DRAIN NOZZLE FIXATION DEVICE

TECHNICAL FIELD

[0001] The present disclosure relates to a drain nozzle fixation device for fixing a drain nozzle which stirs desulfurization wastewater discharged from a desulfurization device disposed on a hull and mixes the desulfurization wastewater with seawater.

BACKGROUND ART

[0002] With the recent tightening of the exhaust gas regulations for ships, in the emission control area (ECA), it is required to use fuel oil containing 0.1% or less of sulfur, or to take an alternative measure that has an equivalent effect. Furthermore, from 2020, also in a normal sea area, it is going to be required to use fuel oil containing 0.5% or less of sulfur, or to take an alternative measure that has an equivalent effect. As an alternative measure, it is permitted to use a desulfurization device capable of reducing sulfur oxide in exhaust gas discharged from a main engine or power generation engines and boilers below the regulation value. Low-sulfur fuel oil is more expensive than conventional heavy fuel oil, and it is unclear whether the supply capacity meets a future increase in demand. Therefore, to continuously use heavy fuel oil, which is inexpensive and has sufficient supply capacity, a desulfurization device is mounted on a ship (see Patent Documents 1 and 2).

[0003] As regulations for ships, there are regulations for pH of desulfurization wastewater discharged from desulfurization devices mounted on ships. At the present time, the pH is restricted to be no less than 6.5 at 4 m from the overboard. To satisfy the regulations, conventionally, the outlet of a drain pipe for desulfurization wastewater discharged from a desulfurization device is provided with a drain nozzle which promotes mixing of desulfurization wastewater and seawater around a ship. A conventional drain nozzle has a cylindrical outer peripheral part and a nozzle part disposed inside the outer peripheral part. Further, one end of the outer peripheral part is integrally bonded and fixed to the outer wall of the hull by welding, and the other end is fixed to the drain pipe. More specifically, the other

end of the outer peripheral part has a flange protruding outward from the outer peripheral surface, and this flange is fastened with a flange of the drain pipe while these flanges are in contact, so that the drain nozzle is fixed to the drain pipe.

Citation List

Patent Literature

[0004]

Patent Document 1: JP5789321B

Patent Document 2: JPH9-239233A

SUMMARY

Problems to be Solved

[0005] However, since the conventional drain nozzle is attached to the outlet of the drain pipe as a part thereof, and the outer peripheral part directly connects the outer wall of the hull to the drain pipe, the drain nozzle is a so-called strength member which requires strength as a structure of the ship. Accordingly, the drain nozzle as the strength member requires time-consuming inspection to check the bonding state of a weld for each welding. Further, since the conventional drain nozzle is integrally bonded to the outer wall of the hull by welding, welding to the outer wall of the hull is necessary for attachment. In addition, for replacement, the conventional drain nozzle requires detachment, for instance, by cutting the weld between the old drain nozzle and the outer wall of the hull and then welding a new drain nozzle to the outer wall of the hull. Therefore, the conventional drain nozzle fixation method takes time and effort for attachment and replacement of the drain nozzle.

[0006] Patent Document 1 discloses a scrubber (wet gas cleaning device) for cleaning exhaust gas discharged from a propelling engine of a ship, for instance. Also, Patent Document 1 discloses that, when a cleaning liquid used in the scrubber is discharged to the outside, a neutralizing agent is added to the cleaning liquid to adjust the pH so as to satisfy the pH discharge regulation. Further, Patent Document 2 discloses an exhaust gas

desulfurization method including an absorption step of bringing exhaust gas and seawater into gas-liquid contact so that sulfur dioxide in the exhaust gas is dissolved in the seawater, an oxidation step of oxidizing the sulfur dioxide to sulfuric acid, a neutralization step of adding an alkaline agent to the seawater during or after the oxidation step to adjust the pH of the seawater, and a discharge step of discharging the seawater after the neutralization step to ocean. However, neither Patent Documents 1 nor 2 pays attention to the drain nozzle fixation method and mentions the above problems.

[0007] In view of the above, an object of at least one embodiment of the present invention is to provide a drain nozzle fixation device whereby it is possible to easily perform attachment and replacement of a drain nozzle.

Solution to the Problems

[0008] (1) A drain nozzle fixation device according to at least one embodiment of the present invention is a drain nozzle fixation device for fixing a drain nozzle which stirs desulfurization wastewater discharged from a desulfurization device disposed on a hull and mixes the desulfurization wastewater with seawater, comprising: a hull outer wall having an opening below a waterline; and an outer-wall-side pipe having a cylindrical shape with an interior space throughout in an axial direction and openings on both ends in the axial direction, a first end of the outer-wall-side pipe in the axial direction being integrally fixed to an opening edge of the hull outer wall, an opening of the first end communicating with an outside of the hull outer wall, a second end of the outer-wall-side pipe in the axial direction being positioned inside the hull outer wall, wherein the drain nozzle is disposed inside the outer-wall-side pipe.

[0009] With the above configuration (1), the outer-wall-side pipe is formed in a cylindrical shape with an interior space throughout in the axial direction and openings on both axial ends communicating with the interior space. Further, a first end of the outer-wall-side pipe in the axial direction is integrally fixed to the edge of the opening of the hull outer wall below the waterline. Further, a second end of the outer-wall-side pipe in the axial direction

is positioned inside the hull outer wall. Thus, it is possible to dispose the drain nozzle inserted from the opening on one of both axial ends of the outer-wall-side pipe inside the interior space. Further, the drain nozzle disposed inside the outer-wall-side pipe can stir and mix desulfurization wastewater flowing from the opening of the second end in the axial direction with seawater. Further, since the drain nozzle is not integrally bonded by welding to the outer-wall-side pipe or pipes unlike the conventional drain nozzle, it is possible to easily perform attachment and replacement.

[0010] Thus, with the above configuration, it is possible to easily perform attachment and replacement of the drain nozzle.

[0011] Further, with the above configuration (1), since the drain nozzle attached to the drain nozzle fixation device is not integrally fixed to the hull outer wall unlike the conventional drain nozzle, the drain nozzle does not need strength as required in the conventional drain nozzle. Thus, it is possible to more flexibly select the material of the drain nozzle and freely exchange the drain nozzle, than the conventional drain nozzle. For instance, fiber reinforced plastic (FRP) and polymer materials can be used as the material of the drain nozzle, and thereby it is possible to reduce the cost and weight of the drain nozzle. Further, since this drain nozzle is not a strength member unlike the conventional drain nozzle, the drain nozzle may be periodically replaced in response to deterioration or wear thereof. Therefore, it is possible to select the material of the drain nozzle in consideration of this point.

[0012] (2) In some embodiments, in the above configuration (1), the drain nozzle includes an outer peripheral part having a cylindrical shape and a nozzle part disposed inside the outer peripheral part, and an outer peripheral surface of the outer peripheral part is disposed adjacent an inner surface of the outer-wall-side pipe without a gap.

[0013] With the above configuration (2), since the outer peripheral surface of the cylindrical outer peripheral part of the drain nozzle is disposed adjacent the inner surface of the outer-wall-side pipe without a gap, it is possible to perform positioning relative to the outer-wall-side pipe only by inserting the drain nozzle into the outer-wall-side pipe at attachment or replacement. Thus, it is possible to efficiently perform attachment and

replacement of the drain nozzle. Further, since the outer peripheral surface of the drain nozzle is disposed adjacent the inner surface of the outer-wall-side pipe without a gap, it is possible to prevent a part of the desulfurization wastewater from flowing into a gap formed between the inner surface of the outer-wall-side pipe and the outer peripheral surface of the outer peripheral part of the drain nozzle and remaining therein, and thus it is possible to prevent smooth flow of desulfurization wastewater from being interrupted by the remaining desulfurization wastewater.

[0014] (3) In some embodiments, in the above configuration (2), the drain nozzle fixation device further comprises a drain nozzle holding member detachably attached in vicinity of the opening of the hull outer wall and configured to prevent the drain nozzle from getting out of the opening of the first end of the outer-wall-side pipe to an outside of the outer-wall-side pipe.

[0015] With the above configuration (3), since the drain nozzle holding member is detachably disposed in the vicinity of the opening of the hull outer wall, by detaching the drain nozzle holding member, it is possible to easily perform attachment and replacement of the drain nozzle from the opening of the first end of the outer-wall-side pipe. Further, by attaching the drain nozzle holding member, it is possible to prevent the drain nozzle from getting out of the opening of the first end of the outer-wall-side pipe to the outside of the outer-wall-side pipe.

[0016] (4) In some embodiments, in the above configuration (3), the outer-wall-side pipe includes a projection protruding inward from an inner surface of the second end, and the drain nozzle is disposed inside the outer-wall-side pipe while a first end surface of the outer peripheral part abuts on the drain nozzle holding member and a second end surface of the outer peripheral part abuts on or is brought close to the projection.

[0017] With the above configuration (4), since the drain nozzle is disposed inside the outer-wall-side pipe while the first end surface of the outer peripheral part abuts on the drain nozzle holding member, and the second end surface of the outer peripheral part abuts on or is brought close to the projection of the outer-wall-side pipe, the position of the drain nozzle in the axial direction is determined only by inserting the drain nozzle into the outer-wall-side

pipe from the opening of the first end of the outer-wall-side pipe and attaching the drain nozzle holding member by an operator. Thus, it is possible to easily perform attachment and replacement of the drain nozzle.

[0018] (5) In some embodiments, in the above configuration (2), the drain nozzle fixation device further comprises an inner pipe connected to the second end of the outer-wall-side pipe, the drain nozzle includes a first flange protruding outward from the outer peripheral surface of the outer peripheral part at a second end of the outer peripheral part opposite to a first end adjacent to the hull outer wall, and the drain nozzle is detachably fixed to the outer-wall-side pipe by fastening the outer-wall-side pipe with the inner pipe while the first flange is sandwiched between the second end of the outer-wall-side pipe and a first end of the inner pipe adjacent to the hull outer wall.

[0019] With the above configuration (5), since the position of the drain nozzle in the axial direction is determined only by fixing the first flange of the drain nozzle to the outer-wall-side pipe, it is possible to easily perform attachment and replacement of the drain nozzle. Further, since the rotational movement of the drain nozzle around the axis is restricted and the position of the drain nozzle in the circumferential direction is determined only by fixing the first flange of the drain nozzle to the outer-wall-side pipe, the drain nozzle does not rotate when stirring and mixing the desulfurization wastewater with seawater. Thus, it is possible to efficiently stir the desulfurization wastewater. Further, the drain nozzle can be easily detached from the outer-wall-side pipe by releasing fastening between the outer-wall-side pipe and the inner pipe. Further, since the drain nozzle fixation device does not need the drain nozzle holding member, it is possible to reduce the number of components.

[0020] (6) In some embodiments, in the above configuration (5), the outer-wall-side pipe includes a second flange protruding outward from an outer surface of the second end of the outer-wall-side pipe, the inner pipe includes a third flange protruding outward from an outer surface of the first end of the inner pipe, and the drain nozzle is detachably fixed to the outer-wall-side pipe by fastening the second flange with the third flange while the first flange is sandwiched between the second flange and the third flange.

[0021] With the above configuration (6), the drain nozzle is detachably fixed to the outer-wall-side pipe by fastening the second flange of the outer-wall-side pipe with the third flange of the inner pipe while the first flange is sandwiched between the second flange and the third flange. Thus, since the first flange is fixed in surface contact with the second flange and the third flange, it is possible to firmly fix the drain nozzle to the outer-wall-side pipe.

[0022] (7) In some embodiments, in the above configuration (5) or (6), the inner pipe includes: a first inner pipe connected to the outer-wall-side pipe; and a second inner pipe connected to the first inner pipe, and the first inner pipe has an axial length longer than the drain nozzle.

[0023] With the above configuration (7), since the first inner pipe has an axial length longer than the drain nozzle, it is possible to detach the drain nozzle from the outer-wall-side pipe only by detaching the first inner pipe from the outer-wall-side pipe or the second inner pipe. Thus, it is possible to easily perform attachment and replacement of the drain nozzle.

[0024] (8) In some embodiments, in the above configuration (4), the drain nozzle fixation device further comprises at least one desulfurization wastewater flow conditioner for conditioning a flow of the desulfurization wastewater to be stirred by the drain nozzle, and the at least one desulfurization wastewater flow conditioner is sandwiched and fixed between the projection of the outer-wall-side pipe and a second end of the outer peripheral part of the drain nozzle opposite to a first end adjacent to the hull outer wall.

[0025] With the above configuration (8), since the desulfurization wastewater flow conditioner conditions the flow of the desulfurization wastewater to be stirred by the drain nozzle, it is possible to improve the efficiency of the drain nozzle. Further, the desulfurization wastewater flow conditioner is sandwiched and fixed between the second end of the outer peripheral part of the drain nozzle and the projection of the outer-wall-side pipe only by inserting the desulfurization wastewater flow conditioner into the outer-wall-side pipe prior to the drain nozzle. Thus, it is possible to easily perform attachment and replacement of the desulfurization wastewater flow conditioner.

[0026] (9) In some embodiments, in the above configurations (5) to (7), the drain nozzle

fixation device further comprises at least one desulfurization wastewater flow conditioner for conditioning a flow of the desulfurization wastewater to be stirred by the drain nozzle, and the at least one desulfurization wastewater flow conditioner is sandwiched and fixed between the second end of the outer peripheral part of the drain nozzle and the first end of the inner pipe.

[0027] With the above configuration (9), since the desulfurization wastewater flow conditioner conditions the flow of the desulfurization wastewater to be stirred by the drain nozzle, it is possible to improve the efficiency of the drain nozzle. Further, the desulfurization wastewater flow conditioner is sandwiched and fixed between the second end of the outer peripheral part of the drain nozzle and the first end of the inner pipe only by sandwiching it between the drain nozzle and the first inner pipe when the outer-wall-side pipe and the inner pipe are fastened. Thus, it is possible to easily perform attachment and replacement of the desulfurization wastewater flow conditioner.

[0028] (10) In some embodiments, in the above configuration (3), (4), or (8), the drain nozzle fixation device further comprises an anti-rotation mechanism including an anti-rotation member inserted in a hole or a groove provided in a first end of the outer peripheral part of the drain nozzle adjacent to the hull outer wall along the axial direction.

With the above configuration (10), the drain nozzle fixation device includes the anti-rotation mechanism including the anti-rotation member inserted in a hole or a groove provided in the first end of the outer peripheral part of the drain nozzle adjacent to the hull outer wall along the axial direction. This restricts the rotational movement of the drain nozzle around the axis and determines the position of the drain nozzle in the circumferential direction, so that the drain nozzle does not rotate when stirring and mixing the desulfurization wastewater with seawater. Thus, it is possible to efficiently stir the desulfurization wastewater.

[0029] (11) In some embodiments, in the above configurations (1) to (10), the drain nozzle fixation device further comprises at least one reinforcement member integrally fixed to an inboard wall surface of the hull outer wall and integrally fixed to an outer surface of the outer-wall-side pipe.

With the above configuration (11), it is possible to reinforce the hull outer wall and the outer-wall-side pipe by the reinforcement member. Further, since the outer-wall-side pipe is reinforced by the reinforcement member, it is possible to reduce the thickness of the outer-wall-side pipe accordingly, and it is possible to prevent increase in weight and cost of the outer-wall-side pipe.

[0030] (12) In some embodiments, in the above configurations (1) to (11), an inner surface of the outer-wall-side pipe has a coating having acid resistance.

With the above configuration (12), since the drain nozzle fixation device has a coating having acid resistance on the inner surface of the outer-wall-side pipe, it is possible to use a material having low acid resistance for the outer-wall-side pipe.

[0031] (13) In some embodiments, in the above configurations (1) to (12),
the drain nozzle is made of a material having a lower strength than the outer-wall-side pipe.

With the above configuration (13), since the drain nozzle is made of a material having a lower strength than the outer-wall-side pipe, it is possible to use light and inexpensive materials for the drain nozzle, and it is possible to reduce the weight and the cost of the drain nozzle.

[0032] (14) In some embodiments, in the above configurations (1) to (13), the first end of the outer-wall-side pipe is integrally fixed to the opening edge of the hull outer wall by welding.

With the above configuration (14), since the first end of the outer-wall-side pipe is integrally fixed to the opening edge of the hull outer wall by welding, it is possible to firmly fix the outer-wall-side pipe and the hull outer wall.

Advantageous Effects

[0033] According to at least one embodiment of the present invention, there is provided a drain nozzle fixation device whereby it is possible to easily perform attachment and replacement of a drain nozzle.

BRIEF DESCRIPTION OF DRAWINGS

[0034] FIG. 1 is a schematic configuration diagram of a drain nozzle fixation device according to an embodiment of the present invention and a ship including the drain nozzle fixation device.

FIG. 2 is a schematic enlarged cross-sectional view of portion A shown in FIG. 1.

FIG. 3 is a cross-sectional view of a drain nozzle shown in FIG. 2.

FIG. 4 is a front view of a drain nozzle shown in FIG. 2.

FIG. 5 is a front view of a drain nozzle holding member shown in FIG. 2.

FIG. 6 is a diagram of a drain nozzle fixation device according to another embodiment of the present invention, which is a schematic enlarged cross-sectional view of portion A shown in FIG. 1.

FIG. 7 is a cross-sectional view of a drain nozzle fixation device according to another embodiment of the present invention, which shows a state where a desulfurization wastewater flow conditioner is disposed between a second end of an outer peripheral part of a drain nozzle and a projection of an outer-wall-side pipe.

FIG. 8 is a cross-sectional view of a drain nozzle fixation device according to another embodiment of the present invention, which shows a state where a desulfurization wastewater flow conditioner is disposed between a second end of an outer peripheral part of a drain nozzle and a first end of an inner-wall-side pipe.

FIG. 9 is a cross-sectional view of a drain nozzle fixation device according to another embodiment of the present invention, which shows a state where a key is inserted in a key groove provided in an outer peripheral part of a drain nozzle and an outer-wall-side pipe.

FIG. 10 is a cross-sectional view of a drain nozzle fixation device according to another embodiment of the present invention, which shows a state where an outer peripheral part of a drain nozzle and a drain nozzle holding member are fixed with a bolt.

FIG. 11 is a front view of a drain nozzle shown in FIG. 10.

FIG. 12 is a cross-sectional view of a drain nozzle fixation device according to another embodiment of the present invention, which shows a state where a coating is provided on an

inner surface of an outer-wall-side pipe.

FIG. 13 is a cross-sectional view of a drain nozzle fixation device according to another embodiment of the present invention, which shows a state where a coating is provided on an inner surface and a second end surface of an outer-wall-side pipe.

DETAILED DESCRIPTION

[0035] Embodiments of the present invention will now be described in detail with reference to the accompanying drawings. It is intended, however, that unless particularly identified, dimensions, materials, shapes, relative positions and the like of components described in the embodiments shall be interpreted as illustrative only and not intended to limit the scope of the present invention.

For instance, an expression of relative or absolute arrangement such as “in a direction”, “along a direction”, “parallel”, “orthogonal”, “centered”, “concentric” and “coaxial” shall not be construed as indicating only the arrangement in a strict literal sense, but also includes a state where the arrangement is relatively displaced by a tolerance, or by an angle or a distance whereby it is possible to achieve the same function.

For instance, an expression of an equal state such as “same” “equal” and “uniform” shall not be construed as indicating only the state in which the feature is strictly equal, but also includes a state in which there is a tolerance or a difference that can still achieve the same function.

Further, for instance, an expression of a shape such as a rectangular shape or a cylindrical shape shall not be construed as only the geometrically strict shape, but also includes a shape with unevenness or chamfered corners within the range in which the same effect can be achieved.

On the other hand, an expression such as “comprise”, “include”, “have”, “contain” and “constitute” are not intended to be exclusive of other components.

Further, in the description below, some the same features are associated with the same reference numerals and not described again.

Each component of a drain nozzle fixation device 1 will now be described.

[0036] FIG. 1 is a schematic configuration diagram of a drain nozzle fixation device according to an embodiment of the present invention and a ship including the drain nozzle fixation device. As shown in FIG. 1, a ship 2 includes a hull 21, a desulfurization device 3 disposed on the hull 21, a drain pipe 5 through which desulfurization wastewater Wd discharged from the desulfurization device 3 flows, a drain nozzle 4 disposed at an outlet side of the drain pipe 5, and a drain nozzle fixation device 1 for fixing the drain nozzle 4.

[0037] The hull 21 has a hull outer wall 12 extending along the vertical direction in the figure and a deck 21a disposed at an upper end of the hull outer wall 12 as shown in FIG. 1, a ship bottom disposed at a lower end of the hull outer wall 12 not depicted, and an inboard space 21b defined by these components. Further, a main engine and a plurality of power generation engines and boilers are disposed in the inboard space 21b of the hull 21.

[0038] The desulfurization device 3 is disposed on the deck 21a of the hull 21, as shown in FIG. 1. The desulfurization device 3 performs desulfurization of exhaust gas generated in the main engine and the power generation engines and boilers and produces desulfurized exhaust gas in which sulfur oxide is reduced below the regulation value. Further, the desulfurization device 3 produces desulfurization wastewater Wd upon desulfurization treatment. As shown in FIG. 1, the desulfurization device 3 has a wastewater storage tank 3a for storing the desulfurization wastewater Wd. The desulfurization wastewater Wd in the present invention includes not only wastewater not subjected to additional treatment after desulfurization but also wastewater subjected to additional treatment after desulfurization, for instance, addition of a pH adjusting agent.

[0039] The drain pipe 5 is disposed in the inboard space 21b of the hull 21 and formed in a cylindrical shape so that the axial direction thereof extends along the vertical direction in FIG. 1. Further, an upper end portion of the drain pipe 5 protrudes outward from the deck 21a of the hull 21, and is configured so that the desulfurization wastewater Wd that overflows the wastewater storage tank 3a of the desulfurization device 3 flows into the pipe. Further, a lower end portion of the drain pipe 5 is bent at a substantially right angle in middle of length

so that a distal end extends along the horizontal direction (right direction in FIG. 1). Further, the distal end of the drain pipe 5 is connected to the drain nozzle fixation device 1.

[0040] FIG. 2 is a schematic enlarged cross-sectional view of portion A shown in FIG. 1. FIG. 3 is a cross-sectional view of the drain nozzle shown in FIG. 2. FIG. 4 is a front view of the drain nozzle shown in FIG. 2. FIG. 6 is a diagram of the drain nozzle fixation device according to another embodiment of the present invention, which is a schematic enlarged cross-sectional view of portion A shown in FIG. 1.

The drain nozzle 4 stirs the desulfurization wastewater Wd discharged from the desulfurization device 3 disposed on the hull 21 and promotes mixing of the desulfurization wastewater Wd and seawater Ws around the hull 21. Further, the drain nozzle 4 includes a cylindrical outer peripheral part 41 and a nozzle part 42 disposed inside the outer peripheral part 41, as shown in FIGs. 2 and 6. More specifically, as shown in FIGs. 3 and 4, the drain nozzle 4 includes an outer peripheral part 41 formed in a cylindrical shape, a nozzle part 42 disposed inside the outer peripheral part 41 and having at least one blade 42a, and a shaft part 43 disposed inside the nozzle part 42. Further, the drain nozzle 4 is placed so that the axis of the drain nozzle 4 is aligned with the axis 1a of the drain nozzle fixation device 1.

[0041] The drain nozzle fixation device 1 includes an outer-wall-side pipe 11 and a hull outer wall 12, as shown in FIGs. 2 and 6.

[0042] The hull outer wall 12 constitutes a part of the hull 21 and has a circular opening 12a penetrating along the thickness direction below a waterline Lw, as shown in FIGs. 1, 2, and 6. The opening 12a of the hull outer wall 12 is formed so that the axis of the opening 12a is aligned with the axis 1a of the drain nozzle fixation device 1.

[0043] The outer-wall-side pipe 11 is placed so that the axis of the outer-wall-side pipe 11 is aligned with the axis 1a of the drain nozzle fixation device 1, as shown in FIGs. 2 and 6. Further, the outer-wall-side pipe 11 is formed in a cylindrical shape with an interior space 11a throughout in the axial direction and openings on both ends in the axial direction, as shown in FIGs. 2 and 6. More specifically, the outer-wall-side pipe 11 has a first end opening 11f formed in a first end 11b positioned adjacent to the hull outer wall 12 in the axial direction,

and a second end opening 11g formed in a second end 11c positioned away from the hull outer wall 12 in the axial direction and inside an inner surface 12c of the hull outer wall 12.

[0044] Further, the first end 11b of the outer-wall-side pipe 11 is integrally fixed to an edge of the opening 12a of the hull outer wall 12, and the first end opening 11f is connected to the outside of the hull outer wall 12, i.e., to outside an outer surface 12b of the hull outer wall 12.

[0045] More specifically, in some embodiments, as shown in FIG. 2, they are integrally fixed by, while an end surface of the first end 11b of the outer-wall-side pipe 11 abuts on the inner surface 12c of the hull outer wall 12, welding a portion of an outer surface 11d of the outer-wall-side pipe 11 at the first end 11b to a portion of the inner surface 12c of the hull outer wall 12 adjacent to the abutting portion which are in the vicinity of the abutting portion.

[0046] Further, an inner surface 11e including the first end opening 11f of the outer-wall-side pipe 11 has a diameter substantially equal to the opening 12a of the hull outer wall 12, so that the first end opening 11f continues to the opening 12a of the hull outer wall 12 without a step. Further, the first end opening 11f of the outer-wall-side pipe 11 is connected to outside the outer surface 12b of the hull outer wall 12 through the opening 12a of the hull outer wall 12.

[0047] FIG. 7 is a cross-sectional view of the drain nozzle fixation device according to another embodiment of the present invention, which shows a state where a desulfurization wastewater flow conditioner is disposed between a second end of the outer peripheral part of the drain nozzle and a projection of the outer-wall-side pipe. FIG. 12 is a cross-sectional view of the drain nozzle fixation device according to another embodiment of the present invention, which shows a state where a coating is provided on the inner surface of the outer-wall-side pipe.

As shown in FIGs. 2, 7, and 12, the drain nozzle 4 is disposed inside the outer-wall-side pipe 11, and an outer peripheral surface 41a of the outer peripheral part 41 is disposed adjacent the inner surface 11e of the outer-wall-side pipe 11 and the peripheral surface of the opening 12a of the hull outer wall 12 without a gap therebetween. More specifically, in

some embodiments, as shown in FIGs. 2 and 7, the outer peripheral surface 41a of the outer peripheral part 41 is in direct contact with the inner surface 11e of the outer-wall-side pipe 11 and the peripheral surface of the opening 12a of the hull outer wall 12, whereby the drain nozzle 4 is placed without a gap from the inner surface 11e of the outer-wall-side pipe 11 and the peripheral surface of the opening 12a of the hull outer wall 12. Further, in some embodiments, as shown in FIG. 12, a coating member 18 is provided on and in direct contact with the inner surface 11e of the outer-wall-side pipe 11 and the peripheral surface of the opening 12a of the hull outer wall 12. As the outer peripheral surface 41a of the outer peripheral part 41 is in contact with the coating member 18, the drain nozzle 4 is placed without a gap from the inner surface 11e of the outer-wall-side pipe 11 and the peripheral surface of the opening 12a of the hull outer wall 12 via the coating member 18.

[0048] Alternatively, in some embodiments, as shown in FIG. 6, the outer surface 11d including the first end 11b of the outer-wall-side pipe 11 has a diameter substantially equal to the opening 12a of the hull outer wall 12 so that the first end 11b can be inserted into the opening 12a. Further, the first end 11b is inserted into the opening 12a of the hull outer wall 12 from the inner surface 12c of the hull outer wall 12, and while an end surface of the first end 11b is aligned with the outer surface 12b of the hull outer wall 12, the outer-wall-side pipe 11 is integrally fixed to the hull outer wall 12 by bonding adjacent portions of the outer surface 11d and the inner surface 12c of the hull outer wall 12 by welding. Further, the first end opening 11f of the outer-wall-side pipe 11 is directly connected to the outside of the outer surface 12b of the hull outer wall 12 not via any member.

[0049] FIG. 8 is a cross-sectional view of the drain nozzle fixation device according to another embodiment of the present invention, which shows a state where a desulfurization wastewater flow conditioner is disposed between a second end of the outer peripheral part of the drain nozzle and a first end of an inner-wall-side pipe. FIG. 13 is a cross-sectional view of the drain nozzle fixation device according to another embodiment of the present invention, which shows a state where a coating is provided on the inner surface and a second end surface of the outer-wall-side pipe.

As shown in FIGs. 6, 8, and 13, the drain nozzle 4 is disposed inside the outer-wall-side pipe 11, and the outer peripheral surface 41a of the outer peripheral part 41 is disposed adjacent the inner surface 11e of the outer-wall-side pipe 11 without a gap therebetween. More specifically, in some embodiments, as shown in FIGs. 6 and 8, the outer peripheral surface 41a of the outer peripheral part 41 is in direct contact with the inner surface 11e of the outer-wall-side pipe 11, whereby the drain nozzle 4 is placed without a gap from the inner surface 11e of the outer-wall-side pipe 11. Alternatively, in some embodiments, as shown in FIG. 13, a coating member 18 is provided on and in direct contact with the inner surface 11e of the outer-wall-side pipe 11. As the outer peripheral surface 41a of the outer peripheral part 41 is in contact with the coating member 18, the drain nozzle 4 is placed without a gap from the inner surface 11e of the outer-wall-side pipe 11 via the coating member 18.

[0050] Furthermore, in some embodiments, the drain nozzle fixation device 1 further includes an inner pipe 14, as shown in FIGs. 2 and 6. The inner pipe 14 constitutes a part of the drain pipe 5. Further, the inner pipe 14 includes a first inner pipe 141 connected to the outer-wall-side pipe 11 and a second inner pipe 142 connected to the first inner pipe 141. As shown in FIG. 6, the first inner pipe 141 is formed in a cylindrical shape, and has a flange 141d protruding outward from the outer peripheral surface of a first end 141a on a side closer to the outer-wall-side pipe 11 in the axial direction, and a flange 141e protruding outward from the outer peripheral surface of a second end 141b on a side away from the outer-wall-side pipe 11 in the axial direction. As shown in FIG. 6, the second inner pipe 142 is formed in a cylindrical shape, and has at least a flange 142c protruding outward from the outer peripheral surface of a first end 142a closer to the first inner pipe 141 among both ends in the axial direction. Inner peripheral surfaces 141c, 142b of the first inner pipe 141 and the second inner pipe 142 have a diameter substantially equal to the inner peripheral surface 41b of the outer peripheral part 41 of the drain nozzle 4 and continue to the inner peripheral surface 41b without a step. Further, the first inner pipe 141 and the second inner pipe 142 are placed so that the axes thereof are aligned with the axis 1a of the drain nozzle fixation device 1.

[0051] Furthermore, in some embodiments, the drain nozzle fixation device 1 further includes a desulfurization wastewater flow conditioner 15, as shown in FIGs. 7 and 8. The desulfurization wastewater flow conditioner 15 conditions the flow of the desulfurization wastewater Wd to be stirred by the drain nozzle 4, and is shaped in a circular plate having a first end surface 15b and a second end surface 15c. Further, the desulfurization wastewater flow conditioner 15 has a plurality of circular through holes 15d penetrating in the plate thickness direction over the entire surface except the outer peripheral edge of the first end surface 15b. The desulfurization wastewater Wd passes through the through holes 15d of the desulfurization wastewater flow conditioner 15 and is thereby conditioned. Further, the desulfurization wastewater flow conditioner 15 is placed so that the axis thereof is aligned with the axis 1a of the drain nozzle fixation device 1.

[0052] In some embodiments, the drain nozzle fixation device 1 includes the hull outer wall 12 and the outer-wall-side pipe 11, as shown in FIGs. 2 and 6. Further, the drain nozzle 4 is disposed inside the outer-wall-side pipe 11.

[0053] With the above configuration, the outer-wall-side pipe 11 is formed in a cylindrical shape with an interior space 11a throughout in the axial direction and openings (first end opening 11f, second end opening 11g) on both axial ends (first end 11b, second end 11c) communicating with the interior space 11a. Further, the first end 11b of the outer-wall-side pipe 11 is integrally fixed to the edge of the opening 12a formed below the waterline Lw of the outer-wall-side pipe 12. Further, the second end 11c of the outer-wall-side pipe 11 is positioned inside the hull outer wall 12. Thus, it is possible to dispose the drain nozzle 4 inserted from the opening on one of both axial ends of the outer-wall-side pipe 11 inside the interior space 11a.

[0054] Further, the drain nozzle 4 disposed inside the outer-wall-side pipe 11 can stir and mix the desulfurization wastewater Wd flowing from the second end opening 11g with seawater Ws. Further, since the drain nozzle 4 is not integrally bonded by welding to the outer-wall-side pipe 12 or pipes (outer-wall-side pipe 11, inner pipe 14) unlike the conventional drain nozzle, it is possible to easily perform attachment and replacement.

[0055] Further, since the drain nozzle 4 attached to the drain nozzle fixation device 1 is not integrally fixed to the hull outer wall 12 unlike the conventional drain nozzle, the drain nozzle 4 does not need strength as required in the conventional drain nozzle. Thus, it is possible to more flexibly select the material of the drain nozzle 4 and freely exchange the drain nozzle 4, than the conventional drain nozzle. For instance, fiber reinforced plastic (FRP) and polymer materials can be used as the material of the drain nozzle 4, and thereby it is possible to reduce the cost and weight of the drain nozzle. Further, since the drain nozzle 4 is not a strength member unlike the conventional drain nozzle, the drain nozzle 4 may be periodically replaced in response to deterioration or wear thereof. Therefore, it is possible to select the material of the drain nozzle 4 in consideration of this point.

[0056] In some embodiments, the drain nozzle 4 is made of a material having a lower strength than the outer-wall-side pipe 11. Examples of the material of the outer-wall-side pipe 11 include rolled steel for general structural (SS material) and stainless steel (SUS material). Examples of the material of the drain nozzle 4 include reinforced plastic (FRP) and polymer materials. In this case, it is possible to use light and inexpensive materials for the drain nozzle 4, and it is possible to reduce the weight and the cost of the drain nozzle 4.

[0057] In some embodiments, the first end 11b of the outer-wall-side pipe 11 is integrally fixed to the edge of the opening 12a of the outer-wall-side pipe 12 by welding. In this case, it is possible to firmly fix the outer-wall-side pipe 11 and the hull outer wall 12.

[0058] In some embodiments, the drain nozzle 4 includes the outer peripheral part 41 and the nozzle part 42. Further, the outer peripheral surface 41a of the outer peripheral part 41 of the drain nozzle 4 is disposed adjacent the inner surface 11e of the outer-wall-side pipe 11 without a gap therebetween.

[0059] With the above configuration, since the drain nozzle 4 is placed without a gap between the outer peripheral surface 41a of the outer peripheral part 41 and the inner surface 11e of the outer-wall-side pipe 11, it is possible to determine the position of the drain nozzle 4 in a direction perpendicular to the axial direction relative to the outer-wall-side pipe 11 only by inserting the drain nozzle 4 into the outer-wall-side pipe 11 at attachment or replacement.

Thus, it is possible to efficiently perform attachment and replacement of the drain nozzle 4. Further, since the drain nozzle 4 is placed without a gap between the outer peripheral surface 41a and the inner surface 11e of the outer-wall-side pipe 11, it is possible to prevent a part of the desulfurization wastewater Wd from flowing into a gap formed between the outer peripheral surface 41a of the outer peripheral part 41 and the inner surface 11e of the outer-wall-side pipe 11 and remaining therein, and thus it is possible to prevent smooth flow of desulfurization wastewater Wd from being interrupted by the remaining desulfurization wastewater Wd.

[0060] In some embodiments, as shown in FIG. 2, the drain nozzle fixation device 1 further includes a drain nozzle holding member 13 detachably attached in the vicinity of the opening 12a of the hull outer wall 12 for preventing the drain nozzle 4 from getting out of the first end opening 11f of the outer-wall-side pipe 11 to the outside of the outer-wall-side pipe 11.

[0061] FIG. 5 is a front view of the drain nozzle holding member shown in FIG. 2.

The drain nozzle holding member 13 is shaped in an annular plate having an outer peripheral surface 13a, an inner peripheral surface 13b, an outer surface 13c, and an inner surface 13d, as shown in FIGs. 2, 5, and 11. Further, as shown in FIGs. 5 and 11, the drain nozzle holding member 13 has a plurality of through holes 13e penetrating along the thickness direction at positions adjacent to the outer peripheral surface 13a. The plurality of through holes 13e are arranged at equal intervals so that their axis are positioned on a circle having a predetermined diameter. Further, in some embodiments, as shown in FIG. 11, the drain nozzle holding member 13 has a plurality of through holes 13f penetrating along the thickness direction at positions adjacent to the inner surface 13d. The plurality of through holes 13f are arranged at equal intervals so that their axis are positioned on a circle having a smaller diameter than that of the predetermined circle on which the through holes 13e are arranged. Further, the drain nozzle holding member 13 is placed so that the axis thereof is aligned with the axis 1a of the drain nozzle fixation device 1.

[0062] As shown in FIG. 2, the hull outer wall 12 has an annular recess 12d recessed from

the outer surface 12b to the inner surface 11e and having a depth substantially equal to the thickness of the drain nozzle holding member 13. The annular recess 12d has an axis identical to the axis of the opening 12a and has a diameter larger than the diameter of the opening 12a. Further, the annular recess 12d has a diameter substantially equal to the outer diameter of the drain nozzle holding member 13.

[0063] As shown in FIG. 2, the drain nozzle holding member 13 is detachably fixed to the hull outer wall 12 by screwing a male thread member 6 inserted in the through hole 13e with a female thread portion 12g formed on a bottom surface 12e of the annular recess 12d while the drain nozzle holding member 13 is inserted in the annular recess 12d from the outer surface 12b of the hull outer wall 12. Further, the inner surface 13d of the drain nozzle holding member 13 touches the bottom surface 12e of the annular recess 12d, and the outer surface 13c is substantially aligned with the outer surface 12b of the hull outer wall 12. Further, the drain nozzle holding member 13 has a diameter substantially equal to the inner peripheral surface 41b of the outer peripheral part 41 of the drain nozzle 4.

[0064] With the above configuration, since the drain nozzle holding member 13 is detachably disposed in the vicinity of the opening 12a of the hull outer wall 12, by detaching the drain nozzle holding member 13, it is possible to easily perform attachment and replacement of the drain nozzle 4 from the first end opening 11f of the outer-wall-side pipe 11. Further, since the first end surface 41c of the outer peripheral part 41 of the drain nozzle 4 is locked to the inner surface 13d of the drain nozzle holding member 13 by the drain nozzle holding member 13, it is possible to prevent the drain nozzle 4 from getting out of the first end opening 11f of the outer-wall-side pipe 11 to the outside of the outer-wall-side pipe 11.

[0065] Although in the above embodiments, the female thread portion 12g and the annular recess 12d are formed in the hull outer wall 12, the annular recess and the female thread portion may be formed in the outer-wall-side pipe 11. In this case, the drain nozzle holding member 13 is inserted in the annular recess formed in the outer-wall-side pipe 11 and fixed to the outer-wall-side pipe 11. Further, the annular recess may be not formed in the outer-wall-side pipe 11 or the hull outer wall 12. In this case, the drain nozzle holding

member 13 is fixed to the outer-wall-side pipe 11 or the hull outer wall 12 while the inner surface 13d is in contact with the outer surface 12b of the hull outer wall 12 or the end surface of the first end 11b of the outer-wall-side pipe 11.

[0066] In some embodiments, the drain nozzle fixation device 1 includes the outer-wall-side pipe 11, the hull outer wall 12, and the drain nozzle holding member 13. Further, the outer-wall-side pipe 11 has a projection 11h protruding inward from the inner surface 11e of the second end 11c, as shown in FIGs. 2, 7, and 12. Further, the drain nozzle 4 is disposed inside the outer-wall-side pipe 11 while the first end surface 41c of the outer peripheral part 41 abuts on the drain nozzle holding member 13, and the second end surface 41d of the outer peripheral part 41 abuts on or is brought close to the projection 11h.

[0067] More specifically, in some embodiments, as shown in FIGs. 2 and 7, when the drain nozzle 4 is inserted from the first end opening 11f of the outer-wall-side pipe 11, the second end surface 41d of the outer peripheral part 41 abuts on a stepped surface 11k formed between the projection 11h and the inner surface 11e of the outer-wall-side pipe 11. The drain nozzle 4 is formed such that the axial length of the outer peripheral part 41 is substantially equal to the sum of the axial length of the outer-wall-side pipe 11 except the projection 11h and the thickness of the annular recess 12d of the hull outer wall 12. Accordingly, when the drain nozzle 4 is placed inside the interior space 11a of the outer-wall-side pipe 11 and inside the opening 12a of the hull outer wall 12, the first end surface 41c is substantially aligned with the bottom surface 12e of the annular recess 12d of the hull outer wall 12. Further, when the drain nozzle holding member 13 is attached to the hull outer wall 12, the first end surface 41c of the outer peripheral part 41 abuts on the inner surface 13d of the drain nozzle holding member 13.

[0068] Further, in some embodiments, the coating member 18 as shown in FIG. 12 adheres to the stepped surface 11k of the outer-wall-side pipe 11. Accordingly, the second end surface 41d of the outer peripheral part 41 of the drain nozzle 4 comes close to the stepped surface 11k of the outer-wall-side pipe 11. Further, the second end surface 41d of the outer peripheral part 41 of the drain nozzle 4 abuts on the coating member 18 provided on

the stepped surface 11k of the outer-wall-side pipe 11. Further, the drain nozzle 4 is formed such that the axial length of the outer peripheral part 41 is shorter than the sum of the axial length of the outer-wall-side pipe 11 except the projection 11h and the thickness of the annular recess 12d of the hull outer wall 12 by the thickness of the coating member 18. Accordingly, when the drain nozzle 4 is placed inside the interior space 11a of the outer-wall-side pipe 11 and inside the opening 12a of the hull outer wall 12, the first end surface 41c is substantially aligned with the bottom surface 12e of the annular recess 12d of the hull outer wall 12. Further, when the drain nozzle holding member 13 is attached to the hull outer wall 12, the first end surface 41c of the outer peripheral part 41 abuts on the inner surface 13d of the drain nozzle holding member 13.

[0069] With the above configuration, since the drain nozzle 4 is disposed inside the outer-wall-side pipe 11 while the first end surface 41c of the outer peripheral part 41 abuts on the drain nozzle holding member 13, and the second end surface 41d of the outer peripheral part 41 abuts on or is brought close to the projection 11h of the outer-wall-side pipe, the position of the drain nozzle 4 in the axial direction is determined only by inserting the drain nozzle 4 into the outer-wall-side pipe 11 from the first end opening 11f of the outer-wall-side pipe 11 and attaching the drain nozzle holding member 13 by an operator. Thus, it is possible to easily perform attachment and replacement of the drain nozzle 4.

[0070] In some embodiments described above, the drain nozzle fixation device 1 further includes the first inner pipe 141 (inner pipe 14) connected to the second end 11c of the outer-wall-side pipe 11, as shown in FIG. 2. Further, the outer-wall-side pipe 11 has a flange 11i protruding outward from the outer surface 11d of the second end 11c. Further, the outer-wall-side pipe 11 is fixed to the first inner pipe 141 by fastening the flanges 11i, 141d while the end surface of the flange 11i is in contact with the end surface of the flange 141d of the first inner pipe 141. The flanges 11i, 141d of the outer-wall-side pipe 11 and the first inner pipe 141 are fastened to each other by screwing a male thread member 7 inserted in the through holes 11j, 141f formed in the flanges 11i, 141d with a nut member 8.

[0071] In some embodiments, the drain nozzle fixation device 1 includes the outer-wall-

side pipe 11 having the projection 11h, the hull outer wall 12, the drain nozzle holding member 13, and at least one desulfurization wastewater flow conditioner 15 described above, and the drain nozzle 4 is disposed inside the outer-wall-side pipe 11. Further, as shown in FIG. 7, the desulfurization wastewater flow conditioner 15 is sandwiched and fixed between the projection 11h of the outer-wall-side pipe 11 and the second end 42f of the outer peripheral part 41 of the drain nozzle 4 opposite to the first end 42e adjacent to the hull outer wall 12.

[0072] As shown in FIG. 7, the desulfurization wastewater flow conditioner 15 is formed such that the diameter of the outer peripheral surface 15a is substantially equal to the diameter of the outer peripheral surface 41a of the outer peripheral part 41 of the drain nozzle 4 to allow the desulfurization wastewater flow conditioner 15 to be inserted inside the inner surface 11e of the outer-wall-side pipe 11. Further, the first end surface 15b of the desulfurization wastewater flow conditioner 15 is in contact with the second end surface 41d of the outer peripheral part 41 of the drain nozzle 4, and the second end surface 15c is in contact with the stepped surface 11k of the projection 11h of the outer-wall-side pipe 11.

[0073] With the above configuration, since the desulfurization wastewater flow conditioner 15 conditions the flow of the desulfurization wastewater Wd to be stirred by the drain nozzle 4, it is possible to improve the efficiency of the drain nozzle 4. Further, the desulfurization wastewater flow conditioner 15 is sandwiched and fixed between the second end 41f of the outer peripheral part 41 of the drain nozzle 4 and the projection 11h of the outer-wall-side pipe 11 only by inserting the desulfurization wastewater flow conditioner 15 into the outer-wall-side pipe 11 prior to the drain nozzle 4. Thus, it is possible to easily perform attachment and replacement of the desulfurization wastewater flow conditioner 15.

[0074] FIG. 9 is a cross-sectional view of the drain nozzle fixation device according to another embodiment of the present invention, which shows a state where a key is inserted in a key groove provided in the outer peripheral part of the drain nozzle and the outer-wall-side pipe. FIG. 10 is a cross-sectional view of the drain nozzle fixation device according to another embodiment of the present invention, which shows a state where the outer peripheral

part of the drain nozzle and the drain nozzle holding member are fixed with a bolt. FIG. 11 is a front view of the drain nozzle shown in FIG. 10.

In some embodiments, as shown in FIGs. 9 to 11, the drain nozzle fixation device 1 includes the outer-wall-side pipe 11, the hull outer wall 12, and the drain nozzle holding member 13, and the drain nozzle 4 is disposed inside the outer-wall-side pipe 11. Further, the drain nozzle fixation device 1 further includes an anti-rotation mechanism 16 including an anti-rotation member 160 (key 161, male thread member 162) inserted in a hole (female thread portion 41j) or a groove (key groove 41i) provided in the first end 41e of the outer peripheral part 41 of the drain nozzle 4 adjacent to the hull outer wall 12 along the axial direction.

[0075] First, the anti-rotation mechanism 16 having the key 161 will be described.

The drain nozzle 4 has a key groove 41i formed in the outer peripheral surface 41a of the outer peripheral part 41 and extending from the first end surface 41c along the axial direction, as shown in FIG. 9. Further, the outer-wall-side pipe 11 has a key groove 11m formed in the inner surface 11e and extending from the end surface of the first end 11b along the axial direction, as shown in FIG. 9. Additionally, the hull outer wall 12 has a key groove 12f formed in the inner peripheral surface of the opening 12a and extending from the outer surface 12b to the inner surface 12c along the axial direction. Each of the key groove 41i of the drain nozzle 4, the key groove 11m of the outer-wall-side pipe 11, and the key groove 12f of the hull outer wall 12 has a channel-shaped cross section perpendicular to the axis 1a of the drain nozzle fixation device 1. Further, the key groove 11m of the outer-wall-side pipe 11 and the key groove 12f of the hull outer wall 12 have substantially the same depth. Accordingly, when the key groove 41i of the drain nozzle 4 is placed so as to face the key groove 11m of the outer-wall-side pipe 11 and the key groove 12f of the hull outer wall 12, a rectangular interior space 16a is defined.

[0076] The key 161 is formed in a rectangular shape and has a thickness larger than the depth of each of the key groove 41i of the drain nozzle 4 and the key groove 11m of the outer-wall-side pipe 11. Further, the thickness of the key 161 is substantially equal to the sum of

the depths of the key groove 41i and the key groove 11m or smaller than the sum of the key groove 41i and the key groove 11m. The key 161 is inserted in the interior space 16a along the axial direction of the key groove 41i from a side of the first end 41e of the outer peripheral part 41 of the drain nozzle 4. Even if the drain nozzle 4 is to rotate around the axis, since the key 161 is locked to the side surface of the key groove 41i, the rotational movement around the axis is restricted.

[0077] Next, the anti-rotation mechanism 16 having the male thread member 162 will be described.

As shown in FIG. 10, the drain nozzle 4 is fixed to the drain nozzle holding member 13 by bolt fixing with the male thread member 162 (bolt). More specifically, the drain nozzle 4 has a female thread portion 41j along the axial direction from the first end surface 41c of the outer peripheral part 41. Further, as shown in FIG. 10, the drain nozzle holding member 13 is detachably fixed to the drain nozzle 4 by inserting the male thread member 162 through the through hole 13f into the female thread portion 41j along the axial direction from the first end 41e of the outer peripheral part 41 of the drain nozzle 4 and screwing the male thread member 162 with the female thread portion 41j while the drain nozzle holding member 13 is inserted in the annular recess 12d from the outer surface 12b of the hull outer wall 12. Further, since the drain nozzle holding member 13 is detachably fixed to the hull outer wall 12 as described above, even if the drain nozzle 4, which is fixed to the drain nozzle holding member 13, is to rotate around the axis, the rotational movement around the axis is restricted.

[0078] With the above configuration, the drain nozzle fixation device 1 includes the anti-rotation mechanism 16 including the anti-rotation member 160 inserted in a hole (female thread portion 41j) or a groove (key groove 41i) provided in the first end 41e of the outer peripheral part 41 of the drain nozzle 4 adjacent to the hull outer wall 12 along the axial direction. This restricts the rotational movement of the drain nozzle 4 around the axis and determines the position of the drain nozzle 4 in the circumferential direction, so that the drain nozzle 4 does not rotate when stirring and mixing the desulfurization wastewater Wd with seawater Ws. Thus, it is possible to efficiently stir the desulfurization wastewater Wd.

[0079] In some embodiments, the drain nozzle fixation device 1 includes the outer-wall-side pipe 11 and the hull outer wall 12. Further, the drain nozzle fixation device 1 further includes the first inner pipe 141 (inner pipe 14) connected to the second end 11c of the outer-wall-side pipe 11, as shown in FIG. 6.

[0080] The drain nozzle 4 has a flange 41g (first flange) protruding outward from the outer peripheral surface 41a at the second end 41f of the outer peripheral part 41, as shown in FIG. 6. The drain nozzle 4 is detachably fixed to the outer-wall-side pipe 11 by fastening the outer-wall-side pipe 11 with the first inner pipe 141 while the flange 41g is sandwiched between the second end 11c of the outer-wall-side pipe 11 and the first end 141a of the first inner pipe 141 closer to the hull outer wall 12.

[0081] With the above configuration, since the position of the drain nozzle 4 in the axial direction is determined only by fixing the flange 41g of the drain nozzle 4 to the outer-wall-side pipe 11, it is possible to easily perform attachment and replacement of the drain nozzle 4. Further, since the rotational movement of the drain nozzle 4 around the axis is restricted and the position of the drain nozzle 4 in the circumferential direction is determined only by fixing the flange 41g of the drain nozzle 4 to the outer-wall-side pipe 11, the drain nozzle 4 does not rotate when stirring and mixing the desulfurization wastewater Wd with seawater Ws. Thus, it is possible to efficiently stir the desulfurization wastewater Wd. Further, the drain nozzle 4 can be easily detached from the outer-wall-side pipe 11 by releasing fastening between the outer-wall-side pipe 11 and the inner pipe 14. Further, since the drain nozzle fixation device 1 does not need the drain nozzle holding member 13, it is possible to reduce the number of components.

[0082] In some embodiments, as shown in FIG. 6, the drain nozzle fixation device 1 includes the outer-wall-side pipe 11 having the flange 11i (second flange), the hull outer wall 12, and the first inner pipe 141 having the flange 141d (third flange), and the drain nozzle 4 having the flange 41g (first flange) is disposed inside the outer-wall-side pipe 11. Further, the drain nozzle 4 is detachably fixed to the outer-wall-side pipe 11 by fastening the flange 11i of the outer-wall-side pipe 11 with the flange 141d of the first inner pipe 141 while the flange

41g is sandwiched between the flange 11i of the outer-wall-side pipe 11 and the flange 141d of the first inner pipe 141. The flange 11i of the outer-wall-side pipe 11 and the flange 141d of the first inner pipe 141 are fastened to each other by screwing a male thread member 7 inserted in the through holes 11j, 41h, 141f formed in each of the flanges 11i, 141d of the outer-wall-side pipe 11 and the first inner pipe 141 and the flange 41g of the drain nozzle 4 with a nut member 8.

[0083] With the above configuration, the drain nozzle 4 is detachably fixed to the outer-wall-side pipe 11 by fastening the flange 11i of the outer-wall-side pipe 11 with the flange 141d of the first inner pipe 141 while the flange 41g is sandwiched between the flange 11i of the outer-wall-side pipe 11 and the flange 141d of the first inner pipe 141. Thus, since the flange 41g of the drain nozzle 4 is fixed in surface contact with the flange 11i of the outer-wall-side pipe 11 and the flange 141d of the first inner pipe 141, it is possible to firmly fix the drain nozzle 4 to the outer-wall-side pipe 11.

[0084] In some embodiments, the drain nozzle fixation device 1 includes the outer-wall-side pipe 11, the hull outer wall 12, the first inner pipe 141 having the flange 141e, and the second inner pipe 142 having the flange 142c, and the drain nozzle 4 having a flange 41g and configured to be detachably fixed to the outer-wall-side pipe 11 by fastening the outer-wall-side pipe 11 with the first inner pipe 141 is disposed inside the outer-wall-side pipe 11, as shown in FIG. 6. Further, the first inner pipe 141 has an axial length longer than the drain nozzle 4.

[0085] The first inner pipe 141 is detachably fixed to the second inner pipe 142 by fastening the flanges 141e, 142c while the end surface of the flange 141e is in contact with the end surface of the flange 142c of the second inner pipe 142. The flanges 141e, 142c of the first inner pipe 141 and the second inner pipe 142 are fastened to each other by screwing a male thread member 7 inserted in the through holes 141g, 142d formed in the flanges 141e, 142c with a nut member 8.

[0086] With the above configuration, since the first inner pipe 141 has an axial length longer than the drain nozzle 4, it is possible to detach the drain nozzle 4 from the outer-wall-

side pipe 11 only by detaching the first inner pipe 141 from the outer-wall-side pipe 11 or the second inner pipe 142. Thus, it is possible to easily perform attachment and replacement of the drain nozzle 4.

[0087] Further, in the above configuration, in a case where the first inner pipe 141 has an axial length shorter than the second inner pipe 142, it is possible to easily detach the first inner pipe 141 from the outer-wall-side pipe 11 or the second inner pipe 142.

[0088] In some embodiments, the drain nozzle fixation device 1 includes the outer-wall-side pipe 11, the hull outer wall 12, the desulfurization wastewater flow conditioner 15, and the first inner pipe 141, and the drain nozzle 4 is disposed inside the outer-wall-side pipe 11, as shown in FIG. 8. Further, as shown in FIG. 8, the desulfurization wastewater flow conditioner 15 is sandwiched and fixed between the second end 41f of the outer peripheral part 41 of the drain nozzle 4 and the first end 141a of the first inner pipe 141.

[0089] As shown in FIG. 8, the desulfurization wastewater flow conditioner 15 is formed such that the diameter of the outer peripheral surface 15a is substantially equal to the diameter of the outer peripheral surface of the flange 11i of the outer-wall-side pipe 11, the diameter of the outer peripheral surface of the flange 41g of the outer peripheral part 41 of the drain nozzle 4, and the diameter of the outer peripheral surface of the flange 141d of the first inner pipe 141. Further, the first end surface 15b of the desulfurization wastewater flow conditioner 15 is in contact with the end surface of the flange 41g, and the second end surface 15c is in contact with the end surface of the flange 141d of the first inner pipe 141.

[0090] Further, the desulfurization wastewater flow conditioner 15 is detachably fixed to the outer-wall-side pipe 11 by fastening the flange 11i of the outer-wall-side pipe 11 with the flange 141d of the first inner pipe 141 while the desulfurization wastewater flow conditioner 15 and the flange 41g of the drain nozzle 4 are together sandwiched between the flange 11i of the outer-wall-side pipe 11 and the flange 141d of the first inner pipe 141. The flange 11i of the outer-wall-side pipe 11 and the flange 141d of the first inner pipe 141 are fastened to each other by screwing a male thread member 7 inserted in the through holes 11j, 41h, 15e, 141f formed in each of the flanges 11i, 141d of the outer-wall-side pipe 11 and the first inner pipe

141, the flange 41g of the drain nozzle 4, and the desulfurization wastewater flow conditioner 15 with a nut member 8.

[0091] With the above configuration, since the desulfurization wastewater flow conditioner 15 conditions the flow of the desulfurization wastewater Wd to be stirred by the drain nozzle 4, it is possible to improve the efficiency of the drain nozzle 4. Further, the desulfurization wastewater flow conditioner 15 is sandwiched and fixed between the second end 41f of the outer peripheral part 41 of the drain nozzle 4 and the first end 141a of the first inner pipe 141 only by sandwiching it between the drain nozzle 4 and the first inner pipe 141 when the outer-wall-side pipe 11 and the first inner pipe 141 are fastened. Thus, it is possible to easily perform attachment and replacement of the desulfurization wastewater flow conditioner 15.

[0092] Although the above-described desulfurization wastewater flow conditioner 15 has a plurality of circular through holes 15d, the through holes may have different opening diameters. Further, the through hole 15d is not limited to a circular shape and may be a rectangular or polygonal shape. Further, the drain nozzle fixation device 1 may have a plurality of desulfurization wastewater flow conditioners 15.

[0093] In some embodiments, the drain nozzle fixation device 1 includes the outer-wall-side pipe 11 and the hull outer wall 12, and the drain nozzle 4 is disposed inside the outer-wall-side pipe 11. Further, the drain nozzle fixation device 1 further includes at least one reinforcement member 17 integrally fixed to the inner surface 12c (inboard wall surface) of the hull outer wall 12 and integrally fixed to the outer surface 11d of the outer-wall-side pipe 11, as shown in FIGs. 12 and 13.

[0094] As shown in FIGs. 12 and 13, the reinforcement member 17 is formed in a triangular prism shape having a first surface 17a abutting on the outer surface 11d of the outer-wall-side pipe 11 and a second surface 17b adjacent to and perpendicular to the first surface 17a and abutting on the inner surface 12c of the hull outer wall 12. Further, the reinforcement member 17 is integrally fixed to the outer surface 11d of the outer-wall-side pipe 11 by bonding, while the first surface 17a abuts on the outer surface 11d of the outer-

wall-side pipe 11, respective portions adjacent to the abutting portion by welding. Further, the reinforcement member 17 is integrally fixed to the inner surface 12c of the hull outer wall 12 by bonding, while the second surface 17b abuts on the inner surface 12c of the hull outer wall 12, respective portions adjacent to the abutting portion by welding.

[0095] With the above configuration, it is possible to reinforce the hull outer wall 12 and the outer-wall-side pipe 11 by the reinforcement member 17. Further, since the outer-wall-side pipe 11 is reinforced by the reinforcement member 17, it is possible to reduce the thickness of the outer-wall-side pipe 11 accordingly, and it is possible to prevent increase in weight and cost of the outer-wall-side pipe 11.

[0096] Although in the above-described embodiments, the reinforcement member 17 has a rectangular prism shape, the reinforcement member 17 may have other shape, such as a triangular pyramid.

[0097] In some embodiments, the drain nozzle fixation device 1 includes the outer-wall-side pipe 11 and the hull outer wall 12, and the drain nozzle 4 is disposed inside the outer-wall-side pipe 11. Further, the drain nozzle fixation device 1 has a coating having acid resistance on the inner surface 11e of the outer-wall-side pipe 11, as shown in FIGs. 12 and 13. Examples of the coating having acid resistance include rubber lining in which a sheet-shaped coating member 18 such as rubber having acid resistance adheres to a target surface.

[0098] More specifically, in some embodiments, as shown in FIG. 12, the coating member 18 adheres to the inner surface 11e of the outer-wall-side pipe 11 having the projection 11h and the inner surface and the stepped surface 11k of the projection 11h. Further, the coating member 18 also adheres to the inner peripheral surface of the opening 12a of the hull outer wall 12, the inner peripheral surface and the bottom surface 12e of the annular recess 12d, and the inner peripheral surface 141c of the first inner pipe 141. Thus, with the coating member 18 interposed between the outer peripheral surface 41a of the outer peripheral part 41 and each of the inner surface 11e of the outer-wall-side pipe 11 and the inner peripheral surface of the opening 12a of the hull outer wall 12, the drain nozzle 4 is placed without a gap from the inner surface 11e of the outer-wall-side pipe 11 and the inner peripheral surface of the

opening 12a of the hull outer wall 12. Additionally, the second end surface 41d of the outer peripheral part 41 of the drain nozzle 4 abuts on the coating member 18 provided on the stepped surface 11k of the outer-wall-side pipe 11. Further, with the coating member 18 interposed between the inner surface 13d of the drain nozzle holding member 13 and the bottom surface 12e of the annular recess 12d, the drain nozzle holding member 13 is placed without a gap from the bottom surface 12e, and the outer surface 13c is substantially aligned with the outer surface 12b of the hull outer wall 12.

[0099] Further, in some embodiments, as shown in FIG. 13, the coating member 18 adheres to the inner surface 11e of the outer-wall-side pipe 11 which fastens the flange 41g of the outer peripheral part 41 of the drain nozzle 4 by sandwiching the flange 41g between the outer-wall-side pipe 11 itself and the first inner pipe 141. Further, the coating member 18 also adheres to the inner peripheral surface 141c of the first inner pipe 141 and the inner peripheral surface 142b of the second inner pipe 142. Thus, with the coating member 18 interposed between the outer peripheral surface 41a of the outer peripheral part 41 of the drain nozzle 4 and the inner surface 11e of the outer-wall-side pipe 11, the drain nozzle 4 is placed without a gap from the inner surface 11e.

[0100] Since the above-described drain nozzle fixation device 1 has the coating having acid resistance on the inner surface 11e of the outer-wall-side pipe 11, it is possible to use a material having low acid resistance for the outer-wall-side pipe 11.

[0101] In the above-described embodiments, rubber lining in which a sheet-shaped coating member 18 such as rubber having acid resistance adheres to a target surface was described as an example of the coating having acid resistance. However, as an alternative, a paint having acid resistance may be applied to the target surface.

[0102] The present invention is not limited to the embodiments described above, but includes modifications to the embodiments described above, and embodiments composed of combinations of those embodiments.

[0103] Although in some embodiments described above, the first inner pipe 141 and the second inner pipe 142 are placed so that the axes thereof are aligned with the axis 1a of the

drain nozzle fixation device 1, they may be placed so that the axes are not aligned with the axis 1a of the drain nozzle fixation device 1. Further, although in some embodiments described above, the inner surface 12c of the outer-wall-side pipe 11 has a constant diameter except the projection 11h, the present invention is not limited thereto. The diameter may gradually increase or decrease from the second end 11c to the first end 11b. In this case, the shape of the outer peripheral part 41 of the drain nozzle 4 may be changed in accordance with the shape of the outer-wall-side pipe 11.

[0104] Further, although the drain nozzle 4 in some embodiments described above includes the outer peripheral part 41, the nozzle part 42 having at least one blade 42a, and the shaft part 43, the present invention is not limited thereto. The drain nozzle 4 may be any nozzle that is configured to stir desulfurization wastewater Wd processed by the desulfurization device 3 disposed on the hull 21 to promote mixing with seawater Ws around the ship disposed and that is disposed inside the outer-wall-side pipe 11.

Reference Signs List

[0105]

1	Drain nozzle fixation device
1a	Axis
11	Outer-wall-side pipe
11a	Interior space
11b	First end
11c	Second end
11d	Outer surface
11e	Inner surface
11f	First end opening
11g	Second end opening
11h	Projection
11i	Flange

11j Through hole

11k Stepped surface

11m Key groove

12 Hull outer wall

12a Opening

12b Outer surface

12c Inner surface

12d Annular recess

12e Bottom surface

12f Key groove

12g Female thread portion

13 Drain nozzle holding member

13a Outer peripheral surface

13b Inner peripheral surface

13c Outer surface

13d Inner surface

13e, 13f Through hole

14 Inner pipe

141 First inner pipe

141a First end

141b Second end

141c Inner peripheral surface

141d, 141e Flange

141f, 141g Through hole

142 Second inner pipe

142a First end

142b Inner peripheral surface

142c Flange

142d	Through hole
15	Desulfurization wastewater flow conditioner
15a	Outer peripheral surface
15b	First end surface
15c	Second end surface
15d, 15e	Through hole
16	Anti-rotation mechanism
16a	Interior space
160	Anti-rotation member
161	Key
162	Male thread member
17	Reinforcement member
17a	First surface
17b	Second surface
18	Coating member
2	Ship
21	Hull
21a	Deck
21b	Inboard space
3	Desulfurization device
3a	Wastewater storage tank
4	Drain nozzle
41	Outer peripheral part
41a	Outer peripheral surface
41b	Inner peripheral surface
41c	First end surface
41d	Second end surface
41e	First end

41f	Second end
41g	Flange
41h	Through hole
41i	Key groove
41j	Female thread portion
42	Nozzle part
42a	Blade
43	Shaft part
5	Drain pipe
6, 7	Male thread member
8	Nut member
Lw	Waterline
Wd	Desulfurization wastewater
Ws	Seawater

CLAIMS

1. A drain nozzle fixation device for fixing a drain nozzle which stirs desulfurization wastewater discharged from a desulfurization device disposed on a hull and mixes the desulfurization wastewater with seawater, the drain nozzle fixation device comprising:

a hull outer wall having an opening below a waterline; and

an outer-wall-side pipe having a cylindrical shape with an interior space throughout in an axial direction and openings on both ends in the axial direction, a first end of the outer-wall-side pipe in the axial direction being integrally fixed to an opening edge of the hull outer wall, an opening of the first end communicating with an outside of the hull outer wall, a second end of the outer-wall-side pipe in the axial direction being positioned inside the hull outer wall,

wherein the drain nozzle is disposed inside the outer-wall-side pipe.

2. The drain nozzle fixation device according to claim 1,

wherein the drain nozzle includes an outer peripheral part having a cylindrical shape and a nozzle part disposed inside the outer peripheral part, and

wherein an outer peripheral surface of the outer peripheral part is disposed adjacent an inner surface of the outer-wall-side pipe without a gap.

3. The drain nozzle fixation device according to claim 2, further comprising a drain nozzle holding member detachably attached in vicinity of the opening of the hull outer wall and configured to prevent the drain nozzle from getting out of the opening of the first end of the outer-wall-side pipe to an outside of the outer-wall-side pipe.

4. The drain nozzle fixation device according to claim 3,

wherein the outer-wall-side pipe includes a projection protruding inward from an inner surface of the second end, and

wherein the drain nozzle is disposed inside the outer-wall-side pipe while a first end surface of the outer peripheral part abuts on the drain nozzle holding member and a second end surface of the outer peripheral part abuts on or is brought close to the projection.

5. The drain nozzle fixation device according to claim 2, further comprising an inner pipe connected to the second end of the outer-wall-side pipe,

wherein the drain nozzle includes a first flange protruding outward from the outer peripheral surface of the outer peripheral part at a second end of the outer peripheral part opposite to a first end adjacent to the hull outer wall, and

wherein the drain nozzle is detachably fixed to the outer-wall-side pipe by fastening the outer-wall-side pipe with the inner pipe while the first flange is sandwiched between the second end of the outer-wall-side pipe and a first end of the inner pipe adjacent to the hull outer wall.

6. The drain nozzle fixation device according to claim 5,

wherein the outer-wall-side pipe includes a second flange protruding outward from an outer surface of the second end of the outer-wall-side pipe,

wherein the inner pipe includes a third flange protruding outward from an outer surface of the first end of the inner pipe, and

wherein the drain nozzle is detachably fixed to the outer-wall-side pipe by fastening the second flange with the third flange while the first flange is sandwiched between the second flange and the third flange.

7. The drain nozzle fixation device according to claim 5 or 6,

wherein the inner pipe includes:

a first inner pipe connected to the outer-wall-side pipe; and

a second inner pipe connected to the first inner pipe, and

wherein the first inner pipe has an axial length longer than the drain nozzle.

8. The drain nozzle fixation device according to claim 4, further comprising at least one desulfurization wastewater flow conditioner for conditioning a flow of the desulfurization wastewater to be stirred by the drain nozzle,

wherein the at least one desulfurization wastewater flow conditioner is sandwiched and fixed between the projection of the outer-wall-side pipe and a second end of the outer peripheral part of the drain nozzle opposite to a first end adjacent to the hull outer wall.

9. The drain nozzle fixation device according to any one of claims 5 to 7, further comprising at least one desulfurization wastewater flow conditioner for conditioning a flow of the desulfurization wastewater to be stirred by the drain nozzle,

wherein the at least one desulfurization wastewater flow conditioner is sandwiched and fixed between the second end of the outer peripheral part of the drain nozzle and the first end of the inner pipe.

10. The drain nozzle fixation device according to any one of claims 3, 4, and 8, further comprising an anti-rotation mechanism including an anti-rotation member inserted in a hole or a groove provided in a first end of the outer peripheral part of the drain nozzle adjacent to the hull outer wall along the axial direction.

11. The drain nozzle fixation device according to any one of claims 1 to 10, further comprising at least one reinforcement member integrally fixed to an inboard wall surface of the hull outer wall and integrally fixed to an outer surface of the outer-wall-side pipe.

12. The drain nozzle fixation device according to any one of claims 1 to 11,
wherein an inner surface of the outer-wall-side pipe has a coating having acid resistance.

13. The drain nozzle fixation device according to any one of claims 1 to 12,

wherein the drain nozzle is made of a material having a lower strength than the outer-wall-side pipe.

14. The drain nozzle fixation device according to any one of claims 1 to 13,

wherein the first end of the outer-wall-side pipe is integrally fixed to the opening edge of the hull outer wall by welding.