separator is difficult to increase, making it difficult to achieve a high concentration of ozone water. Where the pump is an air-driven pump, it is also difficult to suppress fluctuations in delivery pressure of ozone water due to influence of pulsation of the pump.

[0006] Embodiments of the present invention seek to provide a gas solution supply device that can achieve a high concentration of gas solution and can suppress fluctuations in the delivery pressure of gas solution.

SUMMARY OF THE INVENTION

[0007] A gas solution supply device according to a first aspect of the present invention includes: a first gas-liquid separator in which gas solution is stored; a second gas-liquid separator which is provided at a stage subsequent to the first gas-liquid separator and in which gas solution to be supplied to a use point is stored; an intermediate line provided between the first gas-liquid separator and the second gas-liquid separator; a pressure booster pump that is provided on the intermediate line and increases a pressure of gas solution being supplied from the first gas-liquid separator to the second gas-liquid separator; a gas supply line that supplies gas as a material of the gas solution; and a gas dissolving unit that is provided on the intermediate line and dissolves the gas supplied

from the gas supply line in the gas solution supplied from the first gas-liquid separator.

[0008] In this arrangement, the pressure booster pump is provided at a stage preceding the second gas-liquid separator, so that the pressure in the second gas-liquid separator can be increased and a high concentration of gas solution is possible. In addition, providing the second gas-liquid separator at a stage subsequent to the pressure booster pump may result in damper effect, making it possible to suppress fluctuations in delivery pressure of gas solution being supplied from the second gas-liquid separator to the use point.

[0009] In the gas solution supply device according to an embodiment of the present invention, the first gas-liquid separator may include a circulating supply line for circulating and supplying unused gas solution at the use point.

[0010] With this arrangement, unused gas solution at the use point can be recycled and usage of gas as a material of gas solution can be reduced. Since in this case the first gas-liquid separator, to which unused gas solution at the use point is supplied, is provided at a stage preceding the pressure booster pump, there is no need for a pump to increase the pressure of the unused gas solution.

[0011] In the gas solution supply device according to an embodiment of the present invention, the first gas-liquid separator may include a liquid supply line through which liquid as a material of

the gas solution is supplied, and the liquid supply line may include a second gas dissolving unit that dissolves undissolved excess gas discharged from the second gas-liquid separator in the liquid as a material of the gas solution.

[0012] With this arrangement, undissolved excess gas discharged from the second gas-liquid separator can be recycled and usage of gas as a material of gas solution can be reduced.

[0013] The gas solution supply device according to an embodiment of the present invention may include: a first valve provided on a liquid supply line that supplies liquid as a material of the gas solution; a second valve provided on a gas solution supply line that supplies the gas solution to the use point; a third valve provided on an exhaust line from the first gas-liquid separator to an exhaust port; a fourth valve provided on a drain line branching from the exhaust line; and a control unit that performs open and close control of the first valve, the second valve, the third valve, and the fourth valve. The control unit may be configured to: when the gas solution is to be supplied to the use point, perform control to open the first valve, the second valve and the third valve and close the fourth valve, and when the first gas-liquid separator and the second gas-liquid separator are to be cleaned, perform control to close the second valve and the third valve and open the first valve and the fourth valve.

[0014] With this arrangement, gas solution can be supplied to the use point by opening the first, the second and the third valves and closing the fourth valve, while the first gas-liquid separator and the second gas-liquid separator can be cleaned by closing the second and the third valves and opening the first and the fourth valves.

[0015] A method according to another aspect of the present invention is a method for execution in a gas solution supply device, the gas solution supply device including: a first gas-liquid separator in which gas solution is stored; a second gas-liquid separator which is provided at a stage subsequent to the first gas-liquid separator and in which gas solution to be supplied to a use point is stored; an intermediate line provided between the first gas-liquid separator and the second gas-liquid separator; and a pressure booster pump that is provided on the intermediate line and increases a pressure of gas solution being supplied from the first gas-liquid separator to the second gas-liquid separator. The method includes the steps of supplying gas as a material of the gas solution to the intermediate line, and dissolving the supplied gas in the gas solution supplied from the first gas-liquid separator.

[0016] This method can also increase the pressure in the second gas-liquid separator and enable a high concentration of gas solution because the pressure

booster pump is provided at a stage preceding the second gas-liquid separator as with the device above. Further, providing the second gas-liquid separator at a stage subsequent to the pressure booster pump may result in damper effect, making it possible to suppress fluctuations in delivery pressure of gas solution being supplied from the second gas-liquid separator to the use point.

[0017] In the method according to an embodiment of the present invention, the gas solution supply device may include: a first valve provided on a liquid supply line that supplies liquid as a material of the gas solution; a second valve provided on a gas solution supply line that supplies the gas solution to the use point; a third valve provided on an exhaust line from the first gas-liquid separator to an exhaust port; and a fourth valve provided on a drain line branching from the exhaust line. The method may include: when the gas solution is to be supplied to the use point, opening the first valve, the second valve and the third valve and closing the fourth valve, and when the first gas-liquid separator and the second gas-liquid separator are to be cleaned, closing the second valve and the third valve and opening the first valve and the fourth valve.

[0018] According to this method, gas solution can be supplied to the use point by opening the first, the second and the third valves and closing the fourth valve, while the first gas-liquid separator and the second gas-liquid separator can be cleaned by closing the second and