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Non-Patent Literature 2: HP of The Union of Fine Bubbles Scientists and Engineers, http://www.fb-union.org/index.html

SUMMARY

[0011]

However, it cannot be said that such washing is sufficiently studied, and it cannot also be said with respect to the field where high sanitary conditions are demanded that a sufficient effect is obtained by washing with only fine bubbles. For example, the cleaning apparatus described in JP-A No. 2005-118462 performs laundering by a conventional laundry with a conventional washing liquid including a detergent in a washing step before rinsing. JP-A No. 2007-83142 and JP-A No. 2016-132712 describe use of a surfactant for an enhancement in wettability to a washing object, and do not propose any synergetic effect between the type of the surfactant to be selected and the effect of washing with fine bubbles.

[0012]

Thus, all such literature do not sufficiently dissolve any mechanisms for an enhancement in the effect of washing with fine bubbles, and cannot also be said to sufficiently dissolve various conditions for an enhancement in the effect of washing, for example, for an enhancement in the effect of washing due to a combination of fine bubbles with any additive.

[0013]

As described above, a method for washing with fine bubbles, which is a washing method less causing the burden of discharge water to the environment and less applying physical irritation to a washing object, needs an aqueous composition having a washing ability comparable to or more than that of a detergent without use of any detergent and the like in combination.

[0014]

Accordingly, the present disclosure provides an aqueous

for producing fine bubbles by use of such an apparatus.

[0019]

Accordingly, the present disclosure provides the following aqueous composition and washing method.

(i) An aqueous composition for fine bubble production, the composition including one or more components selected from the group consisting of an alkali metal salt of casein, polyoxyethylene dodecyl ether, soybean lecithin, sodium 1-octanesulfonate, saponin and trimethyl stearyl ammonium chloride, and water.

(ii) The aqueous composition for fine bubble production according to (i), wherein the alkali metal salt of casein is casein sodium.

(iii) A washing method including

(1) a step of generating fine bubbles by use of the aqueous composition for fine bubble production according to (i) or (ii),

(2) a step of allowing fine bubbles generated in step (1) to penetrate into fouling of a washing object,

(3) a step of allowing fine bubbles penetrating into the fouling in step (2) to be aggregated, and

(4) a step of allowing fine bubbles aggregated in step (3) to ascend, thereby peeling the fouling from the washing object.

[0020]

The present disclosure also provides the following fine bubble generation apparatus and production method.

(iv) A fine bubble generation apparatus including a fine bubble generation mechanism that generates a fine bubble-containing fluid from a mixed fluid of a liquid and air, wherein

the fine bubble generation mechanism includes a wall that partitions the mixed fluid to be introduced and a fine bubble-containing fluid to be discharged,

the wall has a shape opened at a bottom section and selected from the group consisting of a cone, a frustum and a column,

a first partition section having 2 to 8 communication holes provided between the large-size-bubble removal mechanism and a middle tank section adjacent thereto,

a middle tank section to which the mixed fluid flows from the large-size-bubble removal mechanism via the communication holes,

a cylindrical skirt section provided in the middle tank section with a lower section being opened,

a cylindrical eddy-current generation mechanism which is provided in the skirt section with an upper section being opened and which generates an eddy-current by an inner spiral structure,

a bubble shredding mechanism that shreds bubbles, disposed in a lower tank section adjacent to the middle tank section, and

a discharge pipe provided on a side surface of the lower tank section, wherein

the bubble generation mechanism is provided downstream of the eddy-current generation mechanism.

(vii) A fine bubble generation method, wherein the aqueous composition for fine bubble production according to (i) or (ii) is used for the fine bubble generation apparatus according to any one of (iv) to (vi).

[0020a]

In an aspect, there is provided a fine bubble generation apparatus comprising:

a fine bubble generation mechanism that generates a fine bubble-containing fluid from a mixed fluid of a liquid and air;

a gas-liquid inflow pipe that allows for introduction of the mixed fluid;

a cylindrical gas-liquid mixed phase generation mechanism where the gas-liquid inflow pipe is provided at the center of a cylinder;

an eddy-current generation mechanism which is provided so as to divide the interior of the gas-liquid mixed phase generation mechanism into two sections, which comprises an

upper surface having 2 to 4 holes and a lower surface having 2 to 4 holes disposed with being shifted from the holes of the upper surface, and in which the holes of the upper surface and the holes of the lower surface are pierced so as to correspond to each other; and

a discharge pipe provided on a side surface of the gas-liquid mixed phase generation mechanism, wherein

said fine bubble generation mechanism comprises a wall that partitions the mixed fluid to be introduced and a fine bubble-containing fluid to be discharged,

the wall has a shape opened at a bottom section and selected from the group consisting of a cone, a frustum and a column,

a through-hole for introduction of the mixed fluid into the interior of the wall is formed on at least a part of a side surface of a shape partitioned by the wall, and

the mixed fluid is introduced through the through-hole into the interior of the wall and discharged as a fine bubble-containing fluid from the opening,

the bubble generation mechanism is provided on an end of the gas-liquid inflow pipe, through which the mixed fluid is discharged, and

the gas-liquid inflow pipe is centrally pierced from an upper surface of the cylinder, and an end thereof, through which the mixed fluid is discharged, is placed with a gap from a bottom section of the main body of the cylinder.

[0020b]

In another aspect, there is provided a fine bubble generation apparatus comprising:

a fine bubble generation mechanism that generates a fine bubble-containing fluid from a mixed fluid of a liquid and air;

a gas-liquid inflow pipe that allows for introduction of the mixed fluid;

a large-size-bubble removal mechanism that separates bubbles having a particle size of 1 mm or more;

a first partition section having 2 to 8 communication

holes provided between the large-size-bubble removal mechanism and a middle tank section adjacent thereto;

a middle tank section to which the mixed fluid flows from the large-size-bubble removal mechanism via the communication holes;

a cylindrical skirt section provided in the middle tank section with a lower section being opened;

a cylindrical eddy-current generation mechanism which is provided in the skirt section with an upper section being opened and which generates an eddy-current by an inner spiral structure;

a bubble shredding mechanism that shreds bubbles, disposed in a lower tank section adjacent to the middle tank section; and

a discharge pipe provided on a side surface of the lower tank section, wherein

said fine bubble generation mechanism is provided downstream of the eddy-current generation mechanism, and wherein said fine bubble generation mechanism comprises a wall that partitions the mixed fluid to be introduced and a fine bubble-containing fluid to be discharged,

the wall has a shape opened at a bottom section and selected from the group consisting of a cone, a frustum and a column,

a through-hole for introduction of the mixed fluid into the interior of the wall is formed on at least a part of a side surface of a shape partitioned by the wall, and

the mixed fluid is introduced through the through-hole into the interior of the wall and discharged as a fine bubble-containing fluid from the opening,

the bubble generation mechanism is provided on an end of the gas-liquid inflow pipe, through which the mixed fluid is discharged, and

the gas-liquid inflow pipe is centrally pierced from an upper surface of the cylinder, and an end thereof, through which the mixed fluid is discharged, is placed with a gap from a bottom

section of the main body of the cylinder.

[0020c]

In another aspect, there is provided a fine bubble generation method comprising using the fine bubble generation apparatus as defined above.

[0021]

Fine bubbles produced by use of the aqueous composition as defined above can be used for washing, thereby not only suppressing a load on the ambient environment and relieving physical irritation to clothing and the human skin as washing objects, but also realizing desired cleanliness depending on such washing objects.

[0022]

The fine bubble generation apparatus as defined above can generate fine bubbles having a desired particle size and concentration by use of the bubble generation mechanism provided by the present inventors, even at a relatively low pressure and in a small amount of water as

CLAIMS

1. A fine bubble generation apparatus comprising:

a fine bubble generation mechanism that generates a fine bubble-containing fluid from a mixed fluid of a liquid and air; a gas-liquid inflow pipe that allows for introduction of the mixed fluid;

a cylindrical gas-liquid mixed phase generation mechanism where the gas-liquid inflow pipe is provided at the center of a cylinder;

an eddy-current generation mechanism which is provided so as to divide the interior of the gas-liquid mixed phase generation mechanism into two sections, which comprises an upper surface having 2 to 4 holes and a lower surface having 2 to 4 holes disposed with being shifted from the holes of the upper surface, and in which the holes of the upper surface and the holes of the lower surface are pierced so as to correspond to each other; and

a discharge pipe provided on a side surface of the gas-liquid mixed phase generation mechanism, wherein

said fine bubble generation mechanism comprises a wall that partitions the mixed fluid to be introduced and a fine bubble-containing fluid to be discharged,

the wall has a shape opened at a bottom section and selected from the group consisting of a cone, a frustum and a column,

a through-hole for introduction of the mixed fluid into the interior of the wall is formed on at least a part of a side surface of a shape partitioned by the wall, and

the mixed fluid is introduced through the through-hole into the interior of the wall and discharged as a fine bubble-containing fluid from the opening,

the bubble generation mechanism is provided on an end of the gas-liquid inflow pipe, through which the mixed fluid is discharged, and

the gas-liquid inflow pipe is centrally pierced from an upper surface of the cylinder, and an end thereof, through which the mixed fluid is discharged, is placed with a gap from a bottom section of the main body of the cylinder.

2. A fine bubble generation apparatus comprising:

a fine bubble generation mechanism that generates a fine bubble-

containing fluid from a mixed fluid of a liquid and air;

a gas-liquid inflow pipe that allows for introduction of the mixed fluid;

a large-size-bubble removal mechanism that separates bubbles having a particle size of 1 mm or more;

a first partition section having 2 to 8 communication holes provided between the large-size-bubble removal mechanism and a middle tank section adjacent thereto;

a middle tank section to which the mixed fluid flows from the large-size-bubble removal mechanism via the communication holes;

a cylindrical skirt section provided in the middle tank section with a lower section being opened;

a cylindrical eddy-current generation mechanism which is provided in the skirt section with an upper section being opened and which generates an eddy-current by an inner spiral structure;

a bubble shredding mechanism that shreds bubbles, disposed in a lower tank section adjacent to the middle tank section; and

a discharge pipe provided on a side surface of the lower tank section, wherein

said fine bubble generation mechanism is provided downstream of the eddy-current generation mechanism, and wherein said fine bubble generation mechanism comprises a wall that partitions the mixed fluid to be introduced and a fine bubble-containing fluid to be discharged,

the wall has a shape opened at a bottom section and selected from the group consisting of a cone, a frustum and a column,

a through-hole for introduction of the mixed fluid into the interior of the wall is formed on at least a part of a side surface of a shape partitioned by the wall, and

the mixed fluid is introduced through the through-hole into the interior of the wall and discharged as a fine bubble-containing fluid from the opening,

the bubble generation mechanism is provided on an end of the gas-liquid inflow pipe, through which the mixed fluid is discharged, and

the gas-liquid inflow pipe is centrally pierced from an upper surface of the cylinder, and an end thereof, through which the mixed fluid is discharged, is placed with a gap from a bottom section of the main body of the cylinder.

3. The fine bubble generation apparatus according to claim 1 or 2, wherein the number of the through-hole is 2 to 6 and the through-holes are provided at an equal interval around the wall section.

4. The fine bubble generation apparatus according to any one of claims 1 to 3, wherein the inner diameter of the through-hole is 1 mm to 10 mm.

5. The fine bubble generation apparatus according to any one of claims 1 to 4, further comprises one to four of the fine bubble generation mechanism in the discharge pipe.

6. The fine bubble generation apparatus according to any one of claims 1 to 5, wherein the maximum pressure in the gas-liquid inflow pipe is 0.1 to 0.25 MPa.

7. A fine bubble generation method comprising using the fine bubble generation apparatus according to any one of claims 1 to 6.