

DESCRIPTION

Title of the Invention: ROTATING SPRAY UNIT

5 Technical Field

[0001]

 The present invention relates to a rotating spray unit for cleaning a tank that cleans an inner wall surface of a tank.

10 Background Art

[0002]

 Tanks such as sanitary tanks have conventionally been used in various applications such as product storage, compounding, and sterilization in, for example, the food
15 industry or the pharmaceutical industry. Since it is necessary to maintain the inside of such a tank in a clean state, a rotating spray unit is used as a dedicated cleaning device.

[0003]

20 Specifically, as illustrated in Fig. 12, the rotating spray unit is inserted into a tank 102 from a nozzle 102b formed in an upper lid portion 102a of the tank 102. For example, as illustrated in Fig. 13, a rotating spray unit 104 including an upper rotating body 106 and a lower rotating

body 108 that rotate in opposite directions is used. In addition, two rotating jet holes 110 and two cleaning jet holes 112 are provided in each of the upper rotating body 106 and the lower rotating body 108. The rotating jet hole 110 is a jet hole for jetting a cleaning liquid in a tangential direction to rotate the upper rotating body 106 or the lower rotating body 108, and the cleaning jet hole 112 is a jet hole for jetting a cleaning liquid.

[0004]

10 The rotating spray unit 104 can clean the inside of the tank 102 without taking up much space.

 However, the rotating spray unit 104 described above has the problem that while a part hit by a water stream jetted from the cleaning jet hole 112 in the tank 102 is cleaned, a part not hit by the water stream is not directly cleaned. For this reason, the part not hit by the water stream has to be cleaned by a cleaning liquid flowing down from the part hit by the water stream.

[0005]

20 In addition, since there are only four cleaning jet holes 112 in total, there is the problem that not many parts can be cleaned with the water stream and cleaning unevenness is conspicuous. In particular, there is the problem that it is difficult to clean the inside of a nozzle 102c, for

example.

[0006]

To solve such a problem, a rotating spray unit has been developed in which a first jet hole group and a second
5 jet hole group having different jet angles are formed adjacent to each other in each of an upper rotating body and a lower rotating body (see, for example, Patent Literature 1).

10 Citation List

Patent Literature

[0007]

Patent Literature 1: JP 2020-157214 A

15 Summary of Invention

Technical Problem

[0008]

However, while a rotating spray unit 114 (hereinafter, referred to as a conventional product) described in Patent
20 Literature 1 illustrated in Fig. 14 exhibits high cleaning performance at a jet angle of about 15° to 45° when performing cleaning, cleaning at other jet angles particularly on the low angle side (see reference numeral 136 in Fig. 14) still has to be done by a flowing-down cleaning

liquid.

[0009]

In particular, for example, a large cleaning tank has the problem that a nozzle is often located in an area that is
5 difficult to directly hit by a jet stream, and some area is often left unwashed.

In a case where some area is left unwashed, a large amount of cleaning liquid is required in order to eliminate the unwashed area by performing cleaning for a long time.
10 However, there is a need to save the cleaning liquid.

[0010]

An object of the present invention is to provide a rotating spray unit capable of evenly cleaning the inside of a tank in a short time and saving a cleaning liquid.
15

Solution to Problem

[0011]

A rotating spray unit according to the present invention is
20 a rotating spray unit disposed in a tank and configured to clean an inside of the tank, the rotating spray unit including

a plurality of cleaning jet holes formed in a rotating unit main body that rotates, wherein

some or all of the plurality of cleaning jet holes have different jet angles in an elevation angle direction,

the cleaning jet holes are further opened in a side wall of the rotating unit main body to be inclined in a

5 rotation direction at a predetermined angle with respect to a straight line orthogonal to a rotation axis in a plane centered on the rotation axis, and

when cleaning is performed with the rotating spray unit rotated, a plurality of water streams jetted from the
10 respective cleaning jet holes are dispersed in the elevation angle direction of an upper hemisphere in the tank.

[0012]

In this manner, by making the cleaning jet holes have different jet angles in the elevation angle direction, the
15 inside of the tank can be evenly cleaned in a short time, and a cleaning liquid can be saved.

[0013]

In addition, in the rotating spray unit according to the present invention,

20 the cleaning jet holes include:

a plurality of high-angle jet holes configured to jet a water stream to a high-angle region;

a plurality of intermediate-angle jet holes configured to jet a water stream to an intermediate-angle region; and

a plurality of low-angle jet holes configured to jet a water stream to a low-angle region, and

with reference to an equator orthogonal to the rotation axis of the rotating unit main body,

5 an angle formed by the water stream jetted from each of the high-angle jet holes is more than 60° and 85° or less,

an angle formed by the water stream ejected from each of the intermediate-angle jet holes is more than 30° and 60° or less, and

10 an angle formed by the water stream ejected from each of the low-angle jet holes is 0° or more and 30° or less.

[0014]

In this manner, by forming the high-angle jet holes, the intermediate-angle jet holes, and the low-angle jet holes
15 in the rotating unit main body, an inner wall surface of the tank can be extensively cleaned. Therefore, the inside of the tank can be evenly cleaned in a short time, and the cleaning liquid can be saved.

[0015]

20 In addition, in the rotating spray unit according to the present invention,

a plurality of jet hole regions in each of which a jet hole group is formed in a line in a direction orthogonal to the rotation direction of the rotating unit main body are

disposed on the side wall of the rotating unit main body,

the jet hole regions include:

a high-angle jet hole region configured to jet a water stream to a high-angle region;

5 an intermediate-angle jet hole region configured to jet a water stream to an intermediate-angle region; and

a low-angle jet hole region configured to jet a water stream to a low-angle region, and

angles of the water streams jetted from the jet hole groups included in the respective jet hole regions are different from each other.

[0016]

In this manner, by forming the high-angle jet hole region, the intermediate-angle jet hole region, and the low-angle jet hole region in the rotating unit main body, an inner wall surface of the tank can be extensively cleaned. Therefore, the inside of the tank can be evenly cleaned in a short time, and the cleaning liquid can be saved.

[0017]

20 In addition, in the rotating spray unit according to the present invention,

the high-angle jet hole region includes a high-angle jet hole group including a plurality of the cleaning jet holes,

an angle formed by an equator and a water stream
jetted from the cleaning jet hole closest to the equator of
the high-angle jet hole group is in a range of 50° or more,
and an angle formed by the equator and a water stream jetted
5 from the cleaning jet hole closest to a pole of the high-
angle jet hole group is in a range of 85° or less,

the intermediate-angle jet hole region includes an
intermediate-angle jet hole group including a plurality of
the cleaning jet holes,

10 an angle formed by the equator and a water stream
jetted from the cleaning jet hole closest to the equator of
the intermediate-angle jet hole group is in a range of 10° or
more, and an angle formed by the equator and a water stream
jetted from the cleaning jet hole closest to the pole of the
15 intermediate-angle jet hole group is in a range of 55° or
less,

the low-angle jet hole region includes a low-angle jet
hole group including a plurality of the cleaning jet holes,
and

20 an angle formed by the equator and a low-angle water
stream jetted from the cleaning jet hole closest to the
equator of the low-angle jet hole group is in a range of 0°
or more, and an angle formed by the equator and a water
stream jetted from the cleaning jet hole closest to the pole

of the low-angle jet hole group is in a range of 30° or less.

[0018]

In this manner, by setting the range of the angle formed by each water stream jetted from the cleaning jet hole, it is possible to accurately form the high-angle jet hole region, the intermediate-angle jet hole region, and the low-angle jet hole region.

[0019]

In addition, in the rotating spray unit according to the present invention,

each of the jet hole groups includes two to ten of the cleaning jet holes.

[0020]

That is, by including the above-described number of cleaning jet holes in each jet hole group, the inner wall surface of the tank can be extensively cleaned.

[0021]

In addition, in the rotating spray unit according to the present invention,

the rotating unit main body includes: an upper rotating body including high-angle jet holes, intermediate-angle jet holes, and low-angle jet holes, or a high-angle jet hole region, an intermediate-angle jet hole region, and a low-angle jet hole region; and a lower rotating body that

rotates in a forward direction/a backward direction with respect to the upper rotating body, and the rotating unit main body is formed in a spherical shape by the upper rotating body and the lower rotating body.

5 [0022]

In this manner, a rotational speed of the upper rotating body can be reduced, and a part to be cleaned in the tank can be accurately cleaned. In addition, by making the rotating spray unit spherical, the angles of the water
10 streams jetted from the cleaning jet holes can be appropriately dispersed in the elevation angle direction, and the inner wall surface of the tank can be extensively cleaned.

15 Advantageous Effects of Invention

[0023]

According to the present invention, it is possible to provide the rotating spray unit capable of evenly cleaning the inside of the tank in a short time and saving the
20 cleaning liquid.

Brief Description of Drawings

[0024]

Fig. 1 is a perspective view of a rotating spray unit

according to an embodiment as viewed from above.

Fig. 2 is a front view of the rotating spray unit according to the embodiment.

Fig. 3 is a cross-sectional view illustrating a state
5 in which a plane obtained by cutting an upper rotating body according to the embodiment at a predetermined height is viewed from above.

Fig. 4 is a cross-sectional view of a first jet hole group obtained by cutting the upper rotating body according
10 to the embodiment along line A-A illustrated in Fig. 3, and a cross-sectional view of a second jet hole group obtained by cutting the upper rotating body along line B-B.

Fig. 5 is a cross-sectional view of a third jet hole group obtained by cutting the upper rotating body according
15 to the embodiment along line C-C illustrated in Fig. 3, and a cross-sectional view of a fourth jet hole group obtained by cutting the upper rotating body along line D-D.

Fig. 6 is a cross-sectional view of a fifth jet hole group obtained by cutting the upper rotating body according
20 to the embodiment along line E-E illustrated in Fig. 3, and a cross-sectional view of a sixth jet hole group obtained by cutting the upper rotating body along line F-F.

Fig. 7 is a cross-sectional view illustrating a state in which a plane obtained by cutting a lower rotating body

according to the embodiment at a predetermined height is viewed from above.

Fig. 8 is a drawing illustrating a situation in which water streams jetted from respective jet hole groups in all jet hole regions formed in the upper rotating body according to the embodiment hit an inner wall surface of a tank.

Fig. 9 is a bar graph illustrating cleaning rates in a tank and a nozzle by an embodiment product and cleaning rates in a tank and a nozzle by a conventional product.

Fig. 10 is a bar graph illustrating cleaning efficiencies in the tank and the nozzle by the embodiment product and cleaning efficiencies in the tank and the nozzle by the conventional product.

Fig. 11 is a front view of a rotating spray unit according to another embodiment.

Fig. 12 is a drawing illustrating a situation in which the inside of a tank is cleaned using a conventional rotating spray unit.

Fig. 13 is a front view of the conventional rotating spray unit.

Fig. 14 is a drawing illustrating a situation in which the inside of a cleaning tank is cleaned with the conventional product.

Description of Embodiments

[0025]

Hereinafter, a rotating spray unit according to an embodiment of the present invention will be described by exemplifying a case where the rotating spray unit is spherical with reference to the drawings. Fig. 1 is a perspective view of the rotating spray unit according to the embodiment as viewed from above, and Fig. 2 is a front view of the rotating spray unit. As illustrated in Figs. 1 and 2, a rotating spray unit 2 is formed of, for example, resin such as polytetrafluoroethylene (PTFE), and includes a nozzle portion 4, a fixing ring 6, and a ball main body 8 (rotating unit main body).

[0026]

The rotating spray unit 2 preferably has an outer diameter of about 62 mm to 67 mm when attached from a nozzle 35 having an inner diameter of 80 mm formed in a tank 34 (see Fig. 8), for example. In the present specification, "upper" or "lower" is defined in the states of Figs. 1 and 2.

[0027]

The nozzle portion 4 has a cylindrical shape in which a flow passage 4a for a cleaning liquid is formed, and a large diameter portion 4b having an enlarged diameter is formed at its lower end. In addition, a thread groove (not

illustrated) is formed on the outer periphery of a part of the nozzle portion 4 where the fixing ring 6 is mounted. Furthermore, a port (not illustrated) through which the cleaning liquid jetted from, for example, a jet hole group 12 described later passes is formed in a part of the nozzle portion 4 hidden by the ball main body 8.

[0028]

A thread groove (not illustrated) is formed on an inner peripheral surface of the fixing ring 6, and the fixing ring 6 is mounted at a predetermined position by screwing.

[0029]

The ball main body 8 is a spherical rotating body in which a through hole (not illustrated) to be inserted onto the nozzle portion 4 is formed with a rotation center line L as the axis, and includes an upper rotating body 8a and a lower rotating body 8b. Here, the lower rotating body 8b can rotate in a direction opposite to the upper rotating body 8a, and there may be a gap between the upper rotating body 8a and the lower rotating body 8b, or the upper rotating body 8a and the lower rotating body 8b may be in contact with each other.

[0030]

The ball main body 8 is rotatably fixed at a predetermined position by first inserting the lower rotating body 8b onto the nozzle portion 4 to be landed on the large

diameter portion 4b, then inserting the upper rotating body 8a onto the nozzle portion 4 into abutment with the lower rotating body 8b, and finally attaching the fixing ring 6 to the nozzle portion 4.

5 [0031]

Three types of jet hole regions 10, that is, a high-angle jet hole region 10a for jetting a water stream of the cleaning liquid to a high-angle region of the tank 34 (see Fig. 8), an intermediate-angle jet hole region 10b for
10 jetting a water stream of the cleaning liquid to an intermediate-angle region, and a low-angle jet hole region 10c for jetting a water stream of the cleaning liquid to a low-angle region are formed on a curved surface of the upper rotating body 8a.

15 [0032]

Such jet hole regions 10 include a plurality of jet hole groups 12 formed in a line in a direction orthogonal to a rotation direction of the ball main body 8, that is, the rotation center line L direction. That is, in each of the
20 jet hole regions 10, the jet hole groups 12 each including a plurality of cleaning jet holes 8e for jetting the cleaning liquid are provided at two places, and the respective jet hole groups 12 are formed symmetrically with respect to the rotation center line L of the ball main body 8 (see Fig. 3).

[0033]

The high-angle jet hole region 10a includes a first jet hole group 12a and a second jet hole group 12b as a high-angle jet hole group, the intermediate-angle jet hole region
5 10b includes a third jet hole group 12c and a fourth jet hole group 12d as an intermediate-angle jet hole group, and the low-angle jet hole region 10c includes a fifth jet hole group 12e and a sixth jet hole group 12f as a low-angle jet hole group.

10 [0034]

Three cleaning jet holes 8e are opened in each of the first jet hole group 12a and the second jet hole group 12b, and four cleaning jet holes 8e are opened in each of the third jet hole group 12c, the fourth jet hole group 12d, the
15 fifth jet hole group 12e, and the sixth jet hole group 12f.

[0035]

The number of cleaning jet holes 8e included in each of the jet hole groups 12 is not necessarily limited to the above-described number, and the number of cleaning jet holes
20 8e included in the first jet hole group 12a to the sixth jet hole group 12f may be in a range of 2 to 10. An outer diameter of each cleaning jet hole 8e is preferably in a range of 1.0 mm to 1.8 mm, and more preferably in a range of 1.2 mm to 1.5 mm.

[0036]

Fig. 3 is a cross-sectional view illustrating a state in which a plane obtained by cutting the upper rotating body 8a at a predetermined height is viewed from above. As

5 illustrated in Fig. 3, each of the cleaning jet holes 8e constituting the jet hole groups 12 is opened in a side wall of the rotating unit main body so as to be inclined in the rotation direction at a predetermined angle θ_1 with respect to a straight line X orthogonal to the rotation center line L in a plane centered on the rotation center line L. Here, the
10 angle θ_1 is 5 to 25°. As a result, the rotation of the upper rotating body 8a can be promoted.

[0037]

Figs. 4 to 6 are cross-sectional views of the
15 respective jet hole groups 12 opened in the upper rotating body 8a. As illustrated in Figs. 4 to 6, the respective jet hole groups 12 are formed symmetrically at two places on opposite side walls with respect to the rotation center line L, and angles of the water streams jetted from the jet hole
20 groups 12 included in the respective jet hole regions 10 are different from each other.

[0038]

Here, Fig. 4(a) illustrates a cross section of the first jet hole group 12a (a cross section taken along line A-

A illustrated in Fig. 3), Fig. 4(b) illustrates a cross section of the second jet hole group 12b (a cross section taken along line B-B illustrated in Fig. 3), Fig. 5(a) illustrates a cross section of the third jet hole group 12c (a cross section taken along line C-C illustrated in Fig. 3), Fig. 5(b) illustrates a cross section of the fourth jet hole group 12d (a cross section taken along line D-D illustrated in Fig. 3), Fig. 6(a) illustrates a cross section of the fifth jet hole group 12e (a cross section taken along line E-E illustrated in Fig. 3), and Fig. 6(b) illustrates a cross section of the sixth jet hole group 12f (a cross section taken along line F-F illustrated in Fig. 3).

[0039]

As illustrated in Fig. 4(a), in the first jet hole group 12a forming the high-angle jet hole region 10a for jetting the water stream of the cleaning liquid to the high-angle region, an angle α_1 formed by an equator 16 and a first water stream 14a jetted from the cleaning jet hole 8e closest to a pole is in a range of 60° or more and 80° or less, and an angle β_1 formed by the equator 16 and a first water stream 14a' jetted from the cleaning jet hole 8e closest to the equator is in a range of 50° or more and 70° or less. In addition, an angle γ_1 formed by the first water stream 14a and the first water stream 14a' is in a range of 10° or more

and 30° or less.

[0040]

As illustrated in Fig. 4(b), in the second jet hole group 12b forming the high-angle jet hole region 10a for
5 jetting the water stream of the cleaning liquid to the high-angle region, an angle α_2 formed by the equator 16 and a second water stream 14b jetted from the cleaning jet hole 8e closest to the pole is in a range of 65° or more and 85° or less, and an angle β_2 formed by the equator 16 and a second
10 water stream 14b' jetted from the cleaning jet hole 8e closest to the equator is in a range of 55° or more and 75° or less. In addition, an angle γ_2 formed by the second water stream 14b and the second water stream 14b' is in a range of 10° or more and 30° or less.

15 [0041]

That is, the angle formed by the equator and the water stream jetted from the cleaning jet hole 8e closest to the equator of the high-angle jet hole group is in a range of 50° or more, and the angle formed by the equator and the water
20 stream jetted from the cleaning jet hole 8e closest to the pole of the high-angle jet hole group is in a range of 85° or less.

[0042]

As illustrated in Fig. 5(a), in the third jet hole

group 12c forming the intermediate-angle jet hole region 10b for jetting the water stream of the cleaning liquid to the intermediate-angle region, an angle α_3 formed by the equator 16 and a third water stream 14c jetted from the cleaning jet hole 8e closest to the pole is in a range of 25° or more and 50° or less, and an angle β_3 formed by the equator 16 and a third water stream 14c' jetted from the cleaning jet hole 8e closest to the equator is in a range of 10° or more and 35° or less. In addition, an angle γ_3 formed by the third water stream 14c and the third water stream 14c' is in a range of 15° or more and 40° or less.

[0043]

As illustrated in Fig. 5(b), in the fourth jet hole group 12d forming the intermediate-angle jet hole region 10b for jetting the water stream of the cleaning liquid to the intermediate-angle region, an angle α_4 formed by the equator 16 and a fourth water stream 14d jetted from the cleaning jet hole 8e closest to the pole is in a range of 30° or more and 55° or less, and an angle β_4 formed by a fourth water stream 14d' jetted from the cleaning jet hole 8e closest to the equator is in a range of 10° or more and 45° or less. In addition, an angle γ_4 formed by the fourth water stream 14d and the fourth water stream 14d' is in a range of 10° or more and 45° or less.

[0044]

That is, the angle formed by the equator and the water stream jetted from the cleaning jet hole 8e closest to the equator of the intermediate-angle jet hole group is in a range of 10° or more, and the angle formed by the equator and the water stream jetted from the cleaning jet hole 8e closest to the pole of the intermediate-angle jet hole group is in a range of 55° or less.

[0045]

As illustrated in Fig. 6(a), in the fifth jet hole group 12e forming the low-angle jet hole region 10c for jetting the water stream of the cleaning liquid to the low-angle region, an angle α_5 formed by the equator 16 and a fifth water stream 14e jetted from the cleaning jet hole 8e closest to the pole is in a range of 10° or more and 25° or less, and an angle β_5 formed by the equator 16 and a fifth water stream 14e' jetted from the cleaning jet hole 8e closest to the equator is in a range of 0° or more and 15° or less. In addition, an angle γ_5 formed by the fifth water stream 14e and the fifth water stream 14e' is in a range of 10° or more and 25° or less.

[0046]

As illustrated in Fig. 6(b), in the sixth jet hole group 12f forming the low-angle jet hole region 10c for

jetting the water stream of the cleaning liquid to the low-angle region, an angle α_6 formed by the equator 16 and a sixth water stream 14f jetted from the cleaning jet hole 8e closest to the pole is in a range of 10° or more and 30° or less, and an angle β_6 formed by the equator 16 and a sixth water stream 14f' jetted from the cleaning jet hole 8e closest to the equator is in a range of 0° or more and 20° or less. In addition, an angle γ_6 formed by the sixth water stream 14f and the sixth water stream 14f' is in a range of 10° or more and 30° or less.

[0047]

That is, the angle formed by the equator and the low-angle water stream jetted from the cleaning jet hole 8e closest to the equator of the low-angle jet hole group is in a range of 0° or more, and the angle formed by the equator and the fifth water stream jetted from the cleaning jet hole 8e closest to the pole of the low-angle jet hole group is in a range of 30° or less.

Since the upper rotating body 8a has a rotational speed of 5 rpm or more and 60 rpm or less and rotates slowly, the inside of the tank 34 (see Fig. 8) can be thoroughly cleaned.

[0048]

Fig. 7 is a cross-sectional view illustrating a state

in which a plane obtained by cutting the lower rotating body 8b at a predetermined height is viewed from above. As illustrated in Fig. 7, two rotating jet holes 8x for jetting the cleaning liquid in a tangential direction to rotate the lower rotating body 8b and two cleaning jet holes 8y for jetting the cleaning liquid are opened in a curved surface of the lower rotating body 8b. Here, the rotating jet holes 8x and the cleaning jet holes 8y are opened in the side wall of the rotating unit main body so as to be inclined in the rotation direction at a predetermined angle θ_2 with respect to the straight line X orthogonal to the rotation center line L. Here, the angle θ_2 is 5° to 25° . The lower rotating body 8b is in contact with the upper rotating body 8a and rotates while sliding on the upper rotating body 8a, which makes it possible to reduce the rotational speed of the upper rotating body 8a to rotate the upper rotating body 8a slowly.

[0049]

In the rotating spray unit 2, the upper rotating body 8a and the lower rotating body 8b are filled with the cleaning liquid supplied from the flow passage 4a of the nozzle portion 4 through the port (not illustrated) in the ball main body 8, and the cleaning liquid is jetted from the respective cleaning jet holes 8e to promote the rotation of the upper rotating body 8a. Meanwhile, the cleaning liquid

is jetted in the tangential direction from the rotating jet holes 8x of the lower rotating body 8b, so that the lower rotating body 8b rotates in the direction opposite to the upper rotating body 8a, and the rotational speed of the upper rotating body 8a is reduced. The cleaning liquid is jetted from the respective cleaning jet holes 8e toward a part to be cleaned (for example, an inner wall surface of the tank 34).
[0050]

Fig. 8 is a drawing illustrating a situation in which the water streams jetted from the respective jet hole groups 12 in all the jet hole regions 10 formed in the upper rotating body 8a hit the inner wall surface of the tank 34. According to Fig. 8, by forming the high-angle jet hole region 10a, the intermediate-angle jet hole region 10b, and the low-angle jet hole region 10c in the upper rotating body 8a, the water streams can be jetted not only to an intermediate-angle region 36b but also to a high-angle region 36a and a low-angle region 36c in the tank 34. In addition, since the angles of the water streams jetted from the jet hole groups 12 included in the respective jet hole regions 10 are different from each other, the inner wall surface of the tank 34 can be extensively cleaned.

Examples

[0051]

[Example 1]

Next, an experiment of a cleaning rate performed using the rotating spray unit 2 (embodiment product) according to

5 the embodiment and the rotating spray unit 114 (conventional product) described in Patent Literature 1 will be described.

First, in the experiment, a tank to which the embodiment product was attached and a tank to which the conventional

product was attached were prepared. The respective tanks

10 used here are similar to each other. Both the embodiment product and the conventional product are formed of

polytetrafluoroethylene (PTFE), the embodiment product has an outer diameter of 65 mm, and the conventional product has an outer diameter of 70 mm.

15 The tanks are formed of stainless steel, and have an inner diameter of 1200 mm and a ratio of a height of an upper hemisphere to the inner diameter of 2 : 1.

[0052]

Next, a total of 13 stainless steel test plates coated

20 with, for example, red food coloring as a fake stain were prepared. Among the 13 plates, 8 plates are test plates to

be disposed on an inner wall surface of the tank, and 5

plates are test plates to be disposed in a nozzle of the tank. The respective weights of the 8 test plates to be

disposed on the inner wall surface of the tank and the 5 test plates to be disposed in the nozzle were measured. Next, the 8 test plates were disposed on each of the inner wall surfaces of both the tanks and the 5 test plates were disposed in each of the nozzles thereof, and the respective tanks were cleaned for a predetermined time using the embodiment product and the conventional product. Thereafter, the test plates were removed, and their weights were measured.

10 [0053]

A flow rate of the embodiment product in the test is 70 (L/min), and a jet pressure of cleaning water is 0.15 (Mpa). A flow rate of the conventional product is 90 (L/min), and a jet pressure of cleaning water is 0.15 (Mpa).

15 [0054]

The cleaning rate based on the weight of the test plate before and after cleaning is calculated using the following formula.

Cleaning rate = (weight of test plate before cleaning - weight of test plate after cleaning)/weight of test plate before cleaning ... (Formula 1)

[0055]

Fig. 9(a) is a bar graph illustrating the respective cleaning rates in the tanks by the embodiment product and the

conventional product calculated using Formula 1 (the embodiment product is shown on the left, and the conventional product is shown on the right; the same applies hereinafter). Fig. 9(b) is a bar graph illustrating the respective cleaning rates in the nozzles by the embodiment product and the conventional product calculated using Formula 1.

[0056]

HIGH_100A is a nozzle located in the high-angle region 36a and having an inner diameter of 100 mm, INTERMEDIATE_50A is a nozzle located in the intermediate-angle region 36b and having an inner diameter of 50 mm, and LOW_100A is a nozzle located in the low-angle region 36c and having an inner diameter of 100 mm. The embodiment product and the conventional product are each attached to the nozzle 35 (see Fig. 8) located in the high-angle region 36a and having an inner diameter of 80 mm in the tank 34.

[0057]

According to Fig. 9(a), it can be seen that the cleaning rate in the tank by the embodiment product is higher in the high-angle region and the low-angle region than those of the conventional product. In addition, according to Fig. 9(b), it can be seen that the cleaning rate in the nozzle of the tank by the embodiment product is higher in the intermediate-angle region and the low-angle region than those

of the conventional product.

[0058]

Figs. 10(a) and 10(b) illustrate respective cleaning efficiencies by the embodiment product and the conventional
5 product. The cleaning efficiency is calculated by the following formula.

Cleaning efficiency = cleaning rate/flow rate ...

(Formula 2)

[0059]

10 According to the rotating spray unit 2 of the embodiment, by forming the high-angle jet hole region 10a, the intermediate-angle jet hole region 10b, and the low-angle jet hole region 10c in the upper rotating body 8a, the water streams can be jetted not only to the intermediate-angle
15 region 36b but also to the high-angle region 36a and the low-angle region 36c in the tank 34. In addition, since the angles of the water streams jetted from the jet hole groups
12 included in the respective jet hole regions 10 are different from each other, the inner wall surface of the tank
20 can be extensively cleaned.

Therefore, the inside of the tank 34 can be evenly cleaned in a short time, and the cleaning liquid can be saved.

[0060]

In addition, the first jet hole group 12a and the second jet hole group 12b having different jet angles are formed adjacent to each other in the upper rotating body 8a and the lower rotating body 8b, so that the inside of the tank 34 can be evenly cleaned. Moreover, it is not necessary to adjust the jet angle for each tank 34 to be cleaned, and it is possible to easily attach the rotating spray unit 2 to any tank 34.

[0061]

In addition, since the rotating spray unit 2 has a two-stage structure including the upper rotating body 8a and the lower rotating body 8b, dirt at a part washed out by the cleaning liquid jetted from the upper rotating body 8a is further washed out by the cleaning liquid jetted from the lower rotating body 8b, so that dirt in the tank 34 can be exhaustively cleaned.

[0062]

Moreover, by making the rotating spray unit 2 spherical, the angles of the water streams jetted from the cleaning jet holes 8e can be appropriately dispersed in an elevation angle direction, and the inner wall surface of the tank 34 can be extensively cleaned.

[0063]

In the above-described embodiment, the case has been

exemplified where the rotating spray unit is the rotating spray unit 2 including the upper rotating body 8a and the lower rotating body 8b, but the rotating spray unit does not necessarily have to be spherical and may not include the

5 lower rotating body 8b. In a case where the rotating spray unit 2 is not spherical, the rotating spray unit 2 may have a frustum shape, for example.

[0064]

In addition, in the above-described embodiment, the case has been exemplified where the lower rotating body 8b rotates in the direction opposite to the upper rotating body 8a, but the lower rotating body 8b may rotate in the same forward direction as the upper rotating body 8a.

[0065]

15 Furthermore, in the above-described embodiment, the high-angle jet hole region 10a, the intermediate-angle jet hole region 10b, the low-angle jet hole region 10c, and the respective jet hole groups do not necessarily have to be formed on the curved surface of the upper rotating body 8a as long as the inside of the tank 34 can be evenly cleaned in a short time and the cleaning liquid can be saved.

20 [0066]

That is, it is sufficient that a plurality of jet holes having different jet angles in the elevation angle

direction are provided on the side wall of the ball main body 8, and the function of dispersing the plurality of water streams jetted from the respective cleaning jet holes 8e in the elevation angle direction of the upper hemisphere in the tank 34 can be exhibited when cleaning is performed with the rotating spray unit of the rotating spray unit 2 rotated.

[0067]

Specifically, by configuring the cleaning jet holes 8e so as to include jet holes having different angles in the elevation angle direction: a plurality of high-angle jet holes for jetting a water stream to the high-angle region, a plurality of intermediate-angle jet holes for jetting a water stream to the intermediate-angle region, and a plurality of low-angle jet holes for jetting a water stream to the low-angle region, the plurality of water streams jetted from the respective cleaning jet holes 8e are dispersed in the elevation angle direction of the upper hemisphere in the tank 34, and the function of cleaning a wide range of the inner wall surface of the tank can be realized.

[0068]

For example, the high-angle jet holes are configured to jet the water streams at an angle of more than 60° and 85° or less with respect to the equator, the intermediate-angle jet holes are configured to jet the water streams at an angle

of more than 30° and 60° or less with respect to the equator, and the low-angle jet holes are configured to jet the water streams at an angle of 0° or more and 30° or less with respect to the equator.

5 [0069]

In this case, for example, a rotating spray unit 22 illustrated in Fig. 11 does not include the jet hole groups 12, but the cleaning jet holes 8e are formed in a spiral shape on a curved surface of the ball main body 8, and
10 include the high-angle jet holes, the intermediate-angle jet holes, and the low-angle jet holes, which makes it possible to realize the function of dispersing the plurality of water streams jetted from the respective cleaning jet holes 8e in the elevation angle direction of the upper hemisphere in the
15 tank 34.

[0070]

In addition, in the above-described embodiment, the cleaning jet holes 8e disposed in the high-angle jet hole region 10a may include not only the high-angle jet hole but
20 also the intermediate-angle jet hole and the low-angle jet hole, the cleaning jet holes 8e disposed in the intermediate-angle jet hole region 10b may include not only the intermediate-angle jet hole but also the high-angle jet hole and the low-angle jet hole, and the cleaning jet holes 8e

disposed in the low-angle jet hole region 10c may include not only the low-angle jet hole but also the high-angle jet hole and the intermediate-angle jet hole.

[0071]

5 Moreover, in the above-described embodiment, a plurality of the cleaning jet holes 8e having the same jet angle in the elevation angle direction may be partially included.

10 Furthermore, in the above-described embodiment, the respective cleaning jet holes 8e formed in the rotating spray unit 2 do not necessarily have to have the same hole diameter.

Reference Signs List

15 [0072]

2 Rotating spray unit

4 Nozzle portion

4a Flow passage

4b Large diameter portion

20 6 Fixing ring

8 Ball main body

8a Upper rotating body

8b Lower rotating body

8e Cleaning jet hole

	8x	Rotating jet hole
	8y	Cleaning jet hole
	10	Jet hole region
	10a	High-angle jet hole region
5	10b	Intermediate-angle jet hole region
	10c	Low-angle jet hole region
	12	Jet hole group
	12a	First jet hole group
	12b	Second jet hole group
10	12c	Third jet hole group
	12d	Fourth jet hole group
	12e	Fifth jet hole group
	12f	Sixth jet hole group
	14a	First water stream
15	14b	Second water stream
	14c	Third water stream
	14d	Fourth water stream
	14e	Fifth water stream
	14f	Sixth water stream
20	16	Equator
	22	Rotating spray unit
	34	Tank
	35	Nozzle
	36a	High-angle region

	36b	Intermediate-angle region
	36c	Low-angle region
	102	Tank
	102a	Upper lid portion
5	102b	Nozzle
	102c	Nozzle
	104	Rotating spray unit
	106	Upper rotating body
	108	Lower rotating body
10	110	Rotating jet hole
	112	Cleaning jet hole
	114	Rotating spray unit
	136	Area that has to be cleaned with flowing-down cleaning liquid (area that is difficult to hit by water stream)
15	L	Rotation center line
	X	Straight line orthogonal to L

CLAIMS

[Claim 1]

A rotating spray unit disposed in a tank and
5 configured to clean an inside of the tank, the rotating spray
unit comprising

a plurality of cleaning jet holes formed in a rotating
unit main body that rotates, wherein

some or all of the plurality of cleaning jet holes
10 have different jet angles in an elevation angle direction,

the cleaning jet holes are further opened in a side
wall of the rotating unit main body to be inclined in a
rotation direction at a predetermined angle with respect to a
straight line orthogonal to a rotation axis in a plane
15 centered on the rotation axis, and

when cleaning is performed with the rotating spray
unit rotated, a plurality of water streams jetted from the
respective cleaning jet holes are dispersed in the elevation
angle direction of an upper hemisphere in the tank.

20 [Claim 2]

The rotating spray unit according to claim 1, wherein
the cleaning jet holes include:

a plurality of high-angle jet holes configured to jet
a water stream to a high-angle region;

a plurality of intermediate-angle jet holes configured to jet a water stream to an intermediate-angle region; and

a plurality of low-angle jet holes configured to jet a water stream to a low-angle region, and

5 with reference to an equator orthogonal to the rotation axis of the rotating unit main body,

an angle formed by the water stream jetted from each of the high-angle jet holes is more than 60° and 85° or less,

an angle formed by the water stream ejected from each
10 of the intermediate-angle jet holes is more than 30° and 60° or less, and

an angle formed by the water stream ejected from each of the low-angle jet holes is 0° or more and 30° or less.

[Claim 3]

15 The rotating spray unit according to claim 1, wherein

a plurality of jet hole regions in each of which a jet hole group is formed in a line in a direction orthogonal to the rotation direction of the rotating unit main body are disposed on the side wall of the rotating unit main body,

20 the jet hole regions include:

a high-angle jet hole region configured to jet a water stream to a high-angle region;

an intermediate-angle jet hole region configured to jet a water stream to an intermediate-angle region; and

a low-angle jet hole region configured to jet a water stream to a low-angle region, and

angles of the water streams jetted from the jet hole groups included in the respective jet hole regions are

5 different from each other.

[Claim 4]

The rotating spray unit according to claim 3, wherein

the high-angle jet hole region includes a high-angle jet hole group including a plurality of the cleaning jet

10 holes,

an angle formed by an equator and a water stream

jetted from the cleaning jet hole closest to the equator of the high-angle jet hole group is in a range of 50° or more,

and an angle formed by the equator and a water stream jetted

15 from the cleaning jet hole closest to a pole of the high-angle jet hole group is in a range of 85° or less,

the intermediate-angle jet hole region includes an

intermediate-angle jet hole group including a plurality of the cleaning jet holes,

20 an angle formed by the equator and a water stream

jetted from the cleaning jet hole closest to the equator of the intermediate-angle jet hole group is in a range of 10° or

more, and an angle formed by the equator and a water stream

jetted from the cleaning jet hole closest to the pole of the

intermediate-angle jet hole group is in a range of 55° or less,

the low-angle jet hole region includes a low-angle jet hole group including a plurality of the cleaning jet holes,

5 and

an angle formed by the equator and a low-angle water stream jetted from the cleaning jet hole closest to the equator of the low-angle jet hole group is in a range of 0° or more, and an angle formed by the equator and a water

10 stream jetted from the cleaning jet hole closest to the pole of the low-angle jet hole group is in a range of 30° or less.

[Claim 5]

The rotating spray unit according to claim 3, wherein each of the jet hole groups includes two to ten of the

15 cleaning jet holes.

[Claim 6]

The rotating spray unit according to claim 1, wherein the rotating unit main body includes: an upper rotating body including high-angle jet holes, intermediate-angle jet holes, and low-angle jet holes, or a high-angle jet hole region, an intermediate-angle jet hole region, and a low-angle jet hole region; and a lower rotating body that rotates in a forward direction/a backward direction with respect to the upper rotating body, and the rotating unit main body is formed in a

spherical shape by the upper rotating body and the lower rotating body.