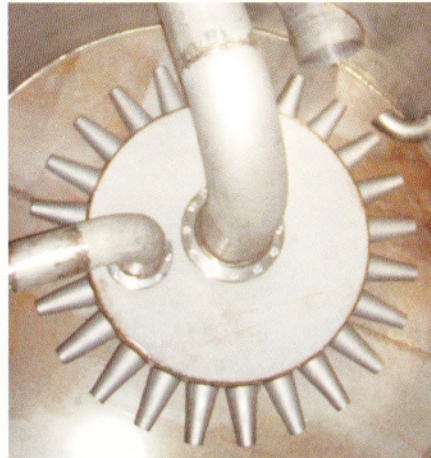


MIXING SYSTEMS, INC.

JET AERATORS ♦ **JET MIXERS** ♦ **SEQUENCING BATCH REACTORS**



Continually Striving for Excellence

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Twenty years of engineering excellence in cost effective, custom-designed jet aeration and jet mixing installations.

Since its beginnings in 1985, Mixing Systems, Inc. has become a preferred provider of submerged jet aeration and jet mixing systems. With hundreds of installations operating worldwide, the company's success and reputation are the direct result of their commitment to product excellence and customer satisfaction.

Because of this commitment to quality, Mixing Systems, Inc. has supplied jet aerators and jet mixers to some of the largest wastewater installations around the world, including many Fortune 500 companies and a variety of industries:

- ◆ Pulp and Paper
- ◆ Chemical
- ◆ Pharmaceutical
- ◆ Textile
- ◆ Petrochemical
- ◆ Food Industries

Mixing Systems' custom designed jet aeration and jet mixing systems are extremely versatile and are suitable for a variety of applications.

- ◆ Activated sludge treatment
- ◆ Oxidation ditches
- ◆ Aerobic sludge digesters
- ◆ Aerobic and anaerobic selector tanks
- ◆ Sludge holding tanks
- ◆ Equalization basins
- ◆ Stripping (VOC removal)
- ◆ pH neutralization
- ◆ Stormwater treatment and mixing
- ◆ Blending two liquids
- ◆ Solids suspension
- ◆ Disinfection
- ◆ Chlorination
- ◆ Dechlorination
- ◆ Pure oxygen systems
- ◆ Flocculation
- ◆ Chemical oxidation
- ◆ Flash mixing
- ◆ Oxygen enhancement in rivers and streams
- ◆ Gas/liquid contacting
- ◆ Mixing anoxic tanks

CUSTOM DESIGNS

Mixing Systems, Inc. provides cost-effective jet aeration solutions for many different applications. Mixing Systems, Inc. supplies complete systems consisting of jet aerators, pumps, blowers, control systems, supports and hardware.

Typical working capacities of installed systems range from 10,000 to **50 million gallons per day** (7 to 35,000 M³/day). Most installations have tank volumes of 5,000 to 240 million gallons (4 to 900,000 M³) and can handle Biochemical Oxygen Demand (BOD₅) loads of 1,000 to **150,000 lb/day** (450 to 68,000 kg/day).

Engineered to accommodate increased capacity loads, typical jet aeration systems can process up to a 100% increase in flow rates and a 30% increase in organic loads.

Mixing Systems' goal is to design and manufacture systems that offer durability, quality and precision at prices that are extremely competitive to comparable systems.

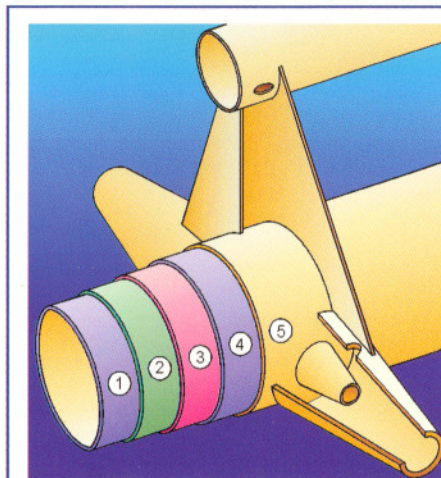
A highly trained staff, extensive experience and computer-aided design enable Mixing Systems to custom design complete aeration systems to the customer's specific needs and individual requirements.

QUALITY MANUFACTURING

Mixing Systems, Inc. typically uses fiberglass reinforced plastic (FRP) for its jet aerators and jet mixers because it is durable, lightweight, corrosion resistant and easily assembled in the field. FRP also has an expected service life of twenty years. Mixing Systems prefers to use 100 psi pipe so the jet aerators will have a 10:1 safety factor.

Mixing Systems' commitment to quality is furthered through the use of clear FRP piping so any flaws or imperfections can be seen and corrected before the system is shipped.

Mixing Systems, Inc. designs, owns and tests its own molds before any parts are fabricated, ensuring tolerance and superior quality. In addition, Mixing Systems, Inc. directs the entire fabrication process to ensure that every component is manufactured to its own high standards and specifications.



Corrosion resistant FRP piping typically used is composed of the several layers.

- ① **Primary corrosion barrier** - "C" veil or Nexus layer with 90% resin and 10% reinforcement.
- ② **Secondary corrosion barrier** - 100 mil chopped strand mat. Resin content of approximately 60% resin / 40% glass.
- ③ **Structural layer** consists of 1/4" to 1/2" continuous glass roving for structural integrity. This consists of 60% glass and 40% resin.
- ④ **Exterior corrosion barrier** - "C" veil or Nexus layer with 90% resin and 10% reinforcement.
- ⑤ **Final layer** - 100% resin and ultraviolet inhibitor.

Jet nozzles are manufactured by the hand lay-up process with a **10 to 20 mil abrasion resistant layer** followed by the structural layer consisting of woven roving, chopped strand mat, resin and finished with a corrosion resistant layer and ultraviolet protection.

The hand laid components are built to exacting tolerances. **Mixing Systems'** nozzles are engineered and fabricated with a standard minimum wall thickness of 0.375" (9.5 mm). To further enhance corrosion resistance, silicon carbide can be bonded to the inner layers of the FRP nozzle such that the silicon carbide and the structural layer of the nozzle form an integral bond.

Jet aerators and jet mixers can also be manufactured in **stainless steel or with special resins** for extremely corrosive environments. In addition, because all units are custom designed, aerators and mixers can be tailored to accommodate unusual requirements.

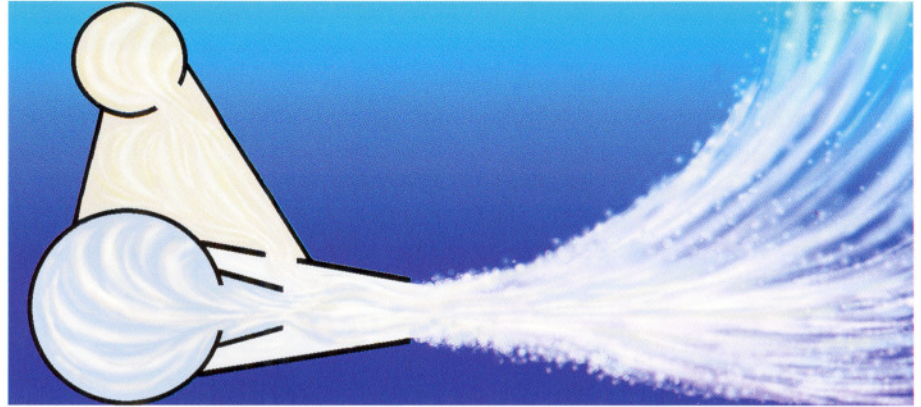
PROVEN TECHNOLOGY

The technology of jet aeration and jet mixing involves combining two fluid streams in a common mixing chamber. One stream is typically a liquid and the second stream is usually a gas. With jet mixing the second stream is another liquid, often entrained from the tank itself.

The basic components of the jet aeration or jet mixing system are:

- Dual concentric jet nozzle
- Piping for the two fluid streams
- Pumps to circulate the tank
- Blowers, for jet aeration systems, to supply the pressurized air flow

One reason jet aeration is more effective than other methods of aeration is because the system utilizes multiple oxygen transfer zones.



1 High contact zone within the nozzles: Oxygen transfer begins when a stream of recirculated liquid from the inner nozzle comes in contact with a stream of pressurized gas, creating an **intense mixing action** in the chamber between the inner and outer nozzle. The intimate contact between the gas and liquid streams results in **micron-size bubbles**.

2 High pressure zone at the tank bottom: Oxygen transfer continues as a plume of fine bubbles, from 0.1 to 1 mm in diameter, is ejected horizontally through the outer nozzle into the main tank volume. The horizontal travel of the plume maintains the gas/liquid transfer interface for a much longer period of 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 absorption efficiency. In addition, injection of the plume into the tank volume thoroughly mixes the tank and keeps the MLSS solids in suspension.

3 Buoyancy bubble rise: As the momentum of the horizontal plume dissipates, the bubbles, now 1 to 3 m in diameter, rise to the surface creating an air lift effect allowing for further molecular dispersion and absorption of solids.

4 Surface agitation: To further enhance oxygen transfer, the liquid momentum near the tank surface draws the air bubbles from the tank surface and redistributes it through the tank volume. Since all aeration and mixing occurs below the surface, there is no mist or spray problems. There are also no icing problems because the jet aerators eliminate thermal stratification and prevent freezing.

ALPHA FACTOR

Jet aeration systems yield a higher alpha factor than fine pore membrane and ceramic type aeration systems. Jet aerators produce a high surface renewal at the gas/liquid interface due to the high shear within the jet nozzles.

Most wastewaters have surfactants present. The surfactants create a resistance to oxygen transfer at the gas/liquid interface. The film thickness is the smallest (lowest resistance) with high shear aeration systems such as jet aerators and surface aerators.

TYPICAL ALPHA FACTORS	
Jet Aerators	0.9
Surface Aerators	0.9
Sparge Turbine	0.9
Coarse Bubble Diffusers	0.8
Fine Pore Diffusers	0.4

In actual wastewater treatment plants, due to the high alpha factor generated by the jet aerators, a lower design standard oxygen is required with the jet aeration system than with fine pore diffused aeration systems.

This is one of the benefits of using jet aerators in wastewater generated from pulp and paper, pharmaceutical, chemical and brewery industries. The total energy consumed for treatment is minimized with jet aeration systems.



BENEFITS AND CONFIGURATIONS

MECHANICAL BENEFITS

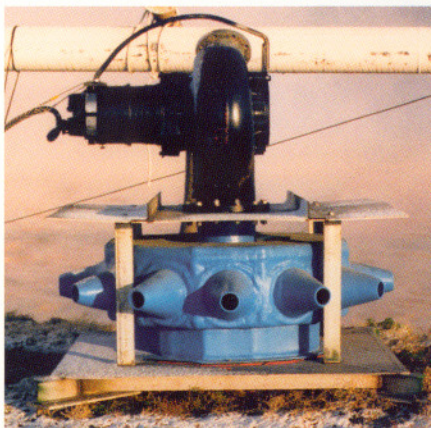
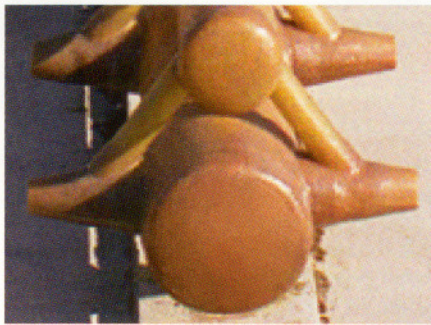
Mixing Systems' submerged jet aeration and jet mixing systems are easier and less expensive to install than comparable systems. All equipment is supplied in prefabricated sections that are easily assembled using field joints or flanged connections. In addition, the jet aeration system contains no in-basin moving parts. All mechanical assemblies such as pumps and blowers are placed outside the tanks where they are easy to service. Combined with a pneumatic backflush designed to eliminate clogging, the systems are virtually maintenance free.

PROCESS BENEFITS

Aeration is often considered to be the heart of the effluent treatment system at most wastewater treatment plants. The correct selection of an aeration system is crucial because the operation of the aeration system requires about 80% of the total operating power cost of a waste water treatment plant.

Mixing Systems, Inc. jet aeration systems provide both environmentally conscious and cost effective operation. Built of quality components with an established reputation for reliability, jet aeration systems have shown energy reductions of up to forty percent over other aeration methods.

In addition, during periods of low service demand, air flow rates can be reduced by controlling and varying the blower output. By regulating the air flow to the aeration system, oxygen transfer rates can be controlled without affecting the mixing efficiency or solids suspension and additional energy savings are achieved.



INNOVATIVE DESIGNS

Mixing Systems supplies jet aerators and jet mixers in three basic configurations, each uniquely suited to different tank designs and different processes.

Directional Mix Jet Aerators

(DMJA) place the nozzles in a linear arrangement on one side of a header pipe which carries the liquid. Flow is aimed in just one direction, making DMJA's ideal for installation near the wall of a long, narrow tank. DMJA's can also be used in series to direct liquid in a circular flow pattern, making them well suited for oxidation ditches, very large round tanks, or irregularly shaped basins.

Bidirectional Mix Jet Aerators

(BMJA) have nozzles arrayed on both sides of a common liquid header, allowing for liquid flow in opposite directions. BMJA's are particularly suited for large circular tanks, long and wide rectangular tanks, and applications that require plug flow conditions.

Eddy Mix Jet Aerators

(EMJA) place the nozzles in a radial arrangement around a common chamber which supplies both air and liquid to the nozzles. The EMJA is well suited for circular tanks. A single unit can accommodate tanks up to 65 feet (20 meters) diameter. For larger tanks, multiple units can be used.

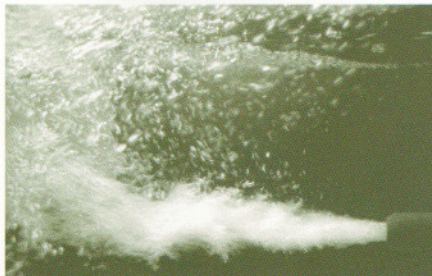
Self-Contained Aerators can be used as an innovative solution for rivers, streams, and tanks that can not be drained. The jet aerator and a submersible pump are mounted together on a common base. These self-contained units can be dropped into a liquid filled tank or stream with a minimum of installation time required.

SYSTEM FLEXIBILITY AT VARYING AIR FLOW RATES. For anoxic conditions the air can be completely shut off and mixing can be continued through the use of the recirculation pump. Anoxic conditions are desirable for nutrient removal and selector tanks.

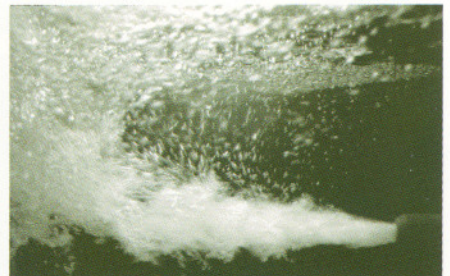
- ◆ Nozzle in operation with 50% design air flow.
- ◆ Total oxygen transfer is 55 to 60% of design.



- ◆ Nozzle in operation with 100% design air flow.
- ◆ Total oxygen transfer is 100% of design.



- ◆ Nozzle in operation with 150% design air flow.
- ◆ Total oxygen transfer is 125% of design.



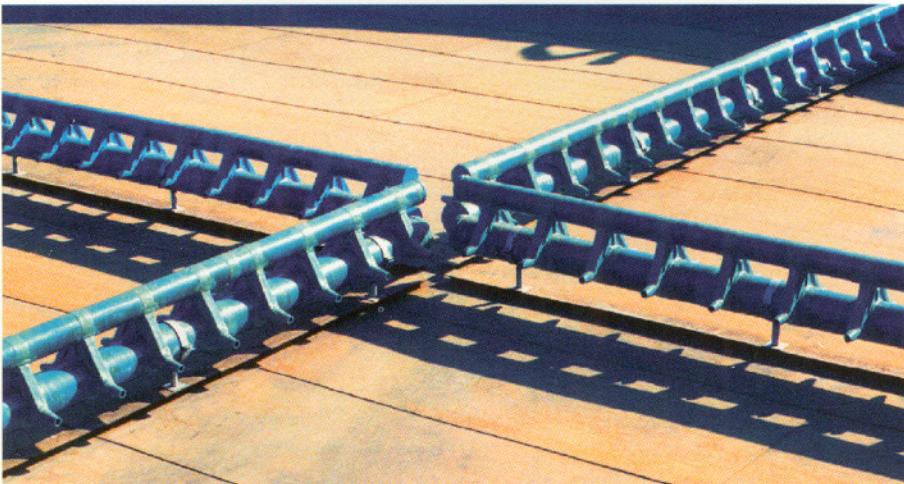
JET AERATION INSTALLATIONS



CHEMICAL / REFINERY

Gulf Coast Waste Disposal Authority, Houston (Bayport), Texas

- ◆ Bidirectional mix jet aerators in five tanks, 310 ft (94 M) long by 54 ft (16.5 M) wide, 21.5 ft (6.5 M) deep
- ◆ Directional mix jet aerators in three circular tanks, 110 ft (33.5 M) diameter, 25 ft (7.6 M) deep
- ◆ Plant treats wastewater from 65 industries in the Houston area
- ◆ **34 MGD plant** (130,000 M³/day) with **twenty-two 75 HP pumps and fifteen 250 HP blowers**
- ◆ Jet aerators replaced surface aerators at this location



CHEMICAL

Georgia Gulf, Plaquemine, Louisiana

- ◆ Chemical plant manufacturing several different chemicals
- ◆ Two tanks, 150 ft (45.7 M) diameter, 22 ft (6.7 M) deep
- ◆ Each tank has four bidirectional mix jet aerators
- ◆ Completely mixed tanks run in series



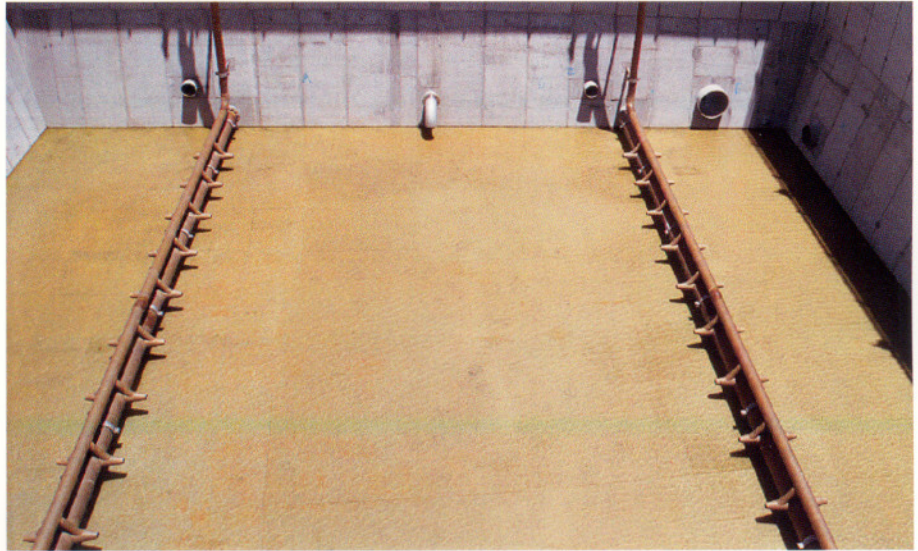
FOOD MANUFACTURER

- ◆ Jet aerators provided for activated sludge, flow equalization, selector and aerobic digester tanks
- ◆ Four in-ground basins
- ◆ Activated sludge basin is 70 by 58 ft (21.3 by 17.7 M) at bottom, 154 by 142 ft (46.9 by 43.3 M) at the liquid surface and has three bidirectional mix jet aerators
- ◆ Aerobic digester is 70 by 25 ft (21.3 by 7.6 M) at bottom, 154 by 109 ft (46.9 by 33.2 M) at the liquid surface and has one bidirectional mix jet aerator
- ◆ Equalization basin is 70 by 30 ft (21.3 by 9.1 M) at bottom, 134 by 94 ft (40.8 by 28.7 M) at the liquid surface and has one bidirectional mix jet aerator
- ◆ Selector tank is 30 ft (9.1 M) diameter and has one eddy mix jet aerator

JET AERATION INSTALLATIONS

CHEMICAL

- ◆ Jet aeration system for two activated sludge tanks
- ◆ Each tank is 72 ft (22 M) square and 30 ft (9 M) deep
- ◆ Each tank has two bidirectional mix jet aerators
- ◆ 3.5 MGD (13,000 M³/day) plant design flow
- ◆ Design COD load of 20,500 lb/day (9,300 kg/day)
- ◆ Four 40 HP pumps and two 200 HP blowers



TEXTILES

- ◆ Manufacturer of textiles, utilizing dyes and other chemicals
- ◆ Three directional mix jet aerators forming an **oxidation ditch** flow pattern
- ◆ 1.1 MGD (4,100 M³/day) plant design flow
- ◆ Design COD load of 31,600 lb/day (14,300 kg/day)
- ◆ Three 100 HP pumps and two 200 HP operating blowers



BACKFLUSH SYSTEM

- ◆ Pneumatic backflush system is used periodically to prevent clogged nozzles

ADVANTAGES OF JET AERATORS

- ◆ Fine bubble aeration
- ◆ High efficiency
- ◆ Low maintenance
- ◆ Increased reliability
- ◆ Energy conservation
- ◆ Flexibility
- ◆ Easy access
- ◆ Cost effective
- ◆ Eliminates splashing
- ◆ Lower off gases
- ◆ Deep tank operation

ADVANTAGES OF JET MIXERS

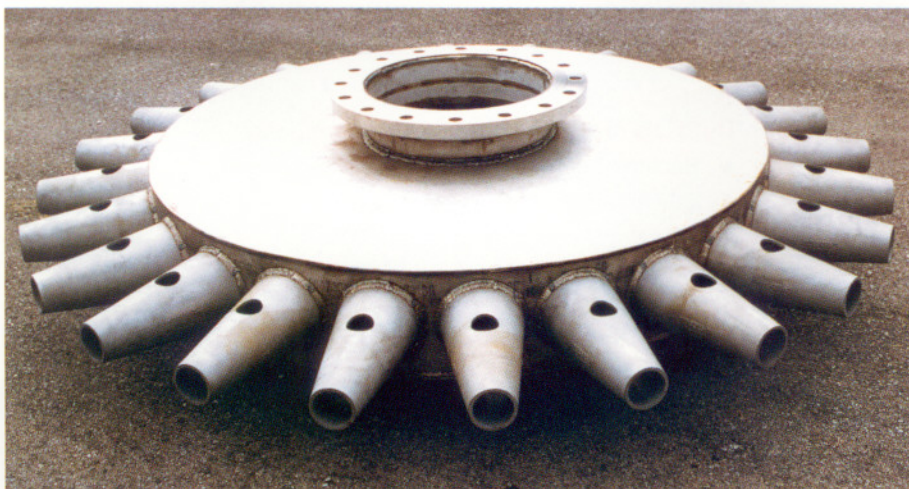
- ◆ No in-basin moving parts
- ◆ Ideal when liquid level fluctuates
- ◆ Control of mixing intensity
- ◆ No structural supports required
- ◆ No long shafts or submerged bearings
- ◆ Effective in both large tanks and deep tanks
- ◆ No special baffles required
- ◆ Corrosion resistant
- ◆ Installed close to the tank bottom

JET MIXING INSTALLATIONS



PHARMACEUTICAL

- ◆ Mixing and oxidation tank
- ◆ Jet mixing system in operation in a tank 44 ft (13.4 M) diameter, 22 ft (6.7 M) liquid level
- ◆ Liquid level fluctuates from 15 to 100%
- ◆ Air flow varies from 0 to 150%
- ◆ One eddy jet mixer shown during tank fill-up



FOOD PROCESSING

- ◆ Mixing application
- ◆ 24-jet Eddy jet mixers are custom designed and manufactured of 316L stainless steel
- ◆ Supplied two 84-inch (213 cm) diameter units
- ◆ 66 ft (20.1 M) and 55 ft (16.8 M) diameter tanks with varying liquid levels

FOOD PROCESSING

- ◆ Directional jet mixers in a tank 160 ft (49 M) diameter, liquid level varying from 3 ft (1 M) to 20 ft (6 M)
- ◆ Equalization tank designed to keep solids in suspension before the flow is treated in aeration tanks
- ◆ Jet aerators for the three aeration tanks were also provided by *Mixing Systems, Inc.*



REFINERY

- ◆ Complete Sequencing Batch Reactor (SBR) system for two 8 ft (2.3 M) diameter, 14 ft (4.3 M) high FRP tanks
- ◆ *Mixing Systems, Inc.* supplied the FRP tanks, pumps, blowers, aerators, decanters, skimmers, and piping

PULP & PAPER

- ◆ Appleton Papers
- ◆ Celgar Pulp Company
- ◆ Consolidated Papers
- ◆ Fibreco Export Pulp Mill
- ◆ Fletcher Challenge
- ◆ Georgia Pacific Corp.
- ◆ Great Lakes Forest Products
- ◆ Harmac Pacific
- ◆ Heilongjiang Paper
- ◆ Indorayon
- ◆ Kimberly-Clark Corp.
- ◆ Millar Western Pulp Ltd.
- ◆ Pine Falls Paper Co.
- ◆ Quesnel River Pulp Co.
- ◆ St. Marys Paper Limited
- ◆ Weyerhaeuser

FOOD INDUSTRIES

- ◆ A.E. Staley
- ◆ Anklam Sugar
- ◆ Archer, Daniels, Midland (ADM)
- ◆ Alabama Feed Products
- ◆ Anheuser Busch
- ◆ Armour Swift Eckrich
- ◆ Cargill, Inc.
- ◆ Carolina By-Products
- ◆ Coca Cola Products, Inc.
- ◆ Coors Brewing Co.
- ◆ Frito Lay
- ◆ International Flavors
- ◆ Lipton
- ◆ M&M Mars
- ◆ McCain Foods
- ◆ Nabisco Foods
- ◆ Pilgrim's Pride
- ◆ Saica, Spain
- ◆ S.G.A.E., Spain
- ◆ Sierra Nevada Brewing
- ◆ Tropicana
- ◆ Tyson Foods
- ◆ Wampler Longacre Chicken Inc.

CHEMICAL

- ◆ Allied Processors, Inc.
- ◆ American Cyanamid
- ◆ BASF Corporation
- ◆ BF Goodrich
- ◆ Cain Chemical
- ◆ Ciba Geigy Corporation
- ◆ Cookson Pigments, Inc.
- ◆ Cytec
- ◆ Dow Chemical
- ◆ Eastman Chemical
- ◆ Exxon
- ◆ Folla, Norway
- ◆ Formosa Plastics Corp.
- ◆ Goodyear
- ◆ Hoechst Celanese
- ◆ Kerr-McGee Chemical
- ◆ Milliken
- ◆ Mobay Chemical Corp.
- ◆ Occidental Chemical
- ◆ SCM Glidco
- ◆ Union Carbide
- ◆ Uniroyal Chemical Ltd.
- ◆ VFT Inc.

PETROCHEMICAL AND REFINERY

- ◆ Amoco
- ◆ BP Oil
- ◆ Equilon
- ◆ Georgia Gulf
- ◆ Gulf Coast Waste Disposal Authority
- ◆ Merck
- ◆ Pemex Refinery
- ◆ Premcor Refining
- ◆ Saudi Arabia Oil Co.
- ◆ Shell Refinery
- ◆ Texaco
- ◆ Uniroyal Chemical Ltd.

TEXTILE

- ◆ Burlington Industries
- ◆ Springs Industry

PHARMACEUTICAL

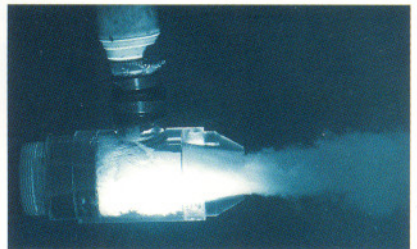
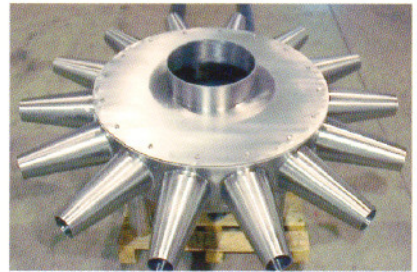
- ◆ Bayer Corporation
- ◆ Ciba Geigy Corporation
- ◆ Eli Lilly
- ◆ Merck Chemical
- ◆ Sterling Winthrop
- ◆ Warner-Lambert
- ◆ Schering Plough

MUNICIPAL

- ◆ Atlantic Waste Disposal
- ◆ Cambridge, Minnesota
- ◆ Fulton County, Georgia
- ◆ Cecos International
- ◆ Colonial Beach, Virginia
- ◆ Heath, Ohio
- ◆ Las Virgines, California
- ◆ Montgomery County, Ohio
- ◆ Morristown, Tennessee
- ◆ Plainview, Minnesota
- ◆ Troy, Ohio
- ◆ Waste Management Inc.

SPECIALTY INDUSTRIES

- ◆ Bechtel
- ◆ Brush Wellman, Inc.
- ◆ Chrysler Corporation
- ◆ Cleveland Electric Illuminating Co.
- ◆ Consolidated Diesel
- ◆ Duke Energy Corp.
- ◆ GE Engine
- ◆ IBM
- ◆ NASA, Huntsville, AL
- ◆ U.S. Department of Energy, Fernald Plant



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