separation tank.

[0005]

In the related art, a mixture of liquid and gas has been introduced into a gas-liquid separation tank from vertically downward to upward. The gas flows upward in the liquid staying inside the gas-liquid separation section, and the liquid subjected to the gas-liquid separation goes downward to perform smooth gas-liquid separation.

However, because the gas-liquid separation is so smooth, the long contact time between gas and liquid cannot be ensured, so that gas dissolution efficiency cannot be raised to the target (for example, the maximum).

[0006]

It is desired to provide a gas dissolved liquid manufacturing device that can improve the gas solubility.

[0007]

A gas dissolved liquid manufacturing device according to one embodiment comprises: a pump configured to pressurize a liquid; a pipe communicating with the pump; a nozzle disposed in the pipe, the nozzle being configured to generate micro bubbles using a supplied gas; and a gas-liquid separation tank whose upper part communicates with the pipe, the gas-liquid separation tank being configured to separate a gas-liquid mixture generated by the nozzle into a gas and a liquid, wherein $0 < d/D \leq 0.5$ and $0 < f/F \leq 5$, where D is an internal diameter of the gas-liquid separation tank, d is an internal diameter of the pipe,

F is a flow rate of a liquid of a gas-liquid mixture supplied to the gas-liquid separation tank from above by the pipe, and f is a flow rate of a gas contained in the gas-liquid mixture.

[0007a]

A gas dissolved liquid manufacturing device according to another embodiment comprises: a pump configured to pressurize a liquid; a pipe communicating with the pump; a nozzle disposed in the pipe, the nozzle being configured to generate micro bubbles using a supplied gas; and a gas-liquid separation tank whose upper part communicates with the pipe, the gas-liquid separation tank being configured to separate a gas-liquid mixture generated by the nozzle into a gas and a liquid. The gas-liquid separation tank has a sectional area of a space through which a liquid is capable of passing, the sectional area decreasing as going downward. The gas dissolved liquid manufacturing device further comprises: a flow rate sensor configured to detect a flow rate of a liquid supplied to the gas-liquid separation tank; and a control unit configured to control the pump so that the lower the flow rate measured by the flow rate sensor, the lower a liquid level is kept. A flow path adjustment member configured to form a discharge port through which a gas-liquid mixture is discharged and a flow path to the discharge port is provided inside the gas-liquid separation tank, and a sectional area of the flow path is smaller than a sectional area of the gas-liquid

separation tank, or the sectional area of the flow path decreases as going downward. The control unit controls the pump so as to keep a liquid level at a position above the flow path adjustment member when a flow rate measured by the flow rate sensor exceeds a threshold, and controls the pump so as to keep a liquid level in the flow path formed by the flow path adjustment member when the flow rate measured by the flow rate sensor is equal to or less than the threshold.

BRIEF DESCRIPTION OF DRAWINGS

CLAIMS:

1. A gas dissolved liquid manufacturing device comprising:

a pump configured to pressurize a liquid;

a pipe communicating with the pump;

a nozzle disposed in the pipe, the nozzle being configured to generate micro bubbles using a supplied gas; and

a gas-liquid separation tank whose upper part communicates with the pipe, the gas-liquid separation tank being configured to separate a gas-liquid mixture generated by the nozzle into a gas and a liquid,

wherein $0 < d/D \leq 0.5$ and $0 < f/F \leq 5$, where D is an internal diameter of the gas-liquid separation tank, d is an internal diameter of the pipe, F is a flow rate of a liquid of a gas-liquid mixture supplied to the gas-liquid separation tank from above by the pipe, and f is a flow rate of a gas contained in the gas-liquid mixture.

2. The gas dissolved liquid manufacturing device according to claim 1, wherein

the gas-liquid separation tank has a sectional area of a space through which a liquid is capable of passing, the sectional area decreasing as going downward, and

the gas dissolved liquid manufacturing device comprises:

a flow rate sensor configured to detect a flow rate

of a liquid supplied to the gas-liquid separation tank; and

a control unit configured to control the pump so that the lower the flow rate measured by the flow rate sensor, the lower a liquid level is kept.

3. A gas dissolved liquid manufacturing device comprising:

a pump configured to pressurize a liquid;

a pipe communicating with the pump;

a nozzle disposed in the pipe, the nozzle being configured to generate micro bubbles using a supplied gas; and

a gas-liquid separation tank whose upper part communicates with the pipe, the gas-liquid separation tank being configured to separate a gas-liquid mixture generated by the nozzle into a gas and a liquid,

wherein

the gas-liquid separation tank has a sectional area of a space through which a liquid is capable of passing, the sectional area decreasing as going downward, and

the gas dissolved liquid manufacturing device comprises:

a flow rate sensor configured to detect a flow rate of a liquid supplied to the gas-liquid separation tank; and

a control unit configured to control the pump so that the lower the flow rate measured by the flow rate sensor, the lower a liquid level is kept,

wherein

a flow path adjustment member configured to form a discharge port through which a gas-liquid mixture is discharged and a flow path to the discharge port is provided inside the gas-liquid separation tank, and a sectional area of the flow path is smaller than a sectional area of the gas-liquid separation tank, or the sectional area of the flow path decreases as going downward, and

the control unit controls the pump so as to keep a liquid level at a position above the flow path adjustment member when a flow rate measured by the flow rate sensor exceeds a threshold, and controls the pump so as to keep a liquid level in the flow path formed by the flow path adjustment member when the flow rate measured by the flow rate sensor is equal to or less than the threshold.

4. The gas dissolved liquid manufacturing device according to claim 3, wherein

a step is provided on an inner wall of the flow path adjustment member.

5. The gas dissolved liquid manufacturing device according to claim 3 or 4, wherein

a protrusion or a structure with irregularity is provided on an inner wall of the flow path adjustment member.

6. The gas dissolved liquid manufacturing device according to any one of claims 1 to 5, wherein

a protrusion or a structure with irregularity is provided on an inner wall of the gas-liquid separation tank.

7. The gas dissolved liquid manufacturing device according to claim 6, wherein

a cross section of the gas-liquid separation tank is substantially circular, and wherein

the pipe is connected to the gas-liquid separation tank such that the pipe is located in a tangential direction of a circle that is an outer edge of the gas-liquid separation tank in plan view so that the gas-liquid mixture flowing into the gas-liquid separation tank moves along the inner wall of the gas-liquid separation tank.

8. The gas dissolved liquid manufacturing device according to any one of claims 1 to 7, wherein

a supply port communicating with the pipe is provided at an upper part of the gas-liquid separation tank,

a shower nozzle communicating with the supply port is provided inside the gas-liquid separation tank, and

the shower nozzle sprays a supplied gas-liquid mixture and discharges the sprayed gas-liquid mixture into the gas-liquid separation tank.

9. The gas dissolved liquid manufacturing device according

to any one of claims 1 to 8, wherein

a plate is provided at or above a liquid level of the gas-liquid separation tank, and

the plate is disposed so that a gas-liquid mixture flowing into the gas-liquid separation tank through the pipe directly hits the plate.

10. The gas dissolved liquid manufacturing device according to any one of claims 1 to 9, wherein

the nozzle is provided at a portion of the pipe, the portion being connected substantially vertically to the gas-liquid separation tank.