply the aqueous absorbent creation auxiliary agent to the mixing tank 355. Accordingly, in a case in which the aqueous absorbent is prepared in the aqueous absorbent preparing unit 350 using seawater, when seawater and the alkaline agent are mixed, by-products, etc., formed by reaction of a component contained in the seawater and the alkaline agent with each other, may be removed. Accordingly, a carbon dioxide removal rate of the aqueous absorbent made of seawater containing more impurities than fresh water, to remove carbon dioxide from exhaust gas, may be prevented from lowering, compared with an aqueous absorbent made of fresh water. The aqueous absorbent creation auxiliary agent stored in the auxiliary agent tank

354 is not particularly limited, and any known aqueous absorbent creation auxiliary agent may be used as long as it may help to seawater and an alkaline agent to be mixed to become an aqueous absorbent.

[00111] In the exhaust gas treatment system 100 of this configuration, since the flow of the cooling liquid or the aqueous absorbent is in one direction and regulated gas-rich absorbent is not recovered and recycled, a component therefore is not required, and thus the configuration may be relatively simple.

[00112]

[00113] Meanwhile, the treatment unit 300 may further include an aqueous absorbent separation unit 360 as shown in FIG. 2.

[00114] The aqueous absorbent separation unit 360 may be connected to the aqueous absorbent tank 340 by an aqueous absorbent separation line LV. Also, as in the second to fourth embodiments of the exhaust gas treatment system 100 and the ship 10 according to the present disclosure to be described later, the aqueous absorbent tank 340 may be connected to the regulated gas-rich absorbent drain port 230 of the reactor 200 by a regulated gas-rich absorbent recovery line LW. In addition, regulated gas-rich absorbent, which is seawater or an aqueous absorbent sprayed into the reactor 200 and has

treated exhaust gas, may be recovered to the aqueous absorbent tank 340 through the regulated gas-rich absorbent recovery line LW. Accordingly, the regulated gas-rich absorbent may be mixed with the aqueous absorbent in the aqueous absorbent tank 340. In this manner, the regulated gas-rich absorbent recovered to the aqueous absorbent tank 340 may be supplied to the aqueous absorbent separation unit 360 through the aqueous absorbent separation line LV. For example, a valve V and a pump P may be provided in the aqueous absorbent separation line LV. In addition, as described above, when a component of the aqueous absorbent detected by the aqueous absorbent component detection sensor 341 provided in the aqueous absorbent tank 340 does not satisfy a predetermined desired component by the recovery of regulated gas-rich absorbent to the aqueous absorbent tank 340, the valve V of the aqueous absorbent separation line LV may be opened and the pump P may be operated so that regulated gas-rich absorbent, together with a portion of the aqueous absorbent, may be supplied to the aqueous absorbent separation unit 360 through the aqueous absorbent separation line LV.

[00115] The aqueous absorbent separation unit 360 may separate the aqueous absorbent from regulated gas-rich absorbent. For example, in the aqueous absorbent separation unit 360, the aqueous absorbent may be separated

from the regulated gas-rich absorbent by filtering foreign substances other than the aqueous absorbent from the regulated gas-rich absorbent using a filter (not shown). However, the configuration for separating the aqueous absorbent from the regulated gas-rich absorbent in the aqueous absorbent separation unit 360 is not particularly limited, and any known configuration may be used as long as it is capable of separating the aqueous absorbent from the regulated gas-rich absorbent.

[00116] The aqueous absorbent separation unit 360 and the mixing tank 355 of the aqueous absorbent preparing unit 350 may be connected by a separated aqueous absorbent supply line LF. Accordingly, the aqueous absorbent separated by the aqueous absorbent separation unit 360 may be supplied to the mixing tank 355 through the separated aqueous absorbent supply line LF. Accordingly, the aqueous absorbent, and fresh water or seawater or an alkaline agent or aqueous absorbent creation auxiliary agent used for preparing the aqueous absorbent may be saved.

[00117] A separated regulated gas-rich absorbent drainage line LDD may be connected to the aqueous absorbent separation unit 360. In addition, regulated gas-rich absorbent from which the aqueous absorbent is separated in the aqueous absorbent separation unit 360 may be drained through the separated regulated gas-rich absorbent drainage

line LDD. The separated regulated gas-rich absorbent drainage line LDD may be connected to the regulated gas-rich absorbent purification unit. The regulated gas-rich absorbent from which the aqueous absorbent is separated and drained through the separated regulated gas-rich absorbent drainage line LDD may be purified in the regulated gas-rich absorbent purification unit and then drained to the outside, for example, to the outside of the ship.

[00118]

[00119] [Ship]

[00120] A first embodiment of the ship 10 according to the present disclosure may include a hull 20 and the exhaust gas treatment system 100 described above.

[00121] As shown in FIGS. 3 and 4, the hull 20 includes an exhaust gas emission device 30 including an engine 31 such as a main engine 31a or an engine for power generation 31b or a boiler 32. In addition, the hull 20 may include a chimney 21 and a residential structure (or deck house) 22.

[00122] The exhaust gas treatment system 100 may be provided in the hull 20. For example, the exhaust gas treatment system 100 may be provided on the chimney 21 of the hull 20. Further, the exhaust gas treatment system 100 may be connected to the exhaust gas emission device 30 to treat the exhaust gas emitted from the exhaust gas emission device 30. A portion of the hull 20 in which the exhaust

gas treatment system 100 is provided is not particularly limited, and the exhaust gas treatment system 100 may be provided in any portion of the hull 20 in which the exhaust gas treatment system 100 is connected to the exhaust gas emission device 30 and treats exhaust gas emitted from the exhaust gas emission device 30.

[00123]

[00124] Second embodiment of exhaust gas treatment system and ship

[00125] Hereinafter, a second embodiment of an exhaust gas treatment system and a ship according to the present disclosure will be described with reference to FIGS. 6 and 7.

[00126] FIG. 6 is a view illustrating a second embodiment of an exhaust gas treatment system according to the present disclosure, FIG. 7 is an enlarged view, like FIG. 4, illustrating a second embodiment of a ship according to the present disclosure.

[00127] Here, a second embodiment of an exhaust gas treatment system and a ship according to the present disclosure is different from the first embodiment of the exhaust gas treatment system and the ship according to the present disclosure described above with reference to FIGS. 1 to 5, in that regulated gas-rich absorbent, which is a cooling liquid or an aqueous absorbent sprayed to exhaust

gas so as to be used for removing carbon dioxide from the exhaust gas, is drained, or regulated gas-rich absorbent is recovered and the aqueous absorbent is separated from regulated gas-rich absorbent.

[00128] Accordingly, a regulated gas-rich absorbent drainage valve VD is provided in the regulated gas-rich absorbent drainage line LD connected to the regulated gas-rich absorbent drain port 230 of the reactor 200, a regulated gas-rich absorbent recovery line LW connected to the aqueous absorbent tank 340 and including a regulated gas-rich absorbent recovery valve VW and a regulated gas-rich absorbent recovery pump PW are further connected to the regulated gas-rich absorbent drain port 230, the treatment unit 300 further includes a third spraying unit 330, first, second, and third supply pipes 311, 321, and 331 of the first, second, third spraying units 310, 320, and 330 are all connected to the aqueous absorbent tank 340, and a seawater spray supply line LE is connected to the first supply pipe 311, to name differences.

[00129] Therefore, hereinafter, the different components will be mainly described, and the remaining components may be referred to as those described above with reference to FIGS. 1 to 5.

[00130]

[00131] In the second embodiment of the exhaust gas

treatment system 100 and the ship 10 according to the present disclosure, as shown in FIG. 6, the regulated gas-rich absorbent drainage line LD connected to the regulated gas-rich absorbent drain port 230 of the reactor 200 includes the regulated gas-rich absorbent drainage valve VD, and the regulated gas-rich absorbent recovery line LW connected to the aqueous absorbent tank 340 and including a regulated gas-rich absorbent recovery valve VW and a regulated gas-rich absorbent recovery pump PW may be further connected to the regulated gas-rich absorbent drain port 230.

[00132] Accordingly, when the regulated gas-rich absorbent recovery valve VW is closed and the regulated gas-rich absorbent drainage valve VD is opened, regulated gas-rich absorbent discharged from the regulated gas-rich absorbent drain port 230 may be drained through the regulated gas-rich absorbent drainage line LD. That is, an open loop state is formed in which regulated gas-rich absorbent, which is a cooling liquid or an aqueous absorbent sprayed into the reactor 200 is drained through the regulated gas-rich absorbent drain line LD.

[00133] Also, when the regulated gas-rich absorbent drainage valve VD is closed, the regulated gas-rich absorbent recovery valve VW is opened, and the regulated gas-rich absorbent recovery pump PW is driven, then the

regulated gas-rich absorbent discharged from the regulated gas-rich absorbent drain port 230 may be recovered to the aqueous absorbent tank 340 through the regulated gas-rich absorbent recovery line LW. That is, a closed loop state may be formed in which regulated gas-rich absorbent, which is a cooling liquid or an aqueous absorbent sprayed into the reactor 200, is recovered. In this manner, the regulated gas-rich absorbent recovered to the aqueous absorbent tank 340 flows to the aqueous absorbent separation unit 360 through the aqueous absorbent separation line LV and the aqueous absorbent may be separated in the aqueous absorbent separation unit 360 as described above.

[00134] In the second embodiment of the exhaust gas treatment system 100 and the ship 10 according to the present disclosure, as shown in FIG. 6, the treatment unit 300 may further include the third spraying unit 330. At least a portion of the third spraying unit 330 may be provided in a portion next to the second spraying unit 320 in the exhaust gas flow direction inside the reactor 200.

[00135] The third spraying unit 330 may include a third supply pipe 331 and a third spray nozzle 332.

[00136] At least a portion of one side of the third supply pipe 331 may be provided inside the reactor 200. The third spray nozzle 332 may be provided in a portion of

the third supply pipe 331 provided in the reactor 200. Accordingly, the aqueous absorbent flowing through the third supply pipe 331 may be sprayed into the reactor 200 through the third spray nozzle 332. The aqueous absorbent may be sprayed into the reactor 200 in a direction opposite to the flow direction of the exhaust gas through the third spray nozzle 332. However, the aqueous absorbent may be sprayed into the reactor 200 in the exhaust gas flow direction through the third spray nozzle 332 and may be sprayed into the reactor 200 in a direction perpendicular to the exhaust gas flow direction to prevent channeling. That is, the aqueous absorbent may be sprayed into the reactor 200 in any direction.

[00137] In the second embodiment of the exhaust gas treatment system 100 and the ship 10 according to the present disclosure, the first, second, and third supply pipes 311, 321, and 331 of the first, second, and third spraying units 310, 320, and 330 may all be connected to the liquid tank 340. For example, as shown in FIG. 6, an aqueous absorbent supply line LT including an aqueous absorbent supply pump PT may be connected to the aqueous absorbent tank 340, and the first, second, and third supply pipes 311, 321, and 331 of the first, second, and third spraying units 310, 320, and 330 may all be connected to the aqueous absorbent supply line LT. In addition, first,

second, and third aqueous absorbent supply valves VT1, VT2, and VT3 may be provided in the first, second, and third supply pipes 311, 321, and 331, respectively.

[00138] In addition, in the second embodiment of the exhaust gas treatment system 100 according to the present disclosure, as shown in FIG. 6, the seawater spray supply line LE connected to a seawater source such as the sea or the like may be connected to the first supply pipe 311 of the first spraying unit 310. In this case, the seawater source may be a cooling liquid source. In addition, the seawater spray supply line LE may include a seawater spray supply valve VE and a seawater spray supply pump PE.

[00139] As described above, in an open loop state in which the regulated gas-rich absorbent recovery valve VW is closed and the regulated gas-rich absorbent drainage valve VD is opened, the first aqueous absorbent supply valve VT1 may be closed and the seawater spray supply valve VE and the second and third aqueous absorbent supply valves VT2 and VT3 may be opened. Also, the seawater spray supply pump PE and the aqueous absorbent supply pump PT may be operated.

[00140] Accordingly, seawater may be sprayed as a cooling liquid into the exhaust gas through the first spray nozzle 312 of the first spraying unit 310 and the aqueous absorbent of the aqueous absorbent tank 340 may be sprayed

to the exhaust gas through the second and third spray nozzles 322 and 332 of the second and third spraying units 320 and 330 to remove carbon dioxide from the exhaust gas. In this case, both or either of the second and third aqueous absorbent supply valves VT2 and VT3 may be opened depending on the amount of the aqueous absorbent to be sprayed.

[00141] In addition, in the closed loop state in which the regulated gas-rich absorbent drainage valve VD is closed and the regulated gas-rich absorbent recovery valve VW is opened, the seawater spray supply valve VE may be closed and the first, second, and third aqueous absorbent supply valves VT1, VT2, and VT3 may all be opened. Also, the aqueous absorbent supply pump PT and the regulated gas-rich absorbent recovery pump PW may be operated.

[00142] Accordingly, the aqueous absorbent of the aqueous absorbent tank 340 may be sprayed into the exhaust gas through the first, second, and third spray nozzles 312, 322, and 332 of the first, second, and third spraying units 310, 320, and 330 to remove carbon dioxide from the exhaust gas. In this case, all, two, or only one of the first, second, and third aqueous absorbent supply valves VT1, VT2, and VT3 may be opened depending on the amount of the aqueous absorbent to be sprayed. In addition, the regulated gas-rich absorbent may be recovered to the

aqueous absorbent tank 340 through the regulated gas-rich absorbent recovery line LW. Also, in this case, if necessary, the first aqueous absorbent supply valve VT1 may be closed, the seawater spray supply valve VE may be opened, and the seawater spray supply pump PE may be operated, so that seawater may be sprayed through the first spray nozzle 312 of the first spraying unit 310.

[00143]

[00144] In the second embodiment of the exhaust gas treatment system 100 and the ship 10 according to the present disclosure having such a configuration, it is possible to switch to the closed loop state in which regulated gas-rich absorbent is recovered and recycled, so that the amount of use of chemicals such as an alkaline agent may be minimized, the open loop state and the closed loop state may be selectively used depending on the situation, and the amount of regulated gas-rich absorbent may be reduced as the regulated gas-rich absorbent is recycled, thereby reducing regulated gas-rich absorbent treatment costs.

[00145]

[00146] Third embodiment of exhaust gas treatment system and ship

[00147] Hereinafter, a third embodiment of an exhaust gas treatment system and a ship according to the present

disclosure will be described with reference to FIGS. 8 and 9.

[00148] FIG. 8 is a view illustrating a third embodiment of an exhaust gas treatment system according to the present disclosure, and FIG. 9 is an enlarged view, like FIG. 4, illustrating a third embodiment of a ship according to the present disclosure.

[00149] Here, the third embodiment of an exhaust gas treatment system and a ship according to the present disclosure is different from the second embodiment of the exhaust gas treatment system and the ship according to the present disclosure described above with reference to FIGS. 6 and 7 above, in that at least one of sulfur oxide and carbon dioxide is removed from the exhaust gas in the treatment unit 300.

[00150] Accordingly, the seawater spray supply line LE is branched into first, second, and third seawater spray supply lines LE1, LE2, and LE3 which are connected to first, second, and third supply pipes 311, 321, and 331, respectively, and have first, second, and third seawater spray supply valves VE1, VE2, and VE3, respectively.

[00151] Therefore, hereinafter, the different components will be mainly described, and the remaining components may be referred to those described above with reference to FIGS. 1 to 7.

[00152]

[00153] In the third embodiment of the exhaust gas treatment system 100 and the ship 10 according to the present disclosure, as shown in FIG. 8, the seawater spray supply line LE may be branched into first, second, and third seawater spray supply lines LE1, LE2, and LE3. In addition, the first, second, and third seawater spray supply lines LE1, LE2, and LE3 may be connected to the first, second, and third supply pipes 311, 321, and 331 of the first, second, and third spraying units 310, 320, and 330, respectively. In addition, the first, second, and third seawater spray supply valves VE1, VE2, and VE3 may be provided in the first, second, and third seawater spray supply lines LE1, LE2, and LE3, respectively.

[00154] In this case, as shown in FIG. 8, a packing PC may also be provided in a portion between the second spraying unit 320 and the third spraying unit 330 inside the reactor 200.

[00155]

[00156] In the third embodiment of the exhaust gas treatment system 100 and the ship 10 according to the present disclosure having the aforementioned configuration, if there is no need to remove sulfur oxide because the exhaust gas emission device 30 uses low sulfur oil as fuel, carbon dioxide may be removed from the exhaust gas as

follows.

[00157] In the open loop state in which the regulated gas-rich absorbent recovery valve VW is closed and the regulated gas-rich absorbent drainage valve VD is opened, the second and third seawater spray supply valves VE2 and VE3 and the first aqueous absorbent supply valve VT1 may be closed, and the first seawater spray supply valve VE1 and the second and third aqueous absorbent supply valves VT2 and VT3 may be opened. In addition, the seawater spray supply pump PE and the aqueous absorbent supply pump PT may be operated.

[00158] Accordingly, seawater may be sprayed as a cooling liquid into the exhaust gas from the first spray nozzle 312 of the first spraying unit 310 and an aqueous absorbent may be sprayed into the exhaust gas from the second and third spray nozzles 322 and 332 of the second and third spraying units 320 and 330 to remove carbon dioxide from the exhaust gas. In addition, regulated gas-rich absorbent may be drained through the regulated gas-rich absorbent drainage line LD.

[00159] In the closed loop state in which the regulated gas-rich absorbent drainage valve VD is closed and the regulated gas-rich absorbent recovery valve VW is opened, the first, second, and third seawater spray supply valves VE1, VE2, and VE3 may all be closed and the first, second,

and third aqueous absorbent supply valves VT1, VT2, and VT3 may all be opened. In addition, the aqueous absorbent supply pump PT and the regulated gas-rich absorbent recovery pump PW may be operated. Accordingly, an aqueous absorbent may be sprayed into the exhaust gas from all of the first, second, and third spray nozzles 312, 322, and 332 of the first, second, and third spraying units 310, 320, and 330 to remove carbon dioxide from the exhaust gas. In addition, regulated gas-rich absorbent may be recovered to the aqueous absorbent tank 340 through the regulated gas-rich absorbent recovery line LW.

[00160] In the closed loop state, the second and third seawater spray supply valves VE2 and VE3 and the first aqueous absorbent supply valve VT1 may be closed, the first seawater spray supply valve VE1 and the second and third aqueous absorbent supply valves VT2 and VT3 may be opened, and the seawater spray supply pump PE, the aqueous absorbent supply pump PT, and the regulated gas-rich absorbent recovery pump PW may be operated. Accordingly, the first spray nozzle 312 of the first spraying unit 310 may spray seawater into the exhaust gas, and the second and third spray nozzles 322 and 332 of the second and third spraying units 320 and 330 may spray the aqueous absorbent into the exhaust gas. In addition, regulated gas-rich absorbent may be recovered to the aqueous absorbent tank

340 through the regulated gas-rich absorbent recovery line LW.

[00161] In addition, in the closed loop state, the second and third seawater spray supply valves VE2 and VE3 and the first and second aqueous absorbent supply valves VT1 and VT2 may be closed, the first seawater spray supply valve VE1 and the third aqueous absorbent supply valve VT3 may be opened, and the seawater spray supply pump PE, the aqueous absorbent supply pump PT, and the regulated gas-rich absorbent recovery pump PW may be operated. Accordingly, the first spray nozzle 312 of the first spraying unit 310 may spray seawater into the exhaust gas, the third spray nozzle 332 of the third spraying unit 330 may spray the aqueous absorbent into the exhaust gas, and the second spray nozzle 322 of the second spraying unit 320 may not spray anything. In addition, regulated gas-rich absorbent may be recovered to the aqueous absorbent tank 340 through the regulated gas-rich absorbent recovery line LW.

[00162] Meanwhile, in the closed loop state, if necessary, the regulated gas-rich absorbent recovery valve VW may be closed and the regulated gas-rich absorbent drainage valve VD may be opened, so that regulated gas-rich absorbent may be drained through the regulated gas-rich absorbent drainage line LD.

[00163]

[00164] In the third embodiment of the exhaust gas treatment system 100 and the ship 10 according to the present disclosure, if it is necessary to remove sulfur oxide from the exhaust gas because the exhaust gas emission device 30 uses high sulfur oil as fuel, only sulfur oxide may be removed from the exhaust gas or sulfur oxide and carbon dioxide may be removed at the same time as follows.

[00165] Also, in this case, the regulated gas-rich absorbent recovery valve VW may be closed and the regulated gas-rich absorbent drainage valve VD may be opened in the open loop state.

[00166] In the case of removing only sulfur oxide, in the open loop state, the first, second, and third aqueous absorbent supply valves VT1, VT2, and VT3 and the third seawater spray supply valve VE3 may be closed and the first and second seawater spray supply valves VE1 and VE2 may be opened. Also, the seawater spray supply pump PE may be driven. Accordingly, seawater may be sprayed into the exhaust gas from the first and second spray nozzles 312 and 322 of the first and second spraying units 310 and 320. Accordingly, sulfur oxide may be removed from the exhaust gas. In this case, the third seawater spray supply valve VE3 may also be opened according to the amount of seawater to be sprayed. In addition, regulated gas-rich absorbent

may be drained through the regulated gas-rich absorbent drainage line LD.

[00167] In addition, in the case of removing sulfur oxide and carbon dioxide at the same time, in the open loop state, the first and second aqueous absorbent supply valves VT1 and VT2 and the third seawater spray supply valve VE3 may be closed, the first and second seawater spray supply valves VE1 and VE2 and the third aqueous absorbent supply valve VT3 may be opened, and the seawater spray supply pump PE and the aqueous absorbent supply pump PT may be operated. Accordingly, seawater may be sprayed into the exhaust gas from the first and second spray nozzles 312 and 322 of the first and second spraying units 310 and 320 so that sulfur oxide may be removed from the exhaust gas, and the aqueous absorbent may be sprayed into the exhaust gas from the third spray nozzle 332 of the third spraying unit 330 so that carbon dioxide may be removed from the exhaust gas. In addition, regulated gas-rich absorbent may be drained through the regulated gas-rich absorbent drainage line LD.

[00168]

[00169] In the third embodiment of the exhaust gas treatment system 100 and the ship 10 according to the present disclosure of this configuration, only carbon dioxide may be removed, only sulfur oxide may be removed, or both sulfur oxide and carbon dioxide may be

simultaneously removed, from the exhaust gas with the single exhaust gas treatment system 100 according to whether the exhaust gas emission device 30 uses low sulfur oil or high sulfur oil as fuel.

[00170]

[00171] Fourth embodiment of exhaust gas treatment system and ship

[00172] Hereinafter, a fourth embodiment of an exhaust gas treatment system and a ship according to the present disclosure will be described with reference to FIGS. 10 and 11.

[00173] FIG. 10 is a view illustrating a fourth embodiment of an exhaust gas treatment system according to the present disclosure, and FIG. 11 is an enlarged view, like FIG. 4, illustrating a fourth embodiment of a ship according to the present disclosure.

[00174] Here, the fourth embodiment of an exhaust gas treatment system and a ship according to the present disclosure is different from the second embodiment of the exhaust gas treatment system according to the present disclosure described above with reference to FIGS. 6 and 7, in that the treatment unit 300 removes at least one of sulfur oxide and carbon oxide and a division unit 240 is provided in the reactor 200 to divide the inside of the reactor 200 into a first region RG1 and a second region RG2.

[00175] Accordingly, the seawater spray supply line LE is branched into first and second seawater spray supply lines LE1 and LE2 which are connected to the first and second supply pipes 311 and 321 of the first and second spraying units 310 and 320, respectively, the first and second seawater spray supply lines LE1 and LE2 include first and second seawater spray supply valves VE1 and VE2, respectively, the division unit 240 dividing the inside of the reactor 200 into the first region RG1 and the second region RG2 is provided inside the reactor 200, a second region regulated gas-rich absorbent drainage line LWA is connected to the second region RG2, a second region regulated gas-rich absorbent recovery line LWB connected to the aqueous absorbent tank 340 is connected to the second region regulated gas-rich absorbent drainage line LWA, and the second region regulated gas-rich absorbent drainage line LWA and the second region regulated gas-rich absorbent recovery line LWB include a second region regulated gas-rich absorbent drainage valve VWA and a second region regulated gas-rich absorbent recovery valve VWB, respectively.

[00176] Therefore, hereinafter, the different components will be mainly described, and the remaining components may be referred to those described above with reference to FIGS. 1 to 7.

[00177]

[00178] In the fourth embodiment of the exhaust gas treatment system 100 and the ship 10 according to the present disclosure, as shown in FIG. 10, the seawater spray supply line LE may be branched into the first and second seawater spray supply lines LE1 and LE2 respectively. In addition, the first and second seawater spray supply lines LE1 and LE2 may be connected to the first and second supply pipes 311 and 321 of the first and second spraying units 310 and 320, respectively. In addition, the first and second seawater spray supply valves VE1 and VE2 may be provided in the first and second seawater spray supply lines LE1 and LE2, respectively.

[00179] In this case, a packing PC may be provided in a portion between the second spraying unit 320 and the third spraying unit 330 inside the reactor 200.

[00180] In the fourth embodiment of the exhaust gas treatment system 100 and the ship 10 according to the present disclosure, as shown in FIG. 10, the division unit 240 may be provided inside the reactor 200 to divide the inside of the reactor 200 into the first region RG1 and the second region RG2. The division unit 240 may allow the exhaust gas to flow from the first region RG1 to the second region RG2 and allow regulated gas-rich absorbent which is an aqueous absorbent sprayed from the third spraying unit

330 to the second region RG2 so as to be used to remove carbon dioxide from the exhaust gas to be drained or recovered, rather than flowing to the first region RG1.

[00181] For example, the division unit 240 may be provided in a portion between the second spraying unit 320 and the third spraying unit 330 inside the reactor 200. In this case, by the division unit 240, the inside of the reactor 200 may be divided into the first region RG1 in which the first spraying unit 310 and the second spraying unit 320 are provided and the second region RG2 in which the third spraying unit 330 is provided.

[00182] The division unit 240 may include a division member 241, a connection member 242, and a cover member 243. The division member 241 may be provided, for example, between the second spraying unit 320 and the third spraying unit 330 inside the reactor 200 to divide the inside of the reactor 200 into the first region RG1 and the second region RG2, and a passage portion (not shown) through which the exhaust gas passes may be formed. For example, the division member 241 may have a shape of a truncated square pyramid having a hollow therein. In addition, lower ends of a plurality of connection members 242, for example, lower ends of four connection members 242, may be connected to upper corners of the division member 241, respectively. In addition, the cover member 243 may be connected to upper

ends of the plurality of connection members 242 so that the aqueous absorbent sprayed from the third spraying unit 330 may not pass through the passage portion of the division member 241. For example, the cover member 243 may have a square pyramid shape with an empty inside.

[00183] In the fourth embodiment of the exhaust gas treatment system 100 and the ship 10 according to the present disclosure, a second region regulated gas-rich absorbent drainage line LWA may be connected to the second region RG2, a second region regulated gas-rich absorbent recovery line LWB connected to the aqueous absorbent tank 340 may be connected to the second region regulated gas-rich absorbent drainage line LWA, and the second region regulated gas-rich absorbent drainage line LWA and the second region regulated gas-rich absorbent recovery line LWB may include a second region regulated gas-rich absorbent drainage valve VWA and a second region regulated gas-rich absorbent recovery valve VWB, respectively.

[00184] The second region regulated gas-rich absorbent drainage line LWA may be connected to the regulated gas-rich absorbent purification unit. Regulated gas-rich absorbent drained from the second region regulated gas-rich absorbent drainage line LWA may be supplied to the regulated gas-rich absorbent purification unit through the second region regulated gas-rich absorbent drainage line

LWA, may be purified by the regulated gas-rich absorbent purification unit, and may be subsequently drained to the outside, e.g., to the outside of the ship 10.

[00185]

[00186] In the fourth embodiment of the exhaust gas treatment system 100 and the ship 10 according to the present disclosure having the aforementioned configuration, if there is no need to remove sulfur oxide because the exhaust gas emission device 30 uses low sulfur oil as fuel, carbon dioxide may be removed from the exhaust gas as follows.

[00187] In the open loop state in which the regulated gas-rich absorbent recovery valve VW is closed and the regulated gas-rich absorbent drainage valve VD is opened, the second seawater spray supply valve VE2 and the first aqueous absorbent supply valve VT1 may be closed, and the first seawater spray supply valve VE1 and the second and third aqueous absorbent supply valves VT2 and VT3 may be opened. In addition, the second region regulated gas-rich absorbent recovery valve VWB may be closed and the second region regulated gas-rich absorbent drainage valve VWA may be opened. In addition, the seawater spray supply pump PE and the aqueous absorbent supply pump PT may be operated.

[00188] Accordingly, seawater may be sprayed as a cooling liquid to the exhaust gas from the first spray

nozzle 312 of the first spraying unit 310, and the aqueous absorbent may be sprayed into the exhaust gas from the second and third spray nozzles 322 and 332 of the second and third spraying units 320 and 330 to remove carbon dioxide from the exhaust gas. In addition, regulated gas-rich absorbent, which is seawater or an aqueous absorbent, used to remove carbon dioxide from exhaust gas may be drained through the regulated gas-rich absorbent drainage line LD and the second region regulated gas-rich absorbent drainage line LWA.

[00189] In addition, in the closed loop state in which the regulated gas-rich absorbent drainage valve VD is closed and the regulated gas-rich absorbent recovery valve VW is opened, both the first and second seawater spray supply valves VE1 and VE2 may be closed and the first, second, and third aqueous absorbent supply valves VT1, VT2, and VT3 may all be opened. In addition, the second region regulated gas-rich absorbent drainage valve VWA may be closed and the second region regulated gas-rich absorbent recovery valve VWB may be opened. In addition, the aqueous absorbent supply pump PT and the regulated gas-rich absorbent recovery pump PW may be operated.

[00190] Accordingly, the aqueous absorbent may be sprayed into the exhaust gas from all of the first, second, and third spray nozzles 312, 322, and 332 of the first,

second, and third spraying units 310, 320, and 330, so that carbon dioxide may be removed from the exhaust gas. In addition, regulated gas-rich absorbent, as an aqueous absorbent which has removed carbon dioxide from the exhaust gas, may be recovered to the aqueous absorbent tank 340 through the regulated gas-rich absorbent recovery line LW and the second region regulated gas-rich absorbent recovery line LWB.

[00191] In the closed loop state, the second seawater spray supply valve VE2 and the first aqueous absorbent supply valve VT1 may be closed, the first seawater spray supply valve VE1 and the second and third aqueous absorbent supply valves VT2 and VT3 may be opened, and the seawater spray supply pump PE, the aqueous absorbent supply pump PT, and the regulated gas-rich absorbent recovery pump PW may be operated. Accordingly, seawater may be sprayed as a cooling liquid into the exhaust gas from the first spray nozzle 312 of the first spraying unit 310, and an aqueous absorbent may be sprayed into the exhaust gas from the second and third spray nozzles 322 and 332 of the second and third spraying units 320 and 330 so that carbon dioxide may be removed from the exhaust gas. In addition, regulated gas-rich absorbent, which is seawater or an aqueous absorbent and has removed carbon dioxide from the exhaust gas, may be recovered to the aqueous absorbent tank

340 through the regulated gas-rich absorbent recovery line LW and the second region regulated gas-rich absorbent recovery line LWB.

[00192] In addition, in the closed loop state, the second seawater spray supply valve VE2 and the first and second aqueous absorbent supply valves VT1 and VT2 may be closed, the first seawater spray supply valve VE1 and the third aqueous absorbent supply valve VT3 may be opened, and the seawater spray supply pump PE, the aqueous absorbent supply pump PT, and the regulated gas-rich absorbent recovery pump PW may be operated. Accordingly, seawater as a cooling liquid may be sprayed into the exhaust gas from the first spray nozzle 312 of the first spraying unit 310 and the aqueous absorbent may be sprayed into the exhaust gas from the third spray nozzle 332 of the third spraying unit 330 so that carbon dioxide may be removed from the exhaust gas, and nothing may be sprayed from the second spray nozzle 322 of the second spraying unit 320. In addition, regulated gas-rich absorbent may be recovered to the aqueous absorbent tank 340 through the regulated gas-rich absorbent recovery line LW and the second region regulated gas-rich absorbent recovery line LWB.

[00193] Meanwhile, in the closed loop state, if necessary, the regulated gas-rich absorbent recovery valve VW may be closed and the regulated gas-rich absorbent

drainage valve VD may be opened, so that regulated gas-rich absorbent may be drained through the regulated gas-rich absorbent drainage line LD.

[00194]

[00195] In the fourth embodiment of the exhaust gas treatment system 100 and the ship 10 according to the present disclosure, if it is necessary to remove sulfur oxide from the exhaust gas because the exhaust gas emission device 30 uses high sulfur oil as fuel, only sulfur oxide may be removed from the exhaust gas or sulfur oxide and carbon dioxide may be removed at the same time as follows.

[00196] In this case, the regulated gas-rich absorbent recovery valve VW may be closed and the regulated gas-rich absorbent drainage valve VD may be opened in the open loop state.

[00197] In the case of removing only sulfur oxide, in the open loop state, the first, second, and third aqueous absorbent supply valves VT1, VT2, and VT3 may all be closed and both the first and second seawater spray supply valves VE1 and VE2 may be opened. Also, the seawater spray supply pump PE may be operated. Accordingly, seawater may be sprayed into the exhaust gas from the first and second spray nozzles 312 and 322 of the first and second spraying units 310 and 320 so that sulfur oxide may be removed from the exhaust gas. In addition, regulated gas-rich absorbent

may be drained through the regulated gas-rich absorbent drainage line LD.

[00198] In the case of removing sulfur oxide and carbon dioxide at the same time, in the open loop state, the first and second aqueous absorbent supply valves VT1 and VT2 may be closed and the first and second seawater spray supply valves VE1 and VE2 and the third aqueous absorbent supply valve VT3 may be opened. In addition, the second region regulated gas-rich absorbent recovery valve VWB may be closed and the second region regulated gas-rich absorbent drainage valve VWA may be opened. In addition, the seawater spray supply pump PE and the aqueous absorbent supply pump PT may be operated. Accordingly, seawater may be sprayed into the exhaust gas from the first and second spray nozzles 312 and 322 of the first and second spraying units 310 and 320 so that sulfur oxide may be removed from the exhaust gas, and the aqueous absorbent may be sprayed into the exhaust gas from the third spray nozzle 332 of the third spraying unit 330 so that carbon dioxide may be removed from the exhaust gas. In this case, regulated gas-rich absorbent may be drained through the regulated gas-rich absorbent drainage line LD and the second region regulated gas-rich absorbent drainage line LWA.

[00199] In the case of removing sulfur oxide and carbon dioxide at the same time, in the open loop state, the first

and second aqueous absorbent supply valves VT1 and VT2 may be closed and the first and second seawater spray supply valves VE1 and VE2 and the third aqueous absorbent supply valve VT3 may be opened. In addition, the second region regulated gas-rich absorbent drainage valve VWA may be closed and the second region regulated gas-rich absorbent recovery valve VWB may be opened. In addition, the seawater spray supply pump PE and the aqueous absorbent supply pump PT may be operated. Accordingly, seawater may be sprayed into the exhaust gas from the first and second spray nozzles 312 and 322 of the first and second spraying units 310 and 320 so that sulfur oxide may be removed from the exhaust gas, and the aqueous absorbent may be sprayed into the exhaust gas from the third spray nozzle 332 of the third spraying unit 330 so that carbon dioxide may be removed from the exhaust gas. In this case, regulated gas-rich absorbent may be drained through the regulated gas-rich absorbent drainage line LD or may be recovered to the aqueous absorbent tank 340 through the second region regulated gas-rich absorbent recovery line LWB.

[00200]

[00201] In the fourth embodiment of the exhaust gas treatment system 100 and the ship 10 according to the present disclosure of this configuration, only carbon dioxide may be removed, only sulfur oxide may be removed,

or both sulfur oxide and carbon dioxide may be simultaneously removed, from the exhaust gas with the single exhaust gas treatment system 100 according to whether the exhaust gas emission device 30 uses low sulfur oil or high sulfur oil as fuel, and since the inside of the reactor 200 is divided by the division unit 240 into the first region RG1 in which the first spraying unit 310 and the second spraying unit 320 are provided and the second region RG2 in which the third spraying unit 330 is provided, efficiency of removing at least one of sulfur oxide and carbon oxide from the exhaust gas may be maximized.

[00202]

[00203] As described above, when the exhaust gas treatment system and a ship including the same according to the present disclosure are used, carbon dioxide may be removed from exhaust gas, regulated gas-rich absorbent which is a cooling liquid or an aqueous absorbent used to remove carbon dioxide from the exhaust gas may be drained, or the regulated gas-rich absorbent may be recovered and the aqueous absorbent may be separated from the regulated gas-rich absorbent, heat of the exhaust gas recovered by the heat recovery unit may increase, and the aqueous absorbent sprayed into the exhaust gas may be created by mixing seawater and an alkaline agent to remove carbon dioxide from the exhaust gas.

[00204]

[00205] The exhaust gas treatment system and a ship including the same described above are not limitedly applied to the configuration of the embodiments described above, but all or some of the embodiments may be selectively combined so that various modifications may be made.

[00206]

[00207] [DESCRIPTION OF REFERENCE NUMERALS]

[00208] 10: SHIP 20: HULL

[00209] 21: CHIMNEY 22: RESIDENTIAL STRUCTURE

[00210] 30: EXHAUST GAS EMISSION DEVICE

[00211] 31: ENGINE

[00212] 31A: MAIN ENGINE

[00213] 31B: ENGINE FOR POWER GENERATION

[00214] 32: BOILER

[00215] 100: EXHAUST GAS TREATMENT SYSTEM

[00216] 200: REACTOR 210: EXHAUST GAS INLET

[00217] 220: EXHAUST GAS OUTLET

[00218] 230: REGULATED GAS-RICH ABSORBENT DRAIN PORT

[00219] 240: DIVISION UNIT

[00220] 241: DIVISION MEMBER

[00221] 242: CONNECTION MEMBER

[00222] 243: COVER MEMBER

[00223] 300: TREATMENT UNIT

[00224] 310: FIRST SPRAYING UNIT

[00225] 311: FIRST SUPPLY PIPE

[00226] 312: FIRST SPRAY NOZZLE

[00227] 320: SECOND SPRAYING UNIT

[00228] 321: SECOND SUPPLY PIPE

[00229] 322: SECOND SPRAY NOZZLE

[00230] 330: THIRD SPRAYING UNIT

[00231] 331: THIRD SUPPLY PIPE

[00232] 332: THIRD SPRAY NOZZLE

[00233] 340: AQUEOUS ABSORBENT TANK

[00234] 341: AQUEOUS ABSORBENT COMPONENT DETECTION SENSOR

[00235] 350: AQUEOUS ABSORBENT PREPARING UNIT

[00236] 351: SEAWATER TANK

[00237] 352: FRESH WATER TANK

[00238] 353: ALKALINE AGENT TANK

[00239] 354: AUXILIARY AGENT TANK

[00240] 355: MIXING TANK

[00241] 360: AQUEOUS ABSORBENT SEPARATION UNIT

[00242] 400: HEAT RECOVERY UNIT

[00243] LD: REGULATED GAS-RICH ABSORBENT DRAINAGE LINE

[00244] LC: CONNECTION LINE

[00245] LS: SEAWATER SUPPLY LINE

[00246] LP, LT: AQUEOUS ABSORBENT SUPPLY LINE

[00247] LR: AQUEOUS ABSORBENT RECOVERY LINE

[00248] LW: REGULATED GAS-RICH ABSORBENT RECOVERY LINE

[00249] LV: AQUEOUS ABSORBENT SEPARATION LINE

[00250] LF: SEPARATED AQUEOUS ABSORBENT SUPPLY LINE

[00251] LDD: SEPARATED REGULATED GAS-RICH ABSORBENT DRAINAGE LINE

[00252] LWA: SECOND REGION REGULATED GAS-RICH ABSORBENT DRAINAGE LINE

[00253] LWB: SECOND REGION REGULATED GAS-RICH ABSORBENT RECOVERY LINE

[00254] LE: SEAWATER SPRAY SUPPLY LINE

[00255] LE1: FIRST SEAWATER SPRAY SUPPLY LINE

[00256] LE2: SECOND SEAWATER SPRAY SUPPLY LINE

[00257] LE3: THIRD SEAWATER SPRAY SUPPLY LINE

[00258] PH: POROUS PLATE

[00259] PC: PACKINGV: VALVE

[00260] VD: REGULATED GAS-RICH ABSORBENT DRAINAGE VALVE

[00261] VW: REGULATED GAS-RICH ABSORBENT RECOVERY VALVE

[00262] VWA: SECOND REGION REGULATED GAS-RICH ABSORBENT DRAINAGE VALVE

[00263] VWB: SECOND REGION REGULATED GAS-RICH ABSORBENT RECOVERY VALVE

[00264] VE: SEAWATER SPRAY SUPPLY VALVE

[00265] VE1: FIRST SEAWATER SPRAY SUPPLY VALVE

[00266] VE2: SECOND SEAWATER SPRAY SUPPLY VALVE

[00267] VE3: THIRD SEAWATER SPRAY SUPPLY VALVE

[00268] VT1: FIRST AQUEOUS ABSORBENT SUPPLY VALVE

[00269] VT2: SECOND AQUEOUS ABSORBENT SUPPLY VALVE

[00270] VT3: THIRD AQUEOUS ABSORBENT SUPPLY VALVE

[00271] VR: FLOW PATH SWITCHING VALVE

[00272] P: PUMP PW: REGULATED GAS-RICH ABSORBENT RECOVERY PUMP

[00273] PE: SEAWATER SPRAY SUPPLY PUMP

[00274] PT: AQUEOUS ABSORBENT SUPPLY PUMP

[00275] RG1: FIRST REGION RG2: SECOND REGION

[00276] PG: EXHAUST PIPE HE: HEATER

[CLAIMS]

[Claim 1]

An exhaust gas treatment system comprising:

a reactor into which exhaust gas is introduced;

a first spraying unit spraying seawater or aqueous absorbent(regulated gas-lean absorbent) into the inside of the reactor;

a packing contacting the exhaust gas passing through the first spraying unit; and

a second spraying unit spraying the aqueous absorbent into the exhaust gas passing through the packing,

wherein the aqueous absorbent is an aqueous alkaline solution,

the exhaust gas treatment system operates in an open loop state or in a closed loop state, and

in the open loop state, the first spraying unit sprays seater and the second spraying unit sprays the aqueous absorbent, and in the closed loop state, both the first spraying unit and the second spraying unit spray the aqueous absorbent.

[Claim 2]

The exhaust gas treatment system of claim 1, further comprising an aqueous absorbent tank storing the aqueous absorbent and connected to the first spraying unit and the second spraying unit to supply the aqueous absorbent thereto.

[Claim 3]

The exhaust gas treatment system of claim 2, wherein the reactor includes an exhaust gas inlet through which the exhaust gas is introduced, and a regulated gas-rich absorbent drain port through which regulated gas-rich absorbent, the seawater or the aqueous absorbent used to treat the exhaust gas, is drained, and

a regulated gas-rich absorbent drainage line, and a regulated gas-rich absorbent recovery line connected to the aqueous absorbent tank, are connected to the regulated gas-rich absorbent drain port, respectively.

[Claim 4]

The exhaust gas treatment system of claim 3, wherein a regulated gas-rich absorbent recovery valve included in the regulated gas-rich absorbent recovery line is closed and a regulated gas-rich absorbent drainage valve included in the regulated gas-rich absorbent drainage line is opened to enter the open loop state, or the regulated gas-rich absorbent drainage valve is closed and the regulated gas-rich absorbent valve is opened to enter the closed loop state.

[Claim 5]

The exhaust gas treatment system of claim 2, further comprising a third spraying unit spraying the aqueous absorbent into the exhaust gas passing through the second spraying unit.

[Claim 6]

The exhaust gas treatment system of claim 5, wherein the first, second, and third spraying units include first, second, and third supply pipes in which at least portions of one sides are provided inside the reactor and the other sides are connected to the aqueous absorbent tank, respectively, and a seawater spray supply line connected to a seawater source is connected to the first supply pipe.

[Claim 7]

The exhaust gas treatment system of claim 6, wherein the seawater spray supply line includes a seawater spray supply valve and a seawater spray supply pump, the first, second, and third supply pipes include first, second, and third aqueous absorbent supply valves, respectively, an aqueous absorbent supply line including an aqueous absorbent supply pump is connected to the aqueous absorbent tank, and the other sides of the first, second, and third supply pipes are connected to the aqueous absorbent supply line.

[Claim 8]

The exhaust gas treatment system of claim 7, wherein the first, second, and third spraying units further include first, second, and third spray nozzles respectively provided in portions of the first, second, and third supply pipes provided inside the reactor.

[Claim 9]

The exhaust gas treatment system of claim 2, further comprising an aqueous absorbent preparing unit connected to the aqueous absorbent tank, and preparing the aqueous absorbent and supplying the prepared aqueous absorbent to the aqueous absorbent tank.

[Claim 10]

A ship comprising:

a hull; and

the exhaust gas treatment system according to any one of claims 1 to 9, provided in the hull.