VORTEX DEBUBBLER
MODEL VDB-1G
OPERATING AND TECHNICAL MANUAL

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1. OVERVIEW

The MSRC vortex debubbler is designed to remove nuisance air bubbles from an input seawater stream before sending the water to bubble-sensitive instruments (e.g. salinometers, fluorometers). The main part of the device is a vertical cylinder. Seawater is injected tangentially into this cylinder causing the water inside to spin rapidly. Centripetal acceleration causes bubbles to migrate to the center axis, where they are drawn off at top center. Cleared output water is drawn off at the bottom periphery.

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2. THEORY OF OPERATION

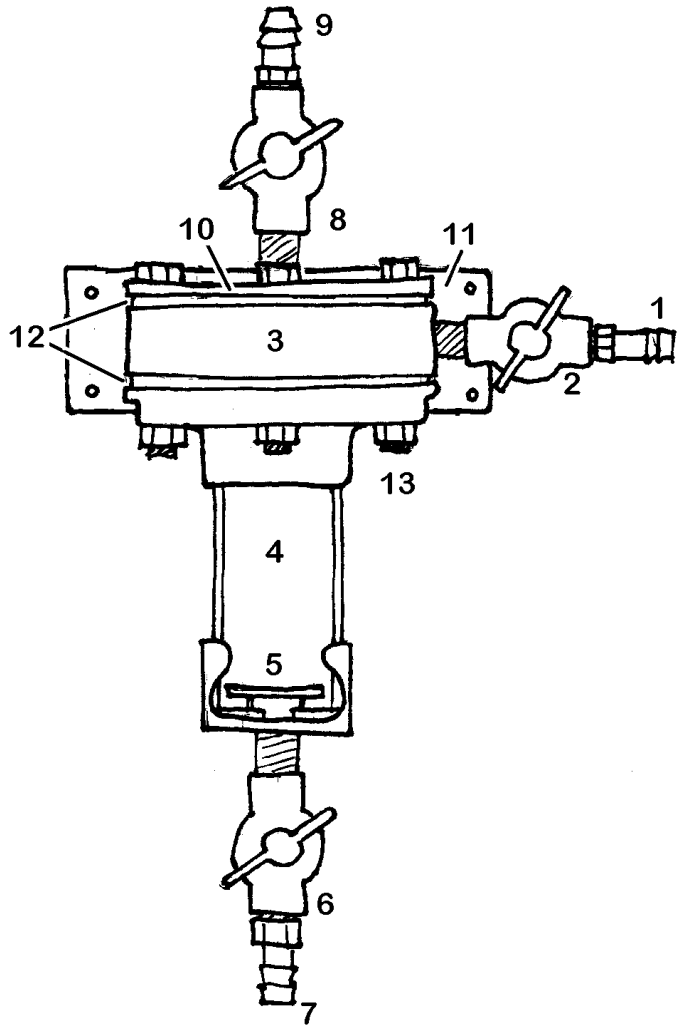

Figure 1: Vortex debubbler external view.
Vortex chamber cut away to show baffle plate

1: input, 2: input valve, 3: injector plate, 4: vortex chamber, 5: output baffle plate, 6: output valve, 7: output, 8: waste valve, 9: waste exhaust, 10: top plate, 11:mounting plate, 12: upper and lower gaskets, 13: clamping bolts.

Referring to Figure 1 at left, input water enters the device through the intake (1), controlled by the intake valve (2). The injector plate (3) introduces water tangentially into the vortex chamber (4), resulting in a high rate of spin to the water in the chamber.

In the vortex chamber the spin imparts a large centripetal acceleration to the water, causing any bubbles to be pushed to the center vertical axis of the chamber, where gravity causes them to migrate upwards. The bubbles and some waste water are drawn through the waste valve (8), and out the waste exhaust (9). Bubble free water is drawn off at the periphery of the bottom of the chamber around the edge of the output baffle plate (5), through the output valve (6), and is available at the output (7).

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3. SPECIFICATIONS

Construction: All internal surfaces are corrosion proof nylon and PVC plastic. Metal hardware is 316 stainless steel.

Connections: Plumbed connections are ¾" PVC plastic ball valves with ¾" female NPT threaded ends. Male NPT x ¾" barb hose adapters are provided to allow an alternate connection option.

- Input: for input of process seawater.
- Waste exhaust: for output of bubbles and approximately 25% of seawater.
- Output: for output of bubble-free seawater.

Controls: Ball valves at input, waste, and output.

Chamber pressure: Units have been tested at MSRC with our commercial potable water supply at 40 PSIG for 30 minutes. Ultimate (destructive) pressure testing of this design has not yet been done (well, not under controlled circumstances anyway). Subjecting the unit to pressures above our test pressure of 40 PSIG is therefore not recommended.

Suggested input flow rate: 18-24 liter/min. (4.75 - 6.35 gallons/min).

Output flow rate: 75% of input flow.

Waste flow rate: 25% of input flow.

Approximate size and weight: Overall size 61 cm tall x 41 cm wide x 23 cm deep (24 x 16 x 9 inches). Shipping weight 8 kg (17 lbs).

4. ASSEMBLY

The following items should be included with each debubbler shipment:

1) This manual,
2) Main debubbler body,
3) Valve assemblies,
4) Roll of Teflon tape.

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The input of the debubbler can be set to either the left or right side of the unit. Examine the main debubbler body to determine the current orientation of the hole in the side of the main injector plate. If the opposite orientation of the input line is desired, loosen and remove the four clamping bolts (#13 in figure 1), top plate (10), gaskets (12), and vortex chamber (4). Flip the injector plate over to the desired orientation and reassemble.

To assemble the unit as shipped, first be sure that an appropriate amount of Teflon thread tape is applied to the threaded nipples on each valve assembly. Screw one valve assembly into each of the three matching threaded holes in the injector plate (3), the top plate (10), and the bottom of the vortex chamber (4). Tighten the threaded joints so that they will not leak and so the valve controls face front.

5. INSTALLATION

The suggested location of the debubbler would be in the wet lab, close to the instruments to be served and above a sink or wet bench. A suitable location should allow the debubbler to be mounted to a vertical wall, with waste connection on top and output connection on the bottom. The axis from waste to output should be as vertical as possible. The input connection should be on the side that allows the most convenient plumbing. The debubbler should be located where inspection during operation and minor adjustment of the valves is easy. The debubbler is best located as close as possible to the instruments it serves to minimize possible degassing and bubble formation in the lines following the debubbler output. The mounting location should allow for some water spillage, as the debubbler will have to be disassembled for cleaning occasionally.

The mounting plate (#11 in figure 1) is predrilled for four ¼" mounting bolts or screws, but can be further drilled or cut as needed. Plumbed connections are ¾" PVC plastic ball valves with ¾" female NPT threaded ends. Male NPT x ¾" barb hose adapters are provided to allow an alternate connection option. The three connections are:

1. INPUT: for input of seawater from the pumping system. Input water should be supplied at 18-24 liters per minute. If the input water is at excessively high pressure, care should be taken to prevent the vortex chamber pressure from exceeding the recommended 40 psi, either by throttling the input with the input valve or preferably by using an upstream pressure regulator of some type.
2. WASTE: for output of bubbles and regulation of downstream pressure. Approximately 25% of input water goes out the waste connection along with separated air. The waste connection can serve an additional function of providing a constant head pressure to downstream instruments. The waste connection should be plumbed up (reasonably vertically) to an open output drain at some height above the

debubbler. If the debubbler can be operated with the waste valve fully open (normally this is easily accomplished) the height of the waste output drain will set the downstream head pressure. As an example, if the waste drain is 5 feet above the instruments, the head pressure will be approximately 2.5 psi. Maximum recommended head is 40 feet (20 psi).

3. OUTPUT: for output of bubble-free seawater. The lines from this connection to the instruments to be served should be as short as possible to minimize the possibility of bubbles forming from outgassing of the output seawater.

6. OPERATION

Check for leaks throughout the startup period, and tighten threaded joints and/or clamping bolts as needed to seal leaks. If input pressure does not exceed the recommended maximum working pressure of 40 psi, the output valve can be closed, the vortex chamber filled with water, the waste valve closed, and the unit checked for leaks under static input pressure.

To begin the initial adjustment procedure, open waste and output valves fully. Throttle down input valve if needed to regulate input flow and/or vortex chamber pressure and apply input water.

Observe the vortex chamber through the clear walls. Water will flow into the chamber and out of the output, but the chamber may or may not fill, and water may not flow from the waste connection. Next throttle down the output valve if needed so that the chamber fills and water begins to flow from the waste connection.

At this point if significant air is present in the input stream you should be able to see the tornado-shaped vortex form in the chamber (for adjustment purposes a little air in the input line is good, and introducing air deliberately during checkout if little exists is not a bad idea). The vortex should be highly visible, with input bubbles immediately being pushed to the center and "queuing up" to go out the waste line. The vortex will generally extend into the waste line and be visible if clear tube is used to plumb the waste.

Throttle down the waste valve if needed to achieve appropriate partition between waste and output flows, but remember this may increase head pressure in the output stream. Optimum operation is usually achieved when approximately 25% of the input water is flowing out of the waste connection. Generally, as more water goes to the waste connection, separation efficiency goes up (but of course output volume goes down). A little experimentation should yield the best valve positions.

Once initial valve adjustment is made, occasional checks on operation are desirable. The debubbler should reestablish the vortex if water is shut off and turned back on, so the adjustment procedure is only needed if inspection reveals unsatisfactory operation.

7. MAINTENANCE

As the debubbler is constructed of corrosion proof PVC plastic, it needs little maintenance aside from cleaning to remove fouling. To clean the debubbler, remove the clamping bolts (#13 in figure 1), disassemble, and clean. To clean below the output baffle plate (5) if needed, unscrew the output valve assembly (6) and work through the threaded hole. It is not recommended to remove the output baffle plate because of the difficulty of reassembly.

When reassembling, a light coat of silicone grease can be applied to the gaskets (12) if desired. If threaded joints are disassembled, fresh Teflon tape should be applied before reassembly.

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