

MIXING SYSTEMS, INC.

NEW ADDRESS AND AREA CODE

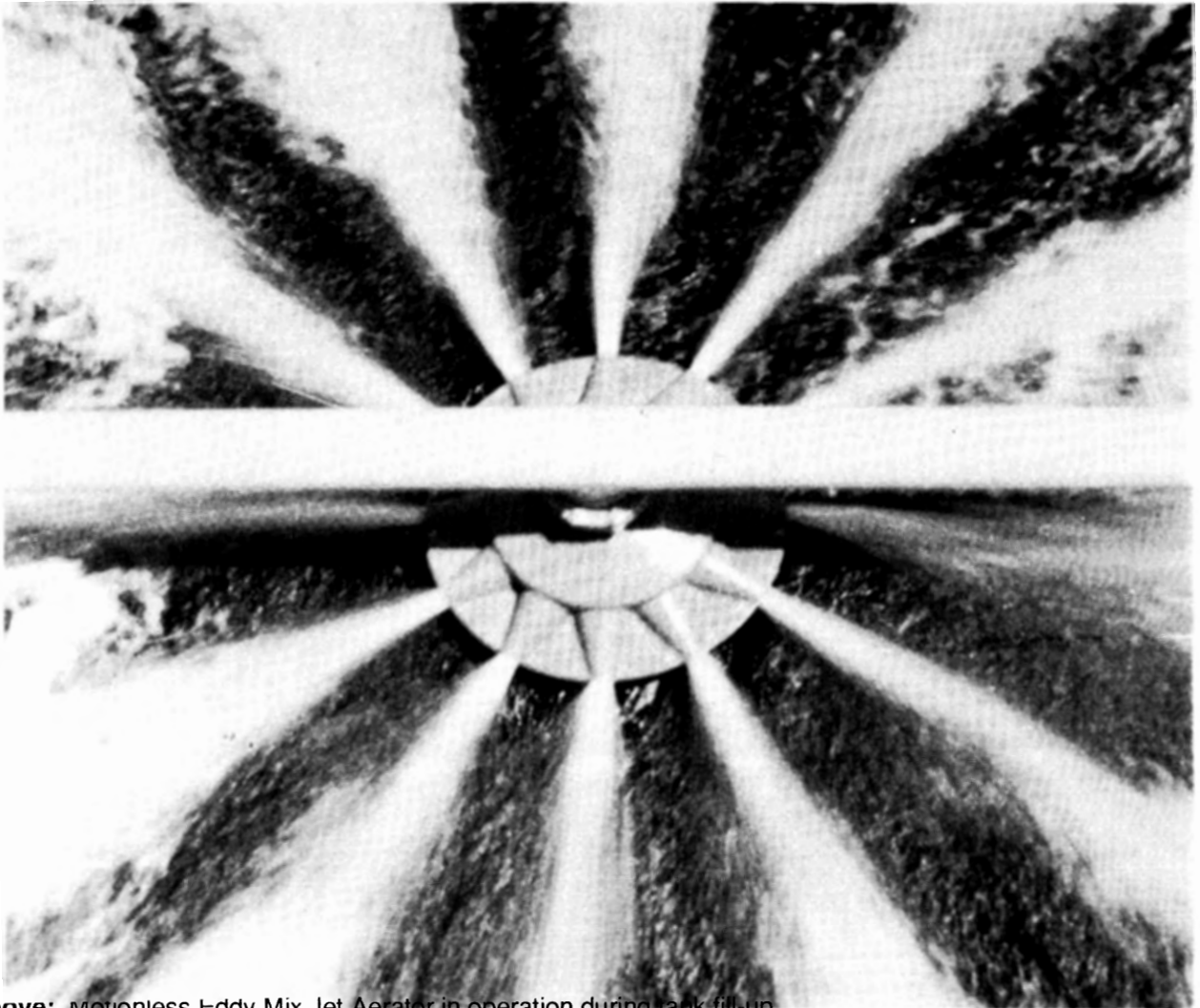
MIXING SYSTEMS INC

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PRINCIPLES AND APPLICATIONS OF JET AERATION



Above: motionless Eddy Mix Jet Aerator in operation during tank fill-up.

PRINCIPLES OF OPERATION

Jet aerators use the ejector method of contacting gases and liquids. The jet consists of a double nozzle arrangement that has a primary inner nozzle, an intermediate high shear mixing chamber and an outer secondary nozzle.

This is how the process works:

1. Liquid, recirculated from the tank, is pumped through the primary inner nozzle where it is converted to a high velocity, low pressure stream.
2. Low pressure gas is introduced perpendicularly to the high velocity liquid stream.
3. Intense contacting and mixing of the two streams occurs in the high shear mixing chamber. The intimate contact between gas and liquid streams results in the formation of micron size bubbles.
4. The fine bubble gas/liquid mist is jetted out through the secondary nozzle into the main tank volume.
5. The high velocity plume from the secondary nozzle travels horizontally, spreading throughout the tank volume before rising to the surface.

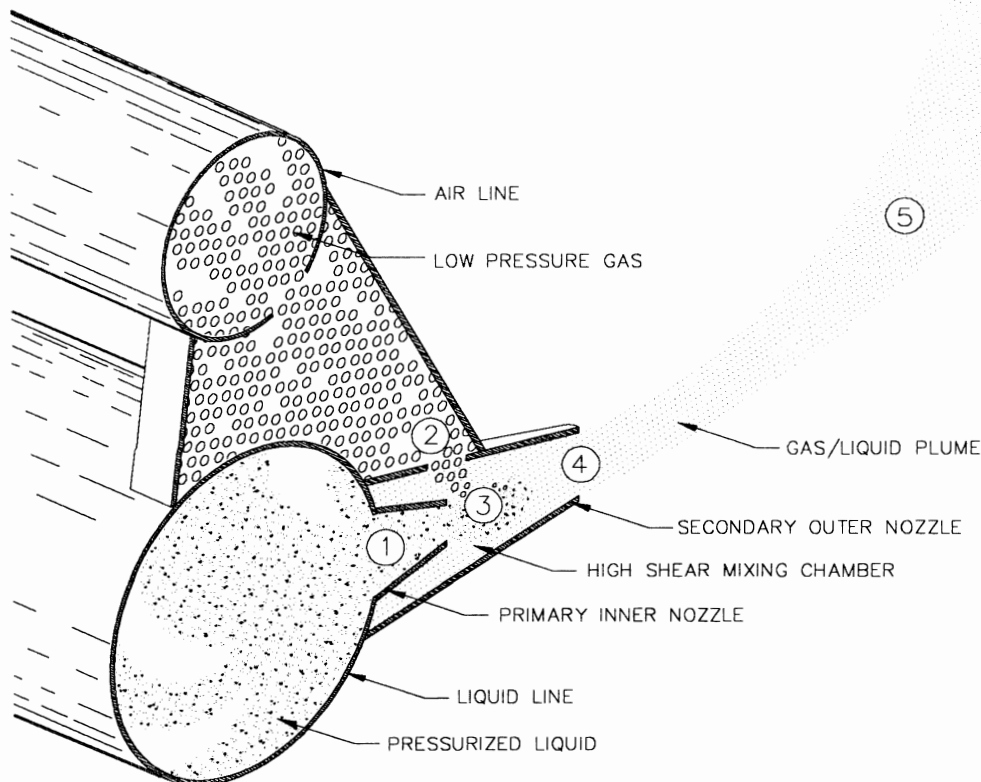
The horizontal travel of the plume maintains high pressure conditions for a longer time than conventional diffused air systems. This high pressure condition gives the gas bubbles a greater opportunity to dissolve in the liquid, increasing the oxygen transfer efficiency.

Injection of the plume into the tank volume provides all the needed mixing energy. The expanding plume's powerful movement creates fine eddy currents in the surrounding liquid, thoroughly mixing the tank and keeping the MLSS solids in suspension.

High velocity gradients are set up in the mixing tank to enhance mixing and solids suspension. The velocity gradients are of a random nature to produce homogeneity of liquid and suspension of solids.

When the plume's initial horizontal momentum dissipates, it rises to the top of the liquid surface. This produces an air lift effect that further mixes tank contents. The jet plume also creates good molecular dispersion, sending molecules to the point of reaction much faster. Such intimate mixing of reactants assures effective process operation.

CROSS SECTION OF THE DIRECTIONAL MIX JET AERATION SYSTEM



ADVANTAGES OF JET AERATORS

ENERGY EFFICIENT

Jet aeration systems use less energy than other diffused aeration systems. In actual waste water treatment plants, side-by-side comparisons with diffused aeration systems have shown **energy reductions of up to forty percent**. Figures are similar when compared with pure oxygen or mechanical aeration systems. Jet aerators have replaced low and high speed aerators on several installations. Low operating power and lower maintenance costs have been the reason for all replacements.

LOW MAINTENANCE

A jet aeration system by Mixing Systems, Inc. consists of quality components with an established reputation for reliability. Materials of construction are durable and resistant to abrasion, corrosion, and ultraviolet light. The **jet nozzles have no moving parts** to wear out or small passages to clog. Pumps and blowers are normally placed outside the tanks where they can be easily serviced. In addition, the system is designed and manufactured to minimize field installation labor. Jet assemblies and piping are usually fiberglass: lightweight, adaptable and easily installed.

OPERATION FLEXIBILITY

Jet aerators are extremely versatile. Mixing is provided by the recirculation pumps. By varying the air flow to the jets, **oxygen transfer rates can match process conditions** without compromising solids suspension and homogeneity of the basin contents. During non-peak periods, with the pumps running at normal power, air flow rates can be decreased by shutting off blowers. Substantial power savings are achieved.

THERMAL ENERGY CONSERVATION

Jet aeration conserves thermal energy of the wastewater and helps maintain high BOD removals and nitrification rates throughout wintertime. All aeration and mixing occurs below the surface so there is **no mist or spray problems** that lead to expensive heat losses. In addition, **no icing problems** occur because the aeration and mixing units eliminate thermal stratification, thus preventing freezing.

FAST, EASY INSTALLATION

Mixing Systems, Inc. designs and manufactures each aerator individually to minimize field installation labor. The equipment is **shipped in pre-fabricated sections** that are joined in the tank by flanged connections or field joints. Supports and support hardware are provided for rapid, simple installation.

OPTIONAL BACK FLUSH FEATURE

An optional backflush system can virtually **eliminate all in-basin maintenance and manual cleaning**. By simply shutting off the pump, opening the backflush valve and continuing to supply air to the system, the air flow blows back through the system in the reverse direction. This cleans the jet nozzles and the entire submerged aeration system of any fouling debris.

LOW OFF GASES

In aeration tanks with high volatile organic compounds (VOC), it is preferable to use minimum quantities of air. This results in less off gases needing to be oxidized at high temperatures in thermal oxidizers. Jet aeration technology uses deep reactors and produces micron size bubbles. The amount of air utilized is reduced so that **comparatively small quantities of gas require thermal oxidation treatment**. In addition, jet aeration systems do not splash water so VOC diffusion into the atmosphere is minimized.

PURE OXYGEN

In instances where **low gas emissions** into the atmosphere is important, jet aeration systems can use pure oxygen or oxygen enriched air to increase the partial pressure of oxygen and reduce quantities of off gases.

COMPARISON OF AERATION METHODS

Equipment Type	Reported Transfer Efficiency * lbs O ₂ /HP-hr at Standard Conditions
MSI Jet Aeration	3.5 to 5.0
Porous Diffused Air	3.0 to 5.0
Tubular Aerators	1.8 to 2.6
Mechanical Surface Aerators axial high-speed	2.0 to 2.5
Mechanical Surface Aerators radial low-speed	2.0 to 4.5
Submerged Turbine	1.7 to 3

* All competitive data from Design of Municipal Wastewater Treatment Plants, Volume I, WEF Manual of Practice No. 8, 1991. Mixing Systems, Inc. data from independent testing.

AVAILABLE JET CONFIGURATIONS

There are three basic jet configurations: Eddy Mix Jet Aerators (EMJA), Directional Mix Jet Aerators (DMJA) and Bidirectional Mix Jet Aerators (BMJA). While each formation is uniquely engineered to meet specific process requirements, they all produce a thorough mixing action that reaches all sides and depths of the tank. In certain applications, pump, blower or piping layouts may dictate one configuration over the other.

EDDY MIX JET AERATOR

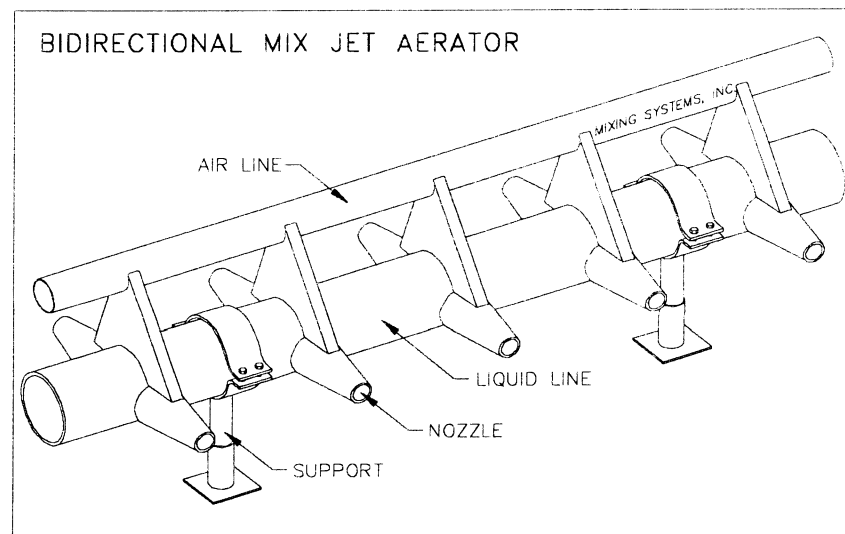
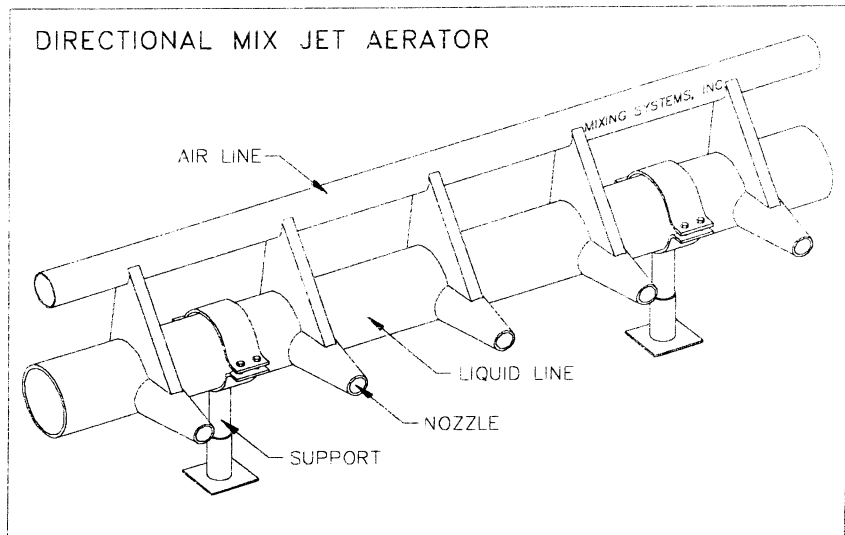
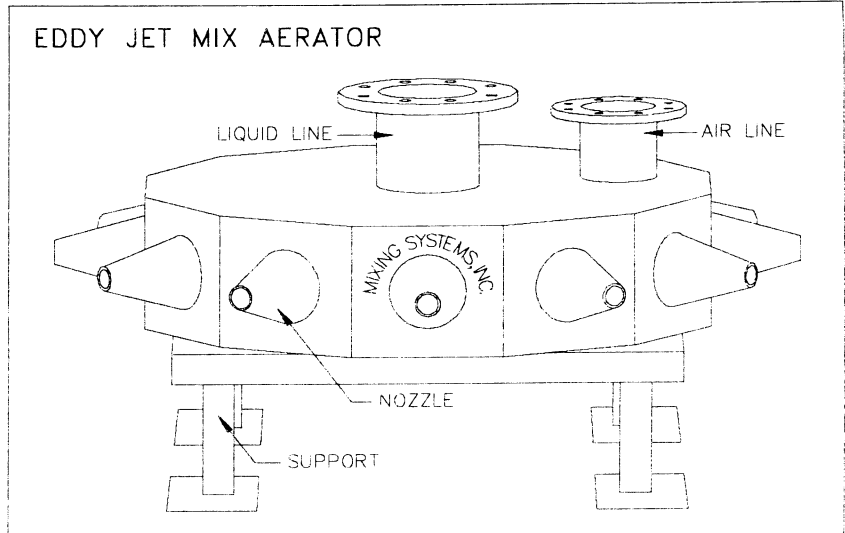
The eddy mix jet aerator (EMJA) configuration arranges jets along a radial pattern. A typical EMJA aerator has twelve jet nozzles arranged thirty degrees apart to form a radial cluster. Air and liquid lines may both enter from the top, as shown to the right, or one may enter from the top and one from the bottom. Eddy mix units are particularly suited for circular tanks.

DIRECTIONAL MIX JET AERATOR

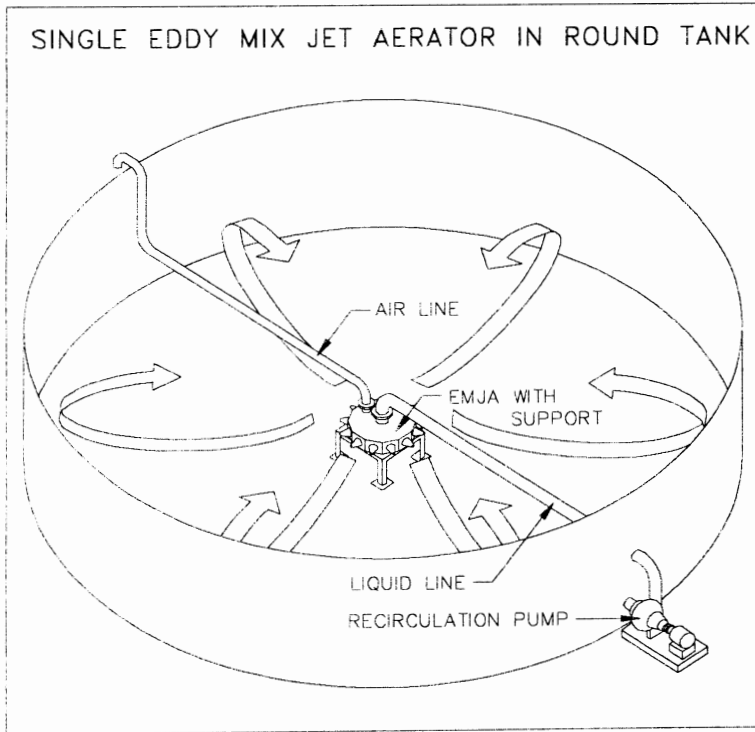
The directional mix jet aerator (DMJA) configuration has jets mounted on just one side of the header, aiming the liquid flow in one direction. Directional mix units can be used singly, in series or grouped in a radial pattern to create a circular liquid flow. Directional mix units are particularly suited for oxidation ditches, large lagoons, long and narrow tanks and applications that may require plug flow conditions.

BIDIRECTIONAL MIX JET AERATOR

The bidirectional mix jet aerator (BMJA) configuration has jets mounted on both side of a common header, allowing for liquid flow in opposite directions. Bidirectional mix units are particularly suited for large circular tanks, long and wide rectangular tanks, and applications that may require plug flow conditions.

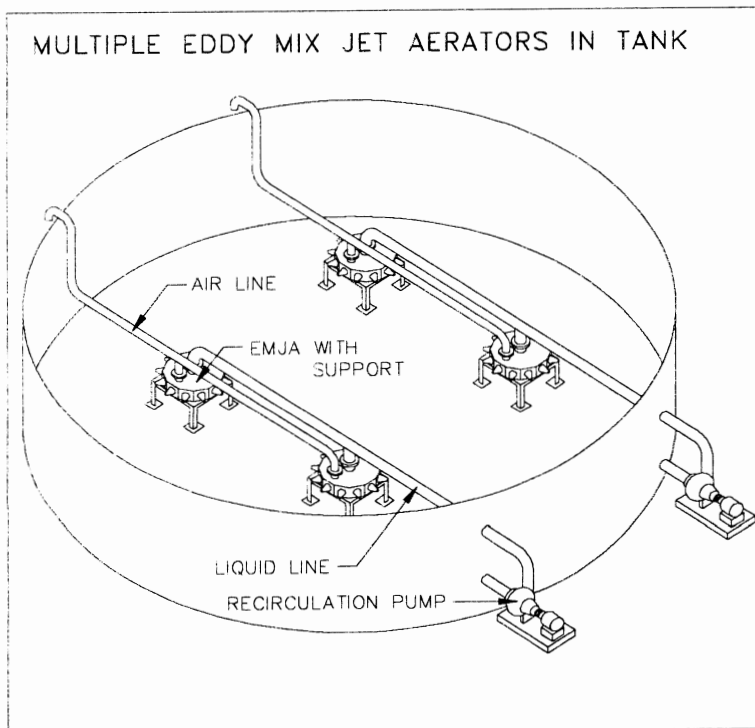


APPLICATIONS FOR EDDY MIX JET AERATORS



ABOVE: One EMJA unit can be used alone in a round tank up to 65 feet in diameter.

BELOW: Multiple EMJA units can be combined to aerate a large round or square tank.



Eddy Mix Jet Aerators (EMJA) are particularly well adapted for tanks 65 feet in diameter or smaller. The effective mixing pattern permits Eddy Mix systems to be installed in square or circular tanks without affecting performance. Typically, these applications are medium-to-high reaction rate systems such as high-rate activated sludge and complete mix designs, aerobic digestion, recarbonation, and chemical oxidations.

PRECISION DESIGN

An EMJA is a precision unit containing multiple jet nozzles arranged in a radial pattern. The unit typically receives air and liquid either through two top inlets or a bottom liquid inlet and a top air liquid. The air and liquid are then distributed uniformly among the nozzles. EMJA's are usually installed so that the centerline of each nozzle is eighteen inches from the floor of the tank.

TYPICAL TANK DESIGN

A single EMJA can aerate and mix a tank up to 65 feet in diameter. For larger tanks multiple units can be incorporated to produce a completely mixed flow pattern. It is common for a series of EMJA's to be used, served by common liquid and air headers. Mixing from one cell to another takes place through the dynamic conditions existing at the boundaries.

SELF-CONTAINED UNITS

EMJA's can also be combined with a submersible pump mounted directly on top. These self-contained units can then be easily dropped in place in small basins, upgrading them with little effort. This design is also good for tanks that cannot be drained for installation.

EDDY JET MIXERS FOR TANK MIXING

When aeration is not required, the eddy jet concept has been used for mixing large equalization tanks, aerobic and anaerobic digesters, neutralization tanks, blending liquids in tanks and for mixing sludge holding tanks. In a mixing system using eddy jet mixers, the recirculation pump outside the tank is the only moving component that would require maintenance. Eddy jet mixers are also an excellent choice when the tank cannot be drained for five to twenty years.

APPLICATIONS FOR DIRECTIONAL MIX JET AERATORS

Directional Mix Jet Aerators (DMJA) are frequently recommended for oxidation channels, aerated lagoons, storm water holding tanks, and plug flow basins.

The DMJA has jets mounted on just one side of a header pointing in a common direction to produce a current type of flow pattern. The discharge pattern creates a momentum, reinforced downstream when successive headers are used, or a transverse bidirectional roll in a plug flow tank. The jets work together to maximize the mixing effort.

Several arrangements of DMJA's are possible. They can be used as a single header, in a row pointing one way, in two rows pointing opposite directions to create a circular movement, or in a radial pattern. With such versatility, it is easy to create an aeration system that will perfectly fit process needs.

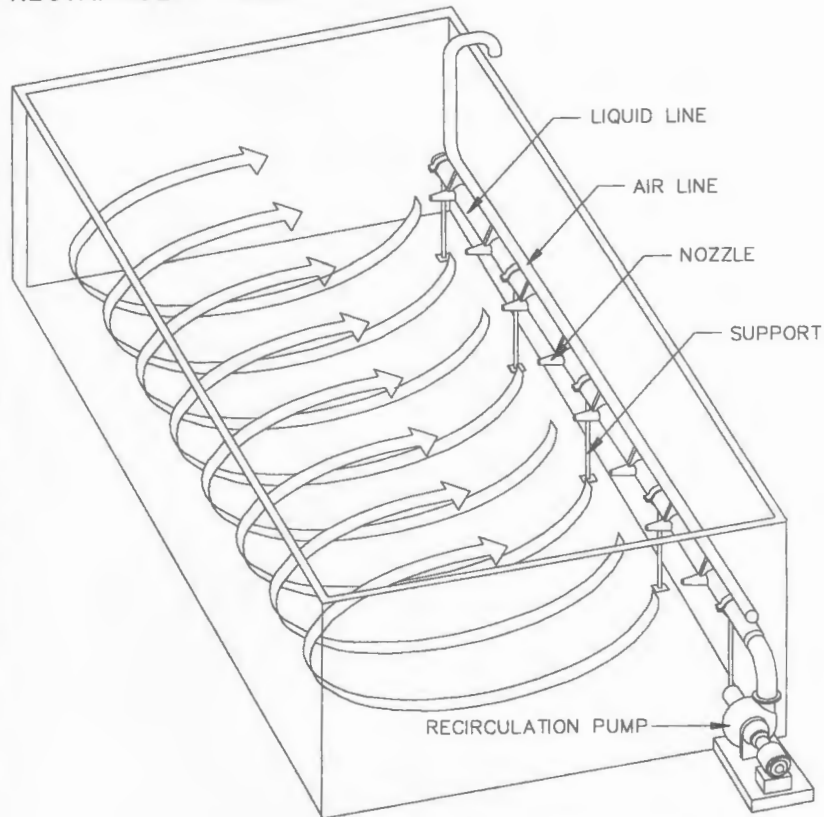
BIDIRECTIONAL MIX JET AERATORS

Bidirectional mix jet aerators (BMJA) are a variation of the DMJA. The BMJA has nozzles on both sides of the header, enabling complete tank mixing with minimal equipment.

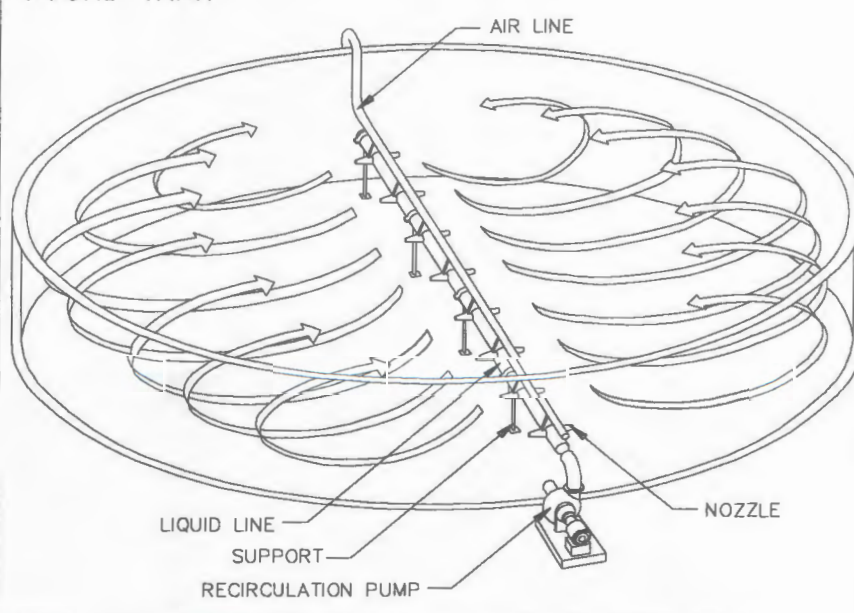
BMJA's are typically used for medium to high rate activated sludge systems and are located along the center of a rectangular, square or circular basin. Rectangular basins wider than 60 feet usually require parallel manifolds to provide highly efficient, completely mixed systems. The BMJA is highly adaptable and can handle a wide range of operating possibilities.

BMJA's are often used in circular tanks where a single operating aerator can cover the entire volume of a tank. In very large circular or rectangular tanks, multiple BMJA's can be used to mix the tank contents thoroughly.

SINGLE DIRECTIONAL MIX JET AERATOR IN RECTANGULAR TANK



SINGLE BIDIRECTIONAL MIX JET AERATOR IN ROUND TANK



SPECIAL APPLICATIONS

OXIDATION DITCHES

Oxidation ditches are known for **minimum operating attention**, shock load resistance and low sludge yield. In addition, the oxidation channel approach taken by Mixing Systems, Inc. is less sensitive to climate conditions. **Oxidation ditches require less space and less power** while still providing high removal efficiencies for BOD, COD and suspended solids.

Jet aeration in deep oxidation channels feature low heat loss due to low surface area. In addition, the jet aerators are submerged, minimizing freezing problems. Operation can continue even during the most adverse temperatures without freeze-over or icing problems.

The circular oxidation ditch with a concentric clarifier is **ideal when space is limited**. The oval design is recommended when the plant layout requires long tanks or rectangular clarifiers. In both cases, common wall construction may be used between the aeration and clarifier walls. Both designs save construction costs while minimizing head loss from aeration tank to clarifier.

DEEP CHANNELS

Mixing Systems, Inc. makes the deep channel work by maintaining the needed minimum channel velocities. In this application, directional mix jet aerators are used to create a uniform plug flow pattern. Each successive DMJA reinforces the momentum provided by the previous one.

One advantage of the oxidation ditch design is that the jet aerators are located near the floor of the tank. **Mixing energy is aimed directly at the bottom of**

the tank where solids would otherwise settle. The rising plume action continues the mixing process throughout the channel depth and maintains uniform velocities, preventing stratification. Consequently jet aerators can be used in oxidation channels 20 to 35 feet deep.

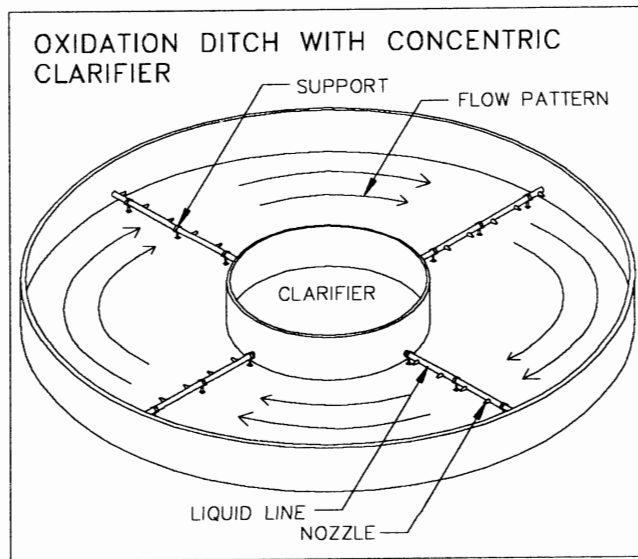
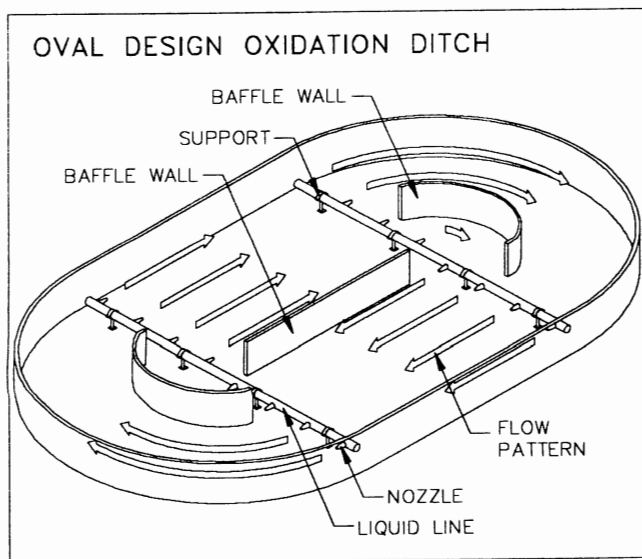
Comparisons with other devices used in this service show that jet aeration maintains higher velocities while transferring more oxygen with less horsepower. Uniformity of velocity is maintained throughout the channel width and depth. Additionally, biological conditions maintained in the tank are equally uniform.

Another advantage of the deep channel is that the channel can be located around the clarifier with a common wall between. This design **saves construction costs and space** while minimizing head loss from aeration tank to clarifier.

DIRECTIONAL JET MIXERS

In applications that require mixing only and no aeration, directional jet mixers are used to create high velocity plumes throughout the tank volume. The directional jet mixers are used for mixing tanks 100 to 250 feet in diameter.

Multiple jet mixers can be installed in a circular tank to conserve momentum and create a clockwise or counter-clockwise motion in the tank. This conservation of momentum results in energy savings for mixing large equalization tanks and storm holding tanks. One or two pumps on the outside are the only moving components of the system that may require some maintenance. The jet mixers inside the tank are stationary and create multiple plumes that keep the tank volume completely mixed.



APPLICATIONS

- ◆ Activated sludge treatment
- ◆ Oxidation ditches
- ◆ Aerobic sludge digesters
- ◆ Sludge holding tanks
- ◆ Equalization basins
- ◆ Stripping (V.O.C. removal)
- ◆ Oxidation reactions
- ◆ pH neutralization
- ◆ Blending two liquids
- ◆ Solids suspension
- ◆ Gas / liquid contacting
- ◆ Sulfite oxidation
- ◆ Stormwater treatment and mixing
- ◆ Ozonation
- ◆ Chlorination
- ◆ Dechlorination
- ◆ Heat transfer
- ◆ Pure oxygen systems
- ◆ Nitrogen and phosphorus removal

PARTIAL LIST OF SATISFIED MSI CUSTOMERS

- ◆ American Cyanamid
- ◆ BASF
- ◆ Ciba Geigy
- ◆ Dow Chemical
- ◆ E.I. DuPont
- ◆ Georgia Gulf
- ◆ Gulf Coast Waste Disposal Authority
- ◆ Kimberly Clark
- ◆ Occidental Chemical
- ◆ Pemex, Mexico
- ◆ Union Carbide
- ◆ Westinghouse
- ◆ Appleton Papers
- ◆ Celgar Pulp Mill
- ◆ Consolidated Papers
- ◆ Fibreco Pulp, Inc.
- ◆ Fletcher Challenge Pulp
- ◆ MacMillan Bloedel Limited
- ◆ Millar Western Pulp Mill
- ◆ Dundee Mills
- ◆ Texprint
- ◆ Chrysler
- ◆ Alabama Feed Products
- ◆ Anheuser Busch
- ◆ Archer, Daniels, Midland (ADM)
- ◆ Frito Lay
- ◆ Tyson Foods
- ◆ Coca-Cola

MAJOR PROCESS BENEFITS

- ◆ Cost effective - Low operating costs
- ◆ Energy efficient - Up to 50% less energy than conventional diffused aerators
- ◆ Thermal energy conservation - No freezing or icing over problems
- ◆ Consistent, uniform mixing
- ◆ Flexible operation
- ◆ Independent control of mixing and oxygen transfer
- ◆ Increased reliability
- ◆ Suitable for deep tanks (Up to 65' deep)
- ◆ Nutrient removal

MAJOR MECHANICAL BENEFITS

- ◆ Corrosion resistant FRP or stainless steel materials
- ◆ Low maintenance
- ◆ No moving parts or small passages to clog
- ◆ Self cleaning back flush capability available
- ◆ Reliable pumps and motors
- ◆ Fast, easy installation

EXPERIENCE YOU CAN RELY ON

Mixing Systems, Inc. offers extensive expertise in jet aeration systems, applicable in many areas. The company manufactures a complete line of jet aeration equipment and employs a specially trained staff backed by computer assistance. All these capabilities can be used in the application, design and manufacture of the system. Each integrated system is specifically engineered for the job, and may employ one or more types of radial or longitudinal jet configurations.

Generally, systems are available in a variety of materials such as fiberglass reinforced plastic (FRP) and stainless steel, all selected for corrosion resistance or other special requirements.

**Ask for more information anytime
by phone, letter or fax.**

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