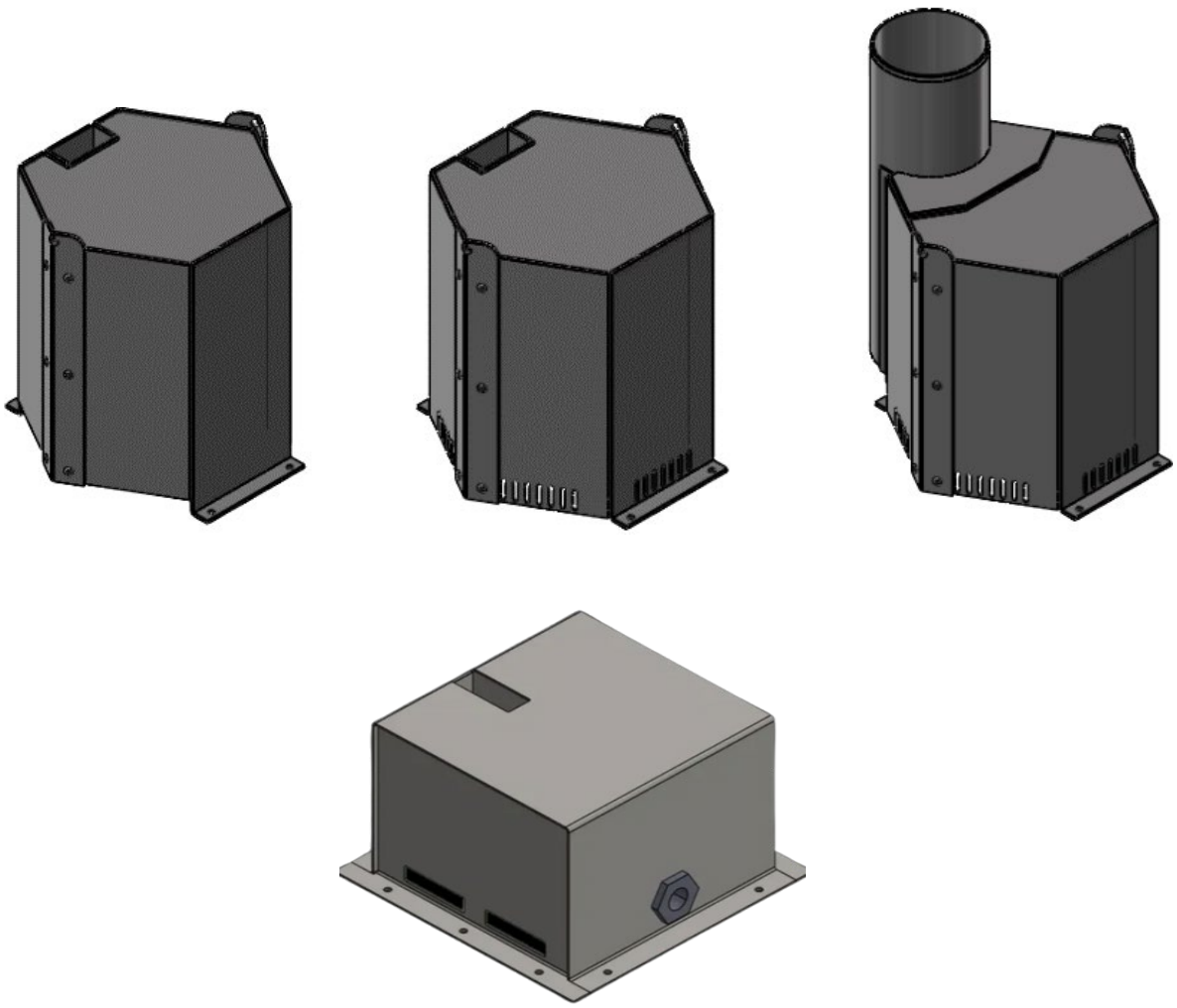
MegaBubble

LOW PRESSURE MIXING & PUMPING

COMPONENT MANUAL



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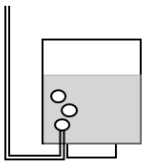
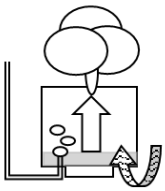
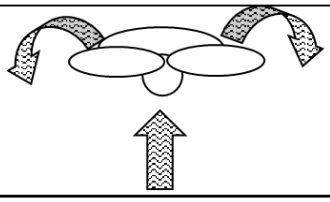
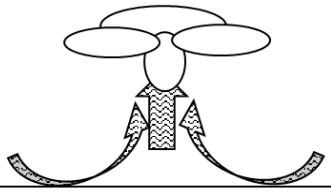
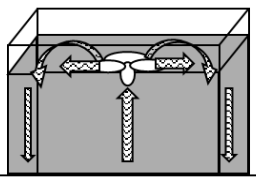
How Mega bubble Works

The power of large bubbles is energy-efficient and provides complete mixing and effective pumping without moving parts or electricity below the water. Mega Bubble generates intermittent, powerful bursts which are powered by a low-pressure compressed air source(s). Potential energy is accumulated in the units and is released all at once, generating powerful forces without directly moving water, as propeller type mixers do. The release of accumulated air lifts liquid and blends the contents. There are no moving parts and minimal maintenance. Mega Bubble pulsed air mixing reduces energy usage, regular maintenance, process downtime, and repairs commonly associated with mechanical mixing systems.

With the release of each bubble, an extremely powerful upward and outward force is generated as the bubble rises. The sudden release of gas accelerates the liquids, and any suspended solids, keeping them in motion and preventing settling. After the large pulse of air is released, gravity and physics take over to force the air bubble to the liquid surface. As the bubble rises it pushes the liquid above it up and out toward the tank perimeter creating a void in the water column.

	**Accumulation** Air accumulates in the Megabubble mixer with air slightly above the static pressure at depth. Air flow rate determines the filling speed.
	**Burst** When the critical point is reached, an air siphon forms and draws the accumulated volume of air out of the ejection port. This draws water and solids into the accumulator. The dual action siphon draws water from the bottom of the mixer through the exhaust with the air as it is released.
	**Rising Bubble** As the bubble begins to rise through the water column, it forms a flat mushroom shape, displacing large amounts of water from the top of the bubble. The large volume of air rises with much higher velocity than smaller bubbles. The water pumped through the mixer as the bubble is released is also forcefully risen
	**Vacuum** In the wake of the rising bubble, a vacuum is formed, drawing liquids and solids with it. This action causes solids to be drawn to the surface.
	**Wake** When the bubble breaks the surface, energy must be dispersed outward as small waves, carrying water and solids particles outwards from the breach zone. This action induces large convection like currents in the water column. The currents move water from the surface back down to bottom of the tank.

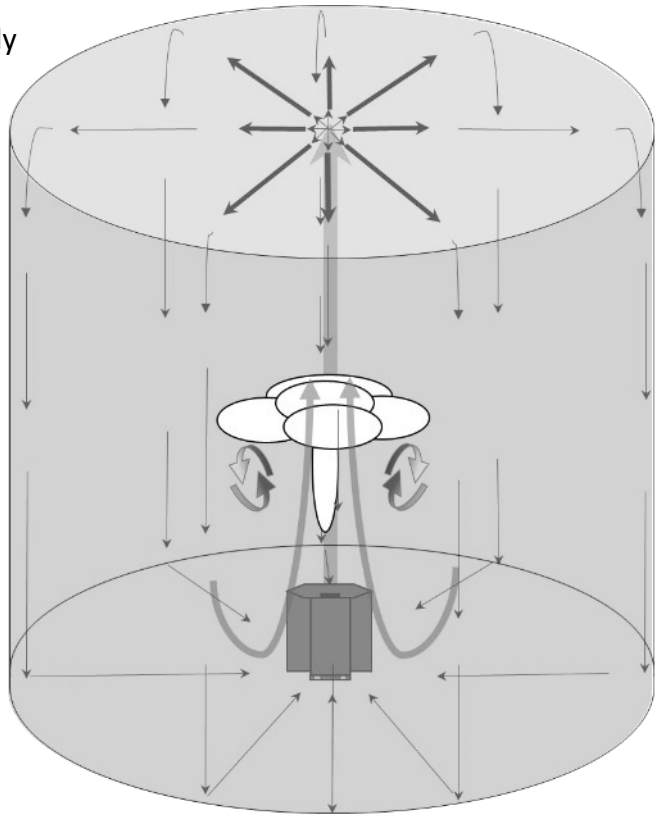
Underneath these mega-sized bubbles, a vacuum is formed from the void that pulls liquids and solids up to the surface. The intermittent bubble induces a vertical circulation, convection-like current, in the tank and mixes the tank's contents. Eddy currents on the periphery of the large bubble aid in mixing and sloughing of filamentous bacteria from flocs, resulting in stronger more granulated floc structures.

The process of releasing bubbles is based on accumulation of airflow to the mixers. Each mixer has a fixed volume to fill prior to bubble release. The pressure needed is the static pressure at the depth the mixers are mounted and the flowrate of gas to the mixers determines rate of bursts. When enough air or gas fills the Mega Bubble unit, the gas shoots out vertically through a riser tube which pulls in and ejects settled solids on the tank floor into the rising liquid stream drafted behind the large bubble.

Although gas (typically air) is used in this process, there tends to be minimal contact time with the water due to high velocities and low relative surface area of the bubble. These characteristics inhibit oxygen from being transferred to the water. This makes the Mega Bubble system suitable for **Anoxic** and even **Anaerobic** applications when intermittently bursting.

When Mega Bubble is directed into a substantially vertical pipe, the bubble is restricted and rises through the pipe as a large slug. Due to the cohesive forces of liquids, the bubble acts as an air piston, lifting liquid up through the pipe up to a maximum of about 2X the depth of the pump. The resulting vacuum draws liquid from the tank bottom into the pipe and will be pumped out with the subsequent burst. The fixed pipe volume allows for flow estimation with each burst.

The ability to distribute mixers and pumps throughout a large area while using a centralized air supply, allows Mega Bubble to be placed in difficult to maintain or remote locations with ease.



Effective mixing column for a single mixer.
Diameter dependent on bubble size and water depth

Installation

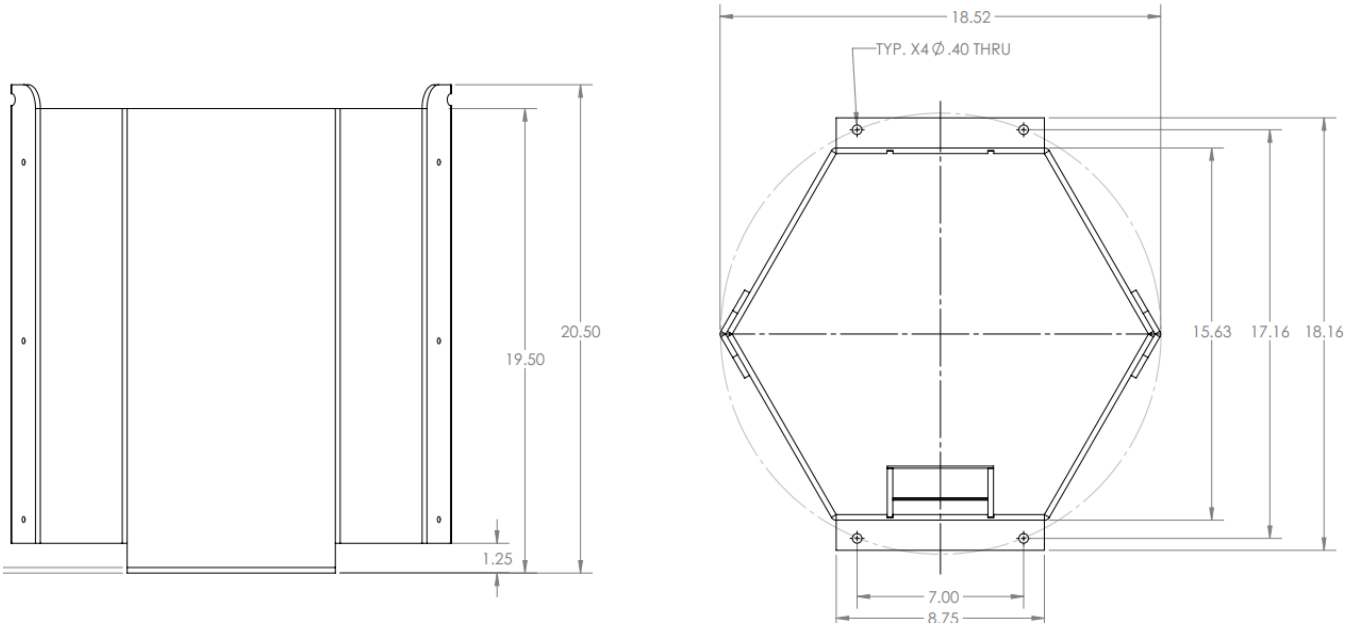
Installation of Pulsed Burst Systems' Mega Bubble mixers is simple. Once they are installed, they require very little maintenance. Only ballasted or tank bottom mount & an air source are needed.

Mounting

The goal is to anchor Mega Bubble units to the ground, tank, or ballast in the desired location, and ensure that gas is being introduced into the unit. Typically, the introduction of air is achieved via a pipe entering from below the unit, or through the wall of the unit - either on the side or top of the unit (if hermetically sealed). Gas must accumulate inside of the container, and the units are designed such that the top of the unit is level horizontally to gravity. Thus, it is important that the top of the container is as level as possible, which can be adjusted while mounting. The units will suffer some loss of performance if mounted with 5-10 degrees off level and will not be operational at around 15 degrees off level.

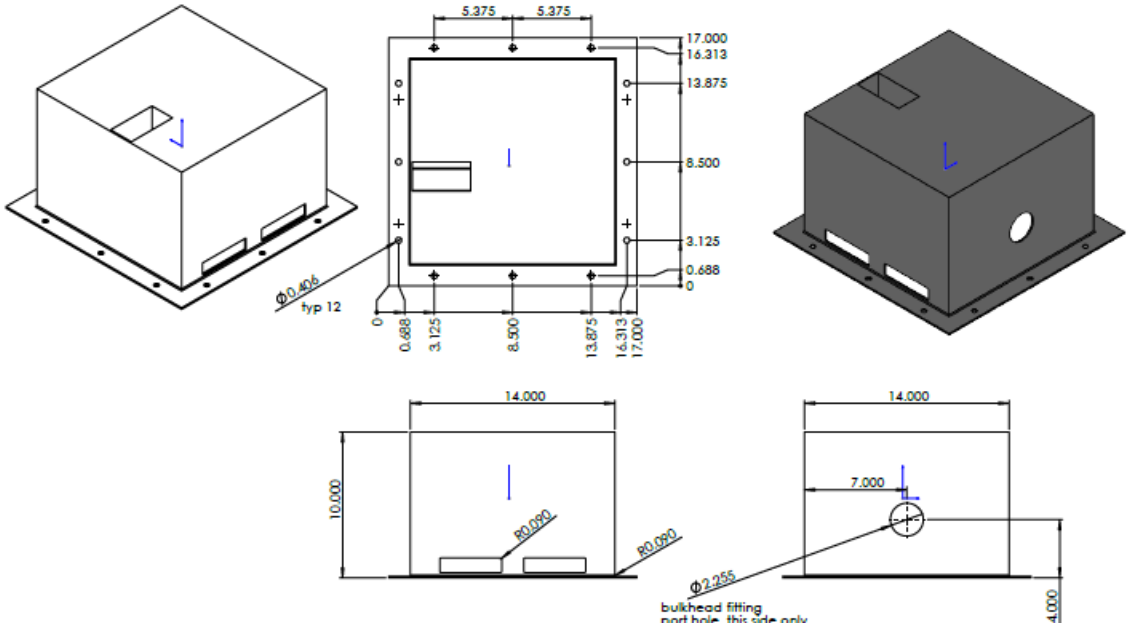
For permanent mounting applications (Recommended), the Mega Bubble units are anchored to the floor or tank bottom. For concrete tanks, this is achieved with concrete anchors. Due to the potential of corrosion, the anchors should be stainless steel, and 3/8" or greater in diameter. It is advised to use lock washers, Nyloc nuts, and/or epoxy adhesive to ensure that they are solidly affixed to the mounting location. Any play in the mount may cause fatigue in the unit.

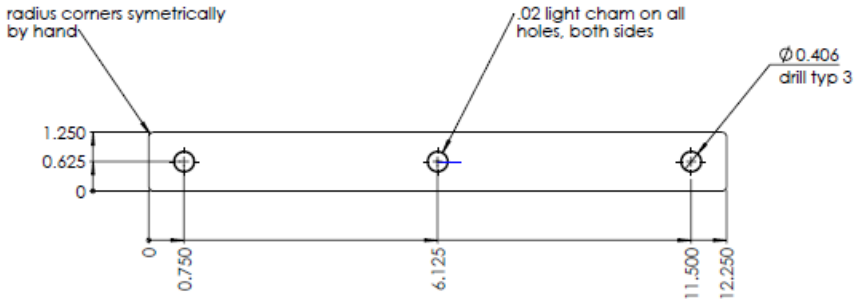
1.5 Mega Bubble Pulsed Air Mixer



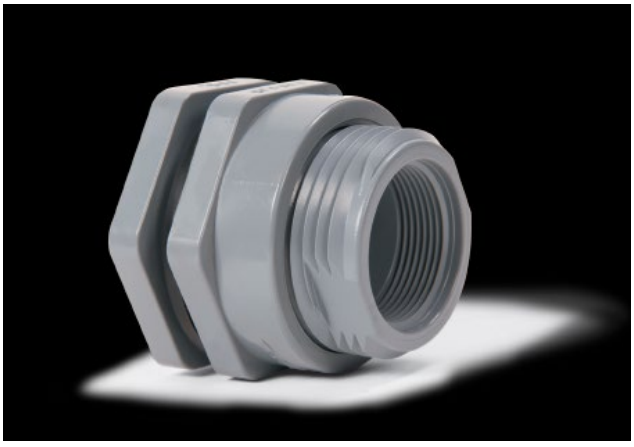
1.5 CF Mega Bubble dimensions, other model specifications will be available at pulsedbursts.com

0.75 Mega Bubble low profile pulsed air mixer & full-length foot strap



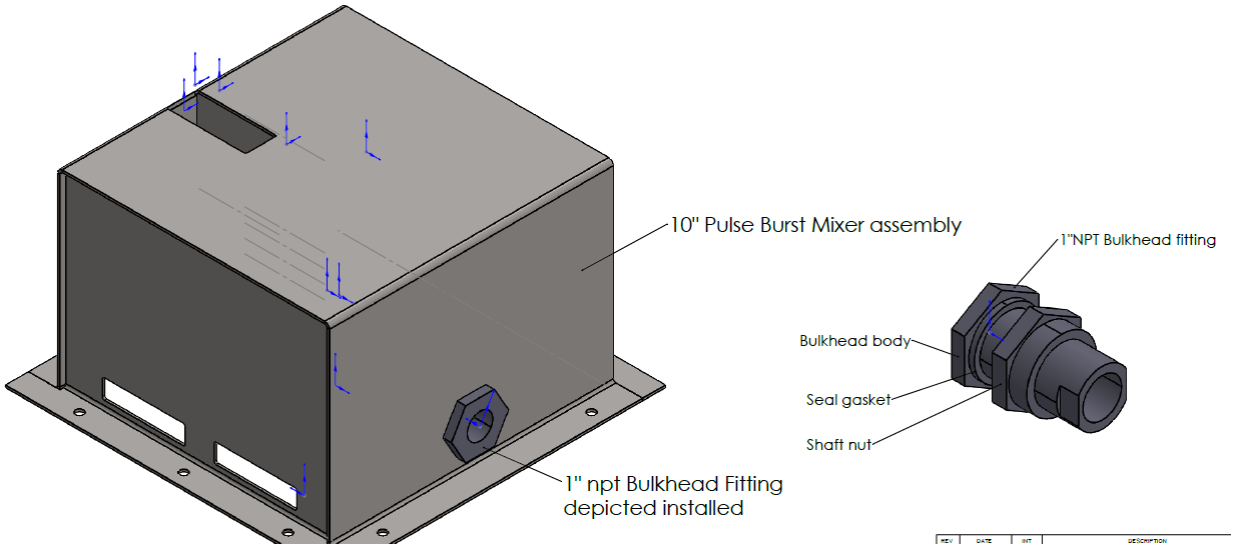


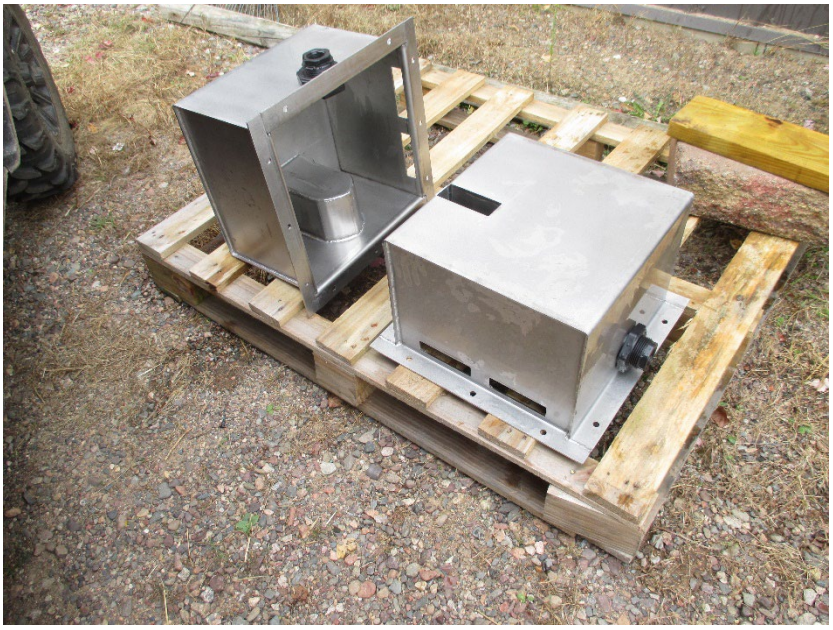
Air intake bulkhead fitting



Model 0.75 Mega Bubble mixer -- air intake fitting installed

Installation instuctions for bulkhead fitting:
1.) Apply a 1/4" bead of 100% silicone waterproof caulk around the entire circumference of the interior and exterior edges of the air inlet opening.
2.) Place bulkhead fitting body/shaft through inlet opening from mixer exterior
3.) Place gasket and nut onto the threaded shaft at the interior of the mixer and tighten firmly using typical torque for PVC materials
4.) Assure full 360 degree coverage of the silicone seal on both exterior and interior of the bulkhead fitting after installation





Mounting Instructions

1. Determine mounting location of Mega Bubble unit to ballast or floor.
    - This may be dependent on the gas source.

2. Mark the location of the mounting bracket holes.
   Note: Steel tank/steel floor may have threaded mounting studs welded to the tank floor in pre-determined locations.
3. For concrete floors or ballast blocks---Bore holes in bottom of tank or ballast block in the marked location to the depth required by the anchors.
   - **Stainless Steel concrete anchors should be used**, **minimum 3/8".**
   - Tapcon anchors or similar are possible to use, but *not* recommended in permanent mounting situations.
4. Drive concrete anchors into place(use of epoxy within drilled hole is recommended to assure positive anchoring)
5. Place MegaBubble unit on concrete anchors. For plastic composite mixers, **place the full-length foot strips over the anchors on each of the mixer legs and secure with stainless steel washers & nuts. Note: For stainless steel mixers, use large circular stainless-steel washers instead of the full-length foot strips.**
   - There should be no play in the MegaBubble unit once anchored, any play in the mount will result in intermittent movement and can lead to mounting failure over time.

Due to the nature of the manufacturing of the MegaBubble, the exhaust port is located on one side of the cube or hex mixer. The exit port side should face the direction of the flow, if possible, to prevent collection of fibrous material or debris accumulation inside of the unit.

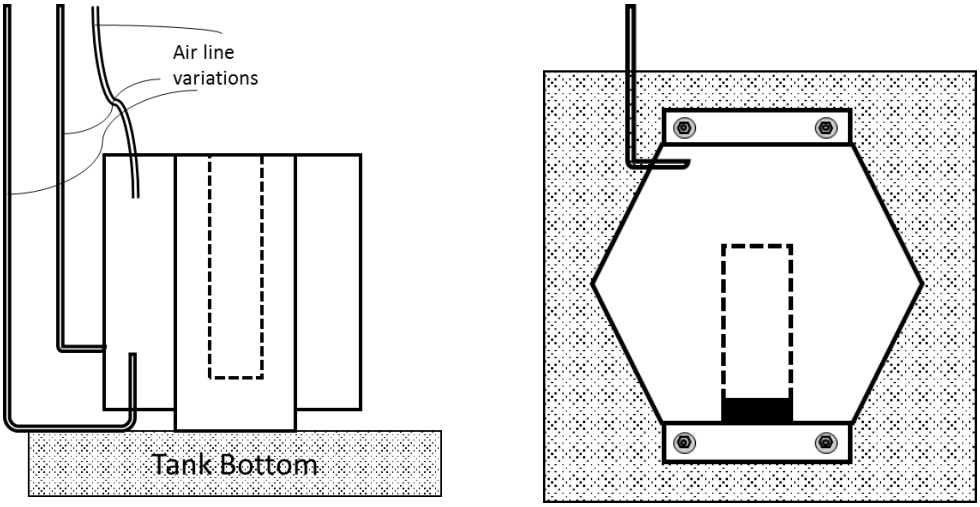
Gas Supply

The gas source should be introduced into the MegaBubble units such that it is below the top three inches of the interior of the container – such that the end of the airline is underwater at least intermittently to prevent fouling. The air source must be positioned so gas is introduced away from the pump insert module, such that gas is not introduced below the discharge port – the hole on the top of the unit is the discharge port. The gas should be introduced at least 3" above the bottom of the unit, which can be accomplished by positioning air source under the unit outer walls but away from the discharge port.

The MegaBubble accumulator is able to collect gas from multiple sources independently or cumulatively, including existing aeration devices, so long as it is accumulated within the MegaBubble unit. When possible, care should be taken to minimize unnecessary obstacles for filamentous solids to get caught on. For example, mounting the air source too close to the mounting plate or going through the side wall with excess tubing could provide potential for string or hair to accumulate. Be certain that any connections are hermetically sealed.

Be sure that the air source is securely attached to the unit or such that it is mounted inside of the unit. Examples shown below. Avoid installing the gas supply close to the bubble mechanism insert discharge, as at high air flow rates the air may not accumulate properly.

If desired, diffusers may be added to the end of the distribution tubing to provide back pressure for distribution systems with multiple units.



Distribution

One of the main advantages to the Mega bubble system is that only low-pressure air is needed to provide the mixing energy, removing the need for electrical runs to mechanical mixers. A single airline can feed a remote distribution manifold feeding multiple units. This makes mixing zones easy to implement.

For installations with single or few mixers, a simple valve manifold is easy to implement. Ball valves can be crude and can be hard to adjust, but they do provide adequate flow splitting in small applications. With larger installations, often with large differences in pipe runs from the manifold, ball valves can make fine adjustments difficult. For zones with more than 4 mixers on a manifold, PBS recommends needle valves, globe valves, or orifice plates. These have a finer control of the air flow and allow for fine adjustments if desired.

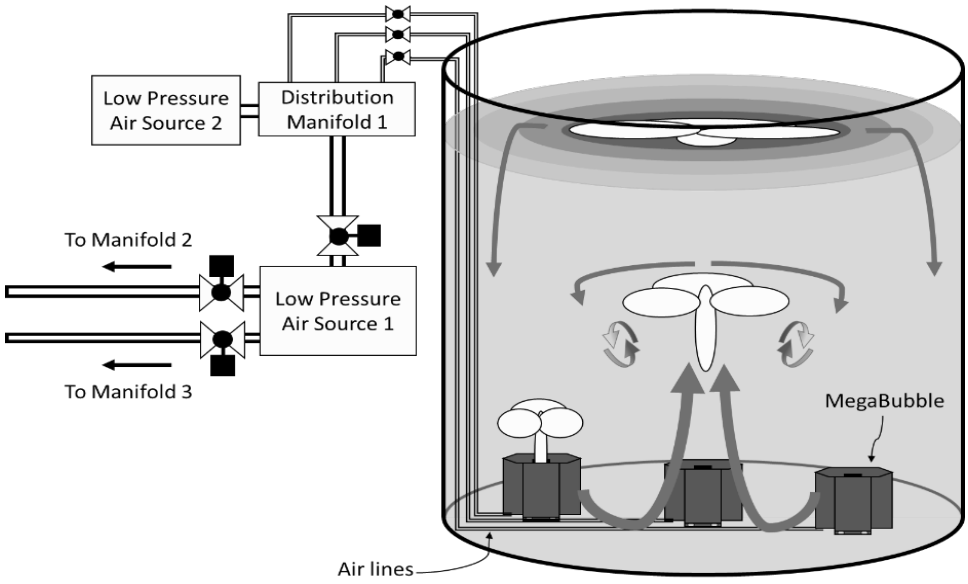
For distribution, there are many ways that a zone may distribute air. Due to the long runs that may be seen in wastewater treatment plants, it is advised that a main air manifold of 4" or larger PVC or stainless pipe be run (to prevent pressure drops) and increase diameter if many mixers are installed. Above the water level at the location of each Mega Bubble unit, a valve (needle or globe) should be attached to the manifold pipe, which is respectively attached to the underwater air tubing to the unit. Keep the manual adjustment valves in an easily accessible spot to simplify initial startup and future adjustments to flow to each unit.

Zone Control

With large installations, where mixing may be intermittently needed or different intensities of mixing are desired at different times, zones may be implemented. Zoning banks of mixers allow

for one air supply (or multiple) to be used to provide high flow to one zone while other zones are idle. Switching zones may be done with a simple controller or implemented in SCADA systems. Zoning can result in greater energy savings than running continuously with on/off regimes or periods of high and low intensity mixing (variable BPM). Multiple air sources may be used in each zone and may be controlled or not depending on the operator's preference.

Each zone may have a different number of units or airflow depending on how the distribution is set up, so care should be taken to think of potential operational flexibility that is desired prior to the distribution design.



Troubleshooting

1. Symptom: No bubble bursts are happening, and no air rising to surface

   Action: Gas is not being supplied to the unit. Check gas supply.

2. Symptom: No bubble burst but gas is bubbling to the surface near Mega Bubble unit

   Action: Bubble unit is either clogged or not level. Check if bubble unit is level. If clogged, clear clog by pressure spraying water into discharge port, or put an extension pole into discharge port to remove debris.

3. Symptom: small bubbles and large burst bubbles are both occurring

Action: Air supply is too high or there is a leak in the Mega Bubble unit. First reduce air volume to Mega Bubble unit. If the problem persists, there is likely a leak in the unit caused by concussive force or otherwise. If the latter, the unit should be replaced.

4. Symptom: bubbles are very small at the surface of the water, but the unit appears to be bursting.

   Action: The Mega Bubble unit volume is too small for the depth. Though the bubble is bursting, it will tend to break up through a deep column of water and appear as smaller bubbles. The unit is still providing mixing but may not be adequate for the application. A larger Mega bubble unit may be needed. Contact Pulsed burst Systems for consultation.

5. Symptom: uneven burst rates or pumping rates from a bank of mixers connected to a common air source.

   Action: Adjust valves to individual mixers to accomplish more even burst rate or pump rate. If one mixer or pump seems to be clogged, open that unit's air supply valve fully, close down on other units supply valves, allow more air to potentially clogged unit to attempt to flush and free clog.