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.

(ia) In one aspect, the present disclosure provides the use of an aqueous composition comprising:

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,

for the production of fine bubbles in a fine bubble generation apparatus comprising a fine bubble generation mechanism wherein the fine bubble generation mechanism generates a fine bubble-containing fluid from a mixed fluid of a liquid and air;

the 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 cone shape opened at a bottom,

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, and

the fine bubbles have a diameter of 100 μm or less.

(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.

(iiia) In another aspect, the present disclosure provides a

washing method comprising:

(1) a step of generating fine bubbles by use of a fine bubble generation apparatus as defined herein and an aqueous composition for fine bubble production as defined herein;

(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,

wherein the fine bubbles have a diameter of 100 μm or less.

[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,

CLAIMS

1. Use of an aqueous composition comprising:

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,

for the production of fine bubbles in a fine bubble generation apparatus comprising a fine bubble generation mechanism wherein the fine bubble generation mechanism generates a fine bubble-containing fluid from a mixed fluid of a liquid and air;

the 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 cone shape opened at a bottom,

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, and

the fine bubbles have a diameter of 100 μm or less.

2. The use according to claim 1, wherein the alkali metal salt of casein is casein sodium.

3. The use according to claim 2, wherein the concentration of casein sodium is equal to or more than 0.004 % by mass and the fine bubble generation apparatus comprises two bubble generation mechanism having a conical shape.

4. A washing method comprising:

(1) a step of generating fine bubbles by use of a fine bubble generation apparatus as defined in claim 1 and an aqueous composition for fine bubble production as defined in claim 1;

(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,

wherein the fine bubbles have a diameter of 100 μm or less.

5. The washing method according to claim 4, wherein the aqueous composition contains 0.01 % by mass of casein sodium, and the fine bubble generated in the step (1) has a 50% cumulative particle size of about 10 μm to 65 μm after 5 minutes from the start of the operation of the bubble generation apparatus.

6. The washing method according to claim 4, wherein the aqueous composition contains 0.01 % by mass of polyoxyethylene dodecyl ether or 0.01 % by mass of trimethyl stearyl ammonium, and the fine bubble generated in the step (1) has a 50% cumulative particle size of about 0.5 μm to 65 μm after 5 minutes from the start of the operation of the bubble generation apparatus.

7. The washing method according to claim 5 or 6, wherein the fine bubble aggregated in the step (3) has a 50% cumulative particle size of about 40 μm to 90 μm after 5 minutes from the stop of the operation of the bubble generation apparatus.