Claims

[Claim 1] A bubble release apparatus for cleaning submerged membranes, the apparatus comprising a first chamber, a second chamber and a third chamber,

wherein each of the three chambers has a bottom opening configured to allow fluid communication between inside of the chamber and outside of the apparatus;

wherein the first chamber is configured to receive a stream of gas from a gas source, the first chamber and the second chamber are configured to be in fluid communication with each other through an upper fluid communication path to accumulate a pocket of gas at an upper end of the first chamber and the second chamber;

the second chamber and the third chamber are configured to be in fluid communication with each other through an intermediate fluid communication path located between the bottom opening of the third chamber and the upper fluid communication path to allow the accumulated pocket of gas to be discharged as a gas bubble into the third chamber; and

the third chamber is configured to allow the gas bubble to expand to a predetermined size before being released from the apparatus to clean submerged membranes, wherein the intermediate fluid communication path has a height which is 5% to 20% of that of the first chamber.

[Claim 2] The apparatus according to claim 1, wherein the first chamber is further configured to receive the stream of gas from a gas diffuser through the bottom opening of the first chamber, or a gas port located on a side surface or a top surface of the first chamber.

[Claim 3] The apparatus according to claim 1 or claim 2, wherein the third chamber includes a first portion extending downwards from the top opening of the third chamber and a second portion extending downwards from the first portion till an upper end of the intermediate fluid communication path, wherein the first portion of the third chamber has a cross-sectional area greater than that of the second portion.

[Claim 4] The apparatus according to claim 3, wherein the first portion has a cross-sectional area which is greater than 100% and less than 1000% of that of the second portion.

[Claim 5] The apparatus according to any preceding claim, wherein the upper fluid communication path has a height which is 5% to 50% of that of the first chamber.

[Claim 6] The apparatus according to any preceding claim, wherein the first chamber and the second chamber have a first common wall, and a top end of the common wall is disposed below a top surface of the first chamber to form the upper fluid communication path.

[Claim 7] The apparatus according to claim 6, wherein the third chamber and the second chamber have a second common wall, and the intermediate fluid

communication path is an intermediate opening located on the second common wall.

[Claim 8] The apparatus according to claim 7, wherein the second chamber is surrounded by the first chamber, and the third chamber is surrounded by the second chamber.

[Claim 9] The apparatus according to claim 8, further comprising a first connection part extending from the second common wall to the first common wall, and a second connection part extending from the first common wall and coupling to an outer body of the apparatus.

[Claim 10] The apparatus according to claim 9, wherein the first connection part and the second connection part are an integral connection panel extending from the second common wall, passing through the first common wall and coupling to the outer body of the apparatus.

[Claim 11] The apparatus according to claim 7, wherein the first chamber, the second chamber and the third chamber are arranged in a row.

[Claim 12] The apparatus according to any one of claim 1 to claim 5, wherein the first chamber is connected to the second chamber through the upper intermediate communication path.

[Claim 13] The apparatus according to claim 12, wherein the second chamber is connected to the third chamber through the intermediate fluid communication path.

[Claim 14] A bubble release device comprising a plurality of bubble release apparatuses according to any one of claim 1 to claim 13, wherein the plurality of bubble release apparatuses are disposed in a guideline rail to form an integral device.

[Claim 15] A gas cleaning system for cleaning submerged membranes, the system comprising at least one bubble release apparatus according to any one of claim 1 to claim 13, or at least one bubble release device according to claim 14, which is to be positioned below at least one hollow fiber membrane module.

[Claim 16] The system according to claim 15, wherein the system comprises a plurality of the bubble release devices which are to be arranged in a row below a plurality of hollow fiber membrane modules.

[Claim 17] The system according to claim 16, wherein the plurality of hollow fiber membrane modules are to be arranged to be in close proximity with one another so that bubbles released from each of the bubble release devices are used to clean more than one hollow fiber membrane modules thereabove.

[Claim 18] The system according to any one of claim 15 to claim 17, wherein each bubble release apparatus or each bubble release device is to be positioned in a range of 0 to 100mm below the at least one hollow fiber membrane module.

[Claim 19] A method of releasing bubbles for cleaning submerged membranes, the method comprising:

positioning a gas cleaning system below at least one submerged hollow fiber membrane module, wherein the gas cleaning system comprises at least one bubble release apparatus according to any one of claim 1 to claim 13, or at least one bubble release device according to claim 14; and

supplying a stream of gas from a gas source to a first chamber of each bubble release apparatus in the gas cleaning system continuously or intermittently so that gas bubbles with a predetermined size for cleaning submerged membranes are released from the gas cleaning system to clean the at least one submerged hollow membrane module.