# Mixing & Agitation:

# Pulsed Air Mixing Technology Increases Operating Efficiency & Reduces Maintenance Costs

# Overview

- What is 'Pulsed Air Mixing'?
  - How does Pulsed Air Mixing Technology work?
- Features & Benefits of the Pulsed Air Mixing Process
  - Hardware & Equipment
- Pulsed Air Mixing Application Montage

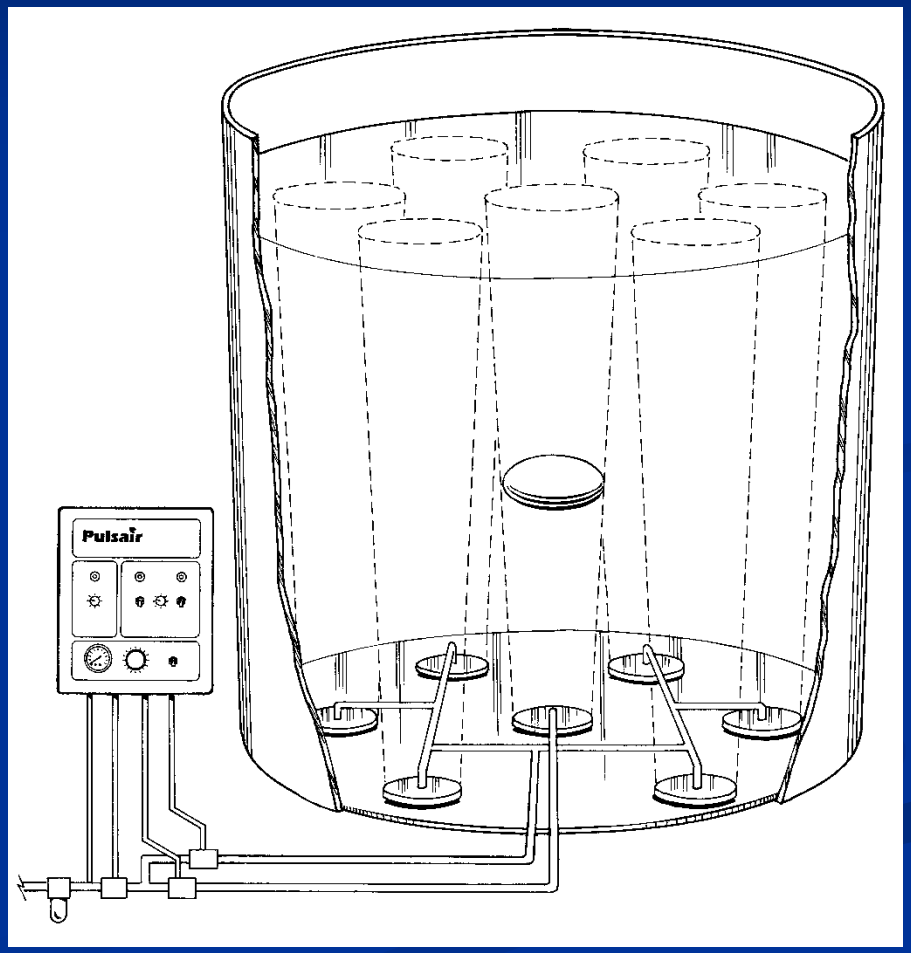
# What is 'Pulsed Air Mixing'? a.k.a 'large bubble mixing'

"Pulsed air mixing" is a *process* developed and patented by Richard E. Parks of Pulsair Systems, Inc.

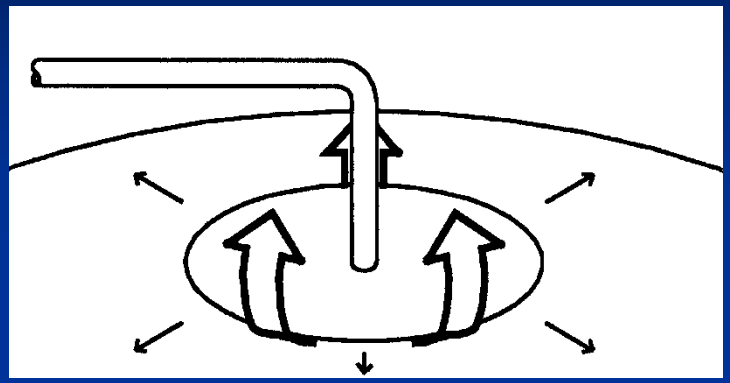
The process is '*the sequential release of compressed air or gas at the bottom of a tank, vessel, basin, etc., for the purpose of creating circulation and mixing*'.

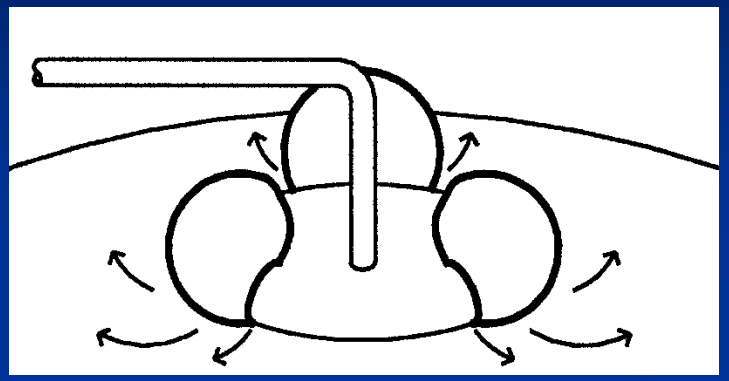
# How does Pulsed Air Mixing Technology work?

Measured amounts of high pressure air/gas are injected ["pulsed"] under flat round discs called accumulator plates installed on the tank bottom.



# "The Bubble" – Part 1

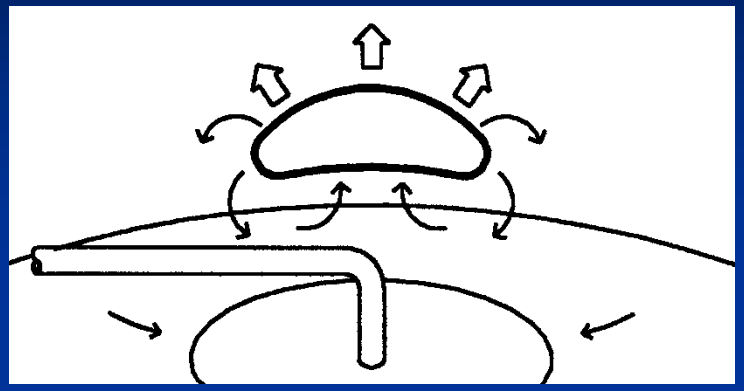


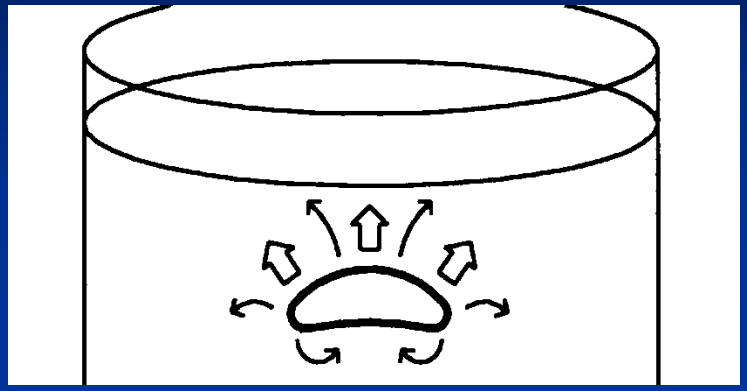


This sudden release of air/gas shocks the liquid, setting the molecules in motion.

As the air/gas "squeezes" out between the plate & tank floor, it sweeps out the heavier liquids & solids.

# "The Bubble" – Part 2

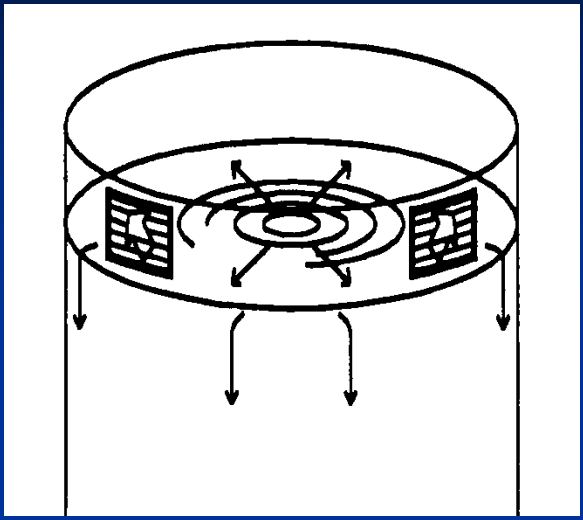


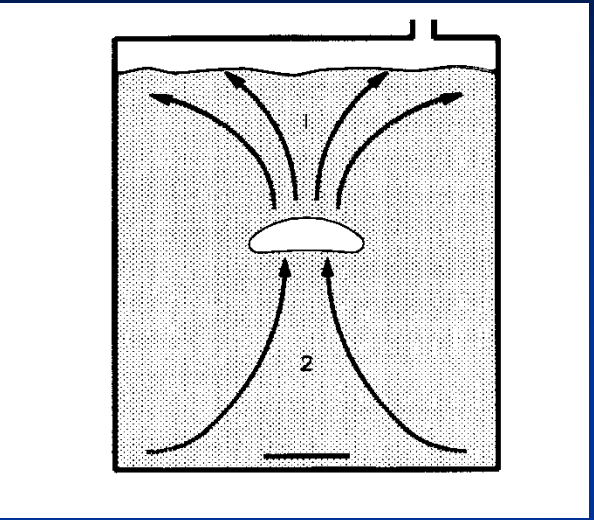


Immediately the air/gas "accumulates" above the plate into a single very large oval shaped bubble.

As the bubble rises to the surface, a vacuum is created that pulls the heavier bottom liquids and solids up with it.

# "The Bubble" – Part 3






As the bubble rises it also pushes the liquid above it up and out toward the tank perimeter.

The liquid moves toward the sides of the tank and travels down the tank wall to the bottom.

# "The Bubble" - Part 4

The process of sequentially releasing the bubbles at timed intervals creates immediate vertical circulation.

By strategically locating the pulse points and accumulator plates on the tank floor, virtually 100% of the tank's contents are involved.

The extremely low surface area/volume ratio and short residence time prevents any meaningful transfer between bubble and liquid, and vice versa.

# Managed Compressed Air

I. **Pulse Rate** – pulse frequency, or number of pulses per minute – set at the controller

II. **Injection Time** – pulse duration, or how long the injection valve is open during the pulse – set at the controller

III. **Injection Pressure** – the pressure in psi of the pulse when it goes into the tank – set at the regulator inside the valve cabinet

# Managed Compressed Air

**Pulse Rate** – relates to 'mixer speed', or the speed of rotation of the liquid; there should never be more than one bubble in the liquid column at a time

For viscous materials, the pulse rate should be slower because the bubble takes longer to rise through the liquid

A faster pulse rate can mix the tank faster, but consumes more air

# Managed Compressed Air

**Injection Time** – relates to pipe length between the injection valve & plate(s), & the number of plates in a manifold

For very long pipe runs or multiple plates in a manifold, the injection time can be increased

In general, the shortest injection time that gets the job done should be used. Longer times consume more air & destroy the integrity of the bubble

# Managed Compressed Air

**Injection Pressure** – relates to the power or energy of each pulse

For heavy slurry materials or high viscosity liquids, use a higher injection pressure

For light materials, a lower injection pressure should be used

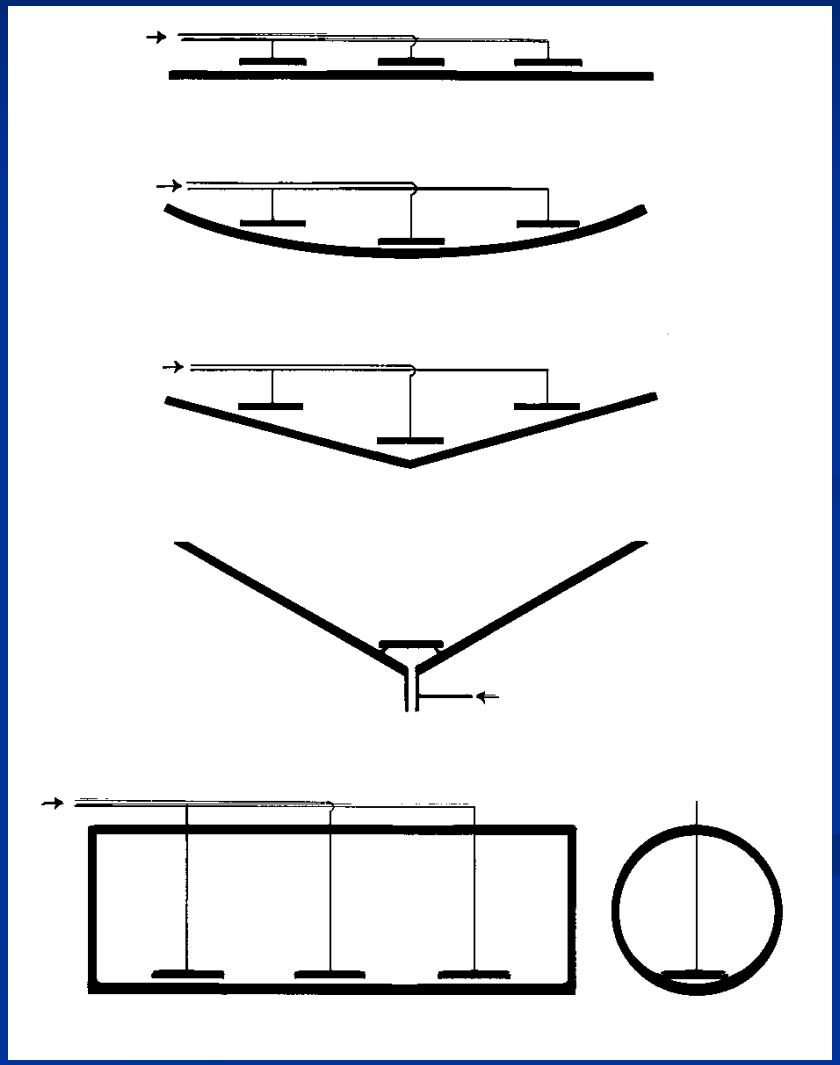
Higher injection pressures consume more air

# What are the features of the Pulsed Air Mixing process?

## Why use it?

# Features of Pulsed Air Mixing

- It is not limited by tank shape, configuration, or size.
- Large diameter tanks, square, rectangular, or horizontal tanks are no problem for the Pulsed Air Mixing process.



# Features of Pulsed Air Mixing

- It can mix a wide range of liquid viscosities, specific gravities, and slurries.
- The photo on the left is tar sludge
- The photo on the right is a high solids slurry

# Features of Pulsed Air Mixing

- It operates without seals, gears, motors, shafts, or impellers.
- It is a "variable speed" mixing system.
- NO moving parts inside the tank or vessel.
- Operates on nitrogen without modification
- It is a "variable horsepower" mixing system.

# Additional Features

- By harnessing gravity, it is a highly efficient mixing system.
- The larger the tank, the higher the efficiency of the Pulsed Air Mixing process.
- Pulsed Air Mixing is very low shear.
- Shear sensitive products, such as complex polymers and food products, can be mixed without fear of degradation.

# What are the benefits of Pulsed Air Mixing?

- Significant process improvement
- Improvements in operating efficiency
- Reduction in maintenance costs

# Process Improvement

- **Faster mixing**
  - 30% - 50% faster than mechanical mixing
  - 75% - 90% faster than conventional air mixing, sparging, or recirculation
- **Better mixing**
  - "Bottom up" mixing pattern is more thorough, involving 100% of the tank's contents
  - Sequential mix pattern provides better uniformity

# Operating Efficiency

- **Uses less compressed air/gas**
  - Typically 40 to 60 times less air/gas than sparging
- **Uses less energy**
  - 25%-75% less energy than mechanical mixing
  - 10HP [5-30 SCFM] can mix a 1 million gallon tank
- **Mixes at any liquid depth**
  - No minimum liquid depth is required as with mechanical mixers

# Continue..

- Able to adjust to a wide range of varying conditions in the same tank, providing more consistent results

- Easy to retrofit into existing tanks & basins – no "I" beams, support bracing, or baffles are required

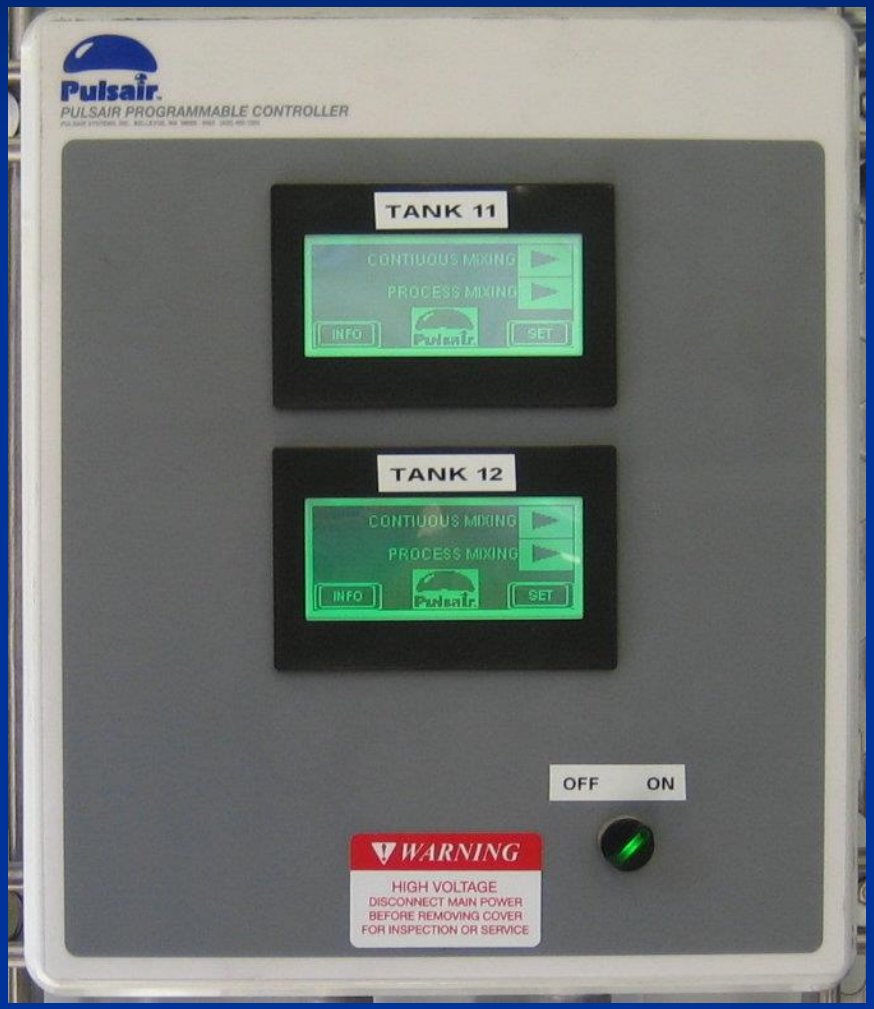
# How does Pulsed Air Mixing reduce maintenance costs?

- **NO moving parts inside the tank or basin**
  - Nothing to wear out or break
  - Only the product moves inside the tank
- **Very little maintenance required**
  - Periodic filter changes and injection valve maintenance
  - All components are OUTSIDE the tank
  - No seals, shafts, gears, or motors to leak or maintain
- **Keeps tank floors & basin bottoms clean**

# Hardware & Equipment
## Typical Components

- Controller
- Electro-pneumatic Interface – EPI
- Filter & regulator
- Injection valves
- Accumulator Plate(s)
- Compressed air/gas source

# Control system
## Example: Pulsair PPC-1000




- Operates on 110VAC & less than 10 watts – output signals are 24VDC
- Operates up to two tanks, but controls an unlimited number of injection valves
- Easy to use touchscreen
- Designed to integrate with existing plant PLCs

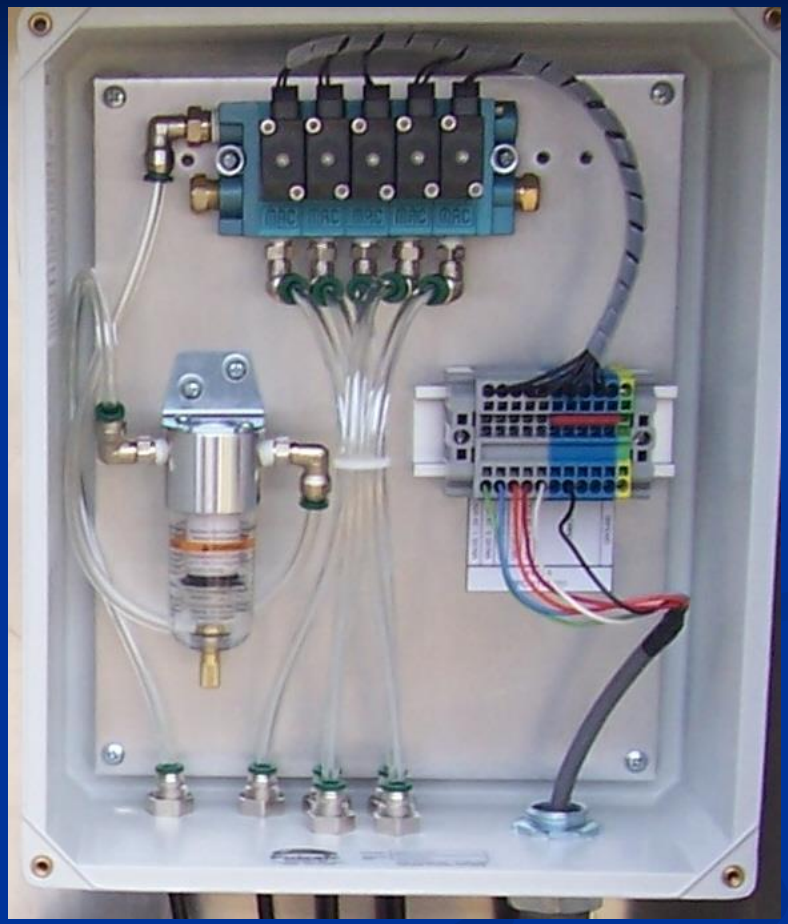
# Control System

## Example: Pulsair PPC-2000 & 3000


- Fully programmable PLC based system
- Designed for multiple tank control & virtually unlimited number of injection valves
- Integrates easily with plant PLCs, DCS, or SCADA systems
- Utilizes GOT [touchscreen] for data entry

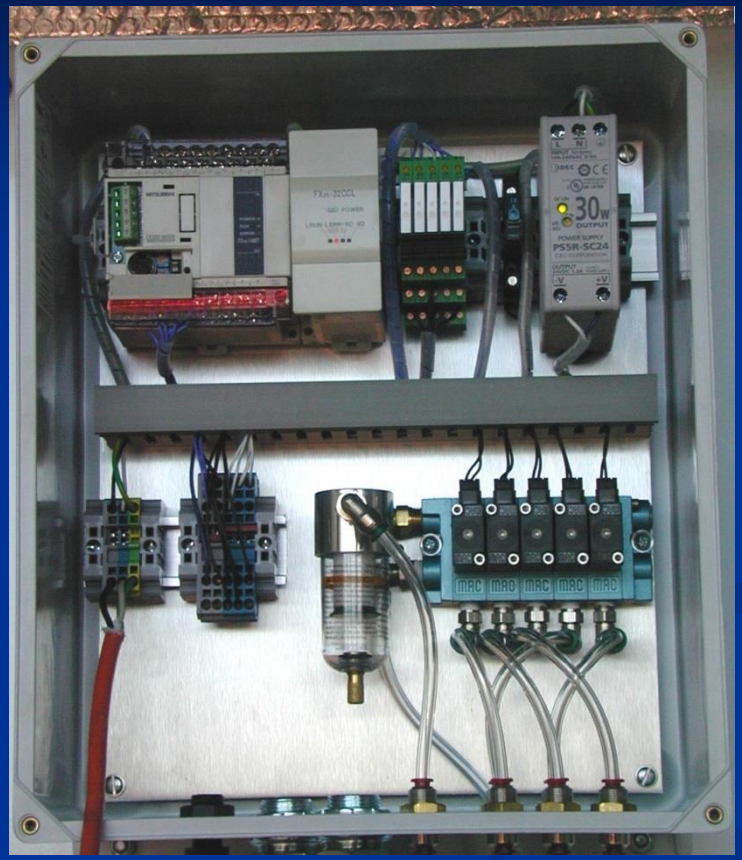

EPI
Injection Valves
Regulator
Filter
Pulsair
SYSTEMS, INC.
WARNING

# Electro-Pneumatic Interface - EPI

The EPI converts electrical signals from the controller to pneumatic signals that operate the injection valves

# CC-Link - EPI


Pulsair EPI with CC-Link network module. Used with multiple tanks/many valves and long distances between valve cabinets.

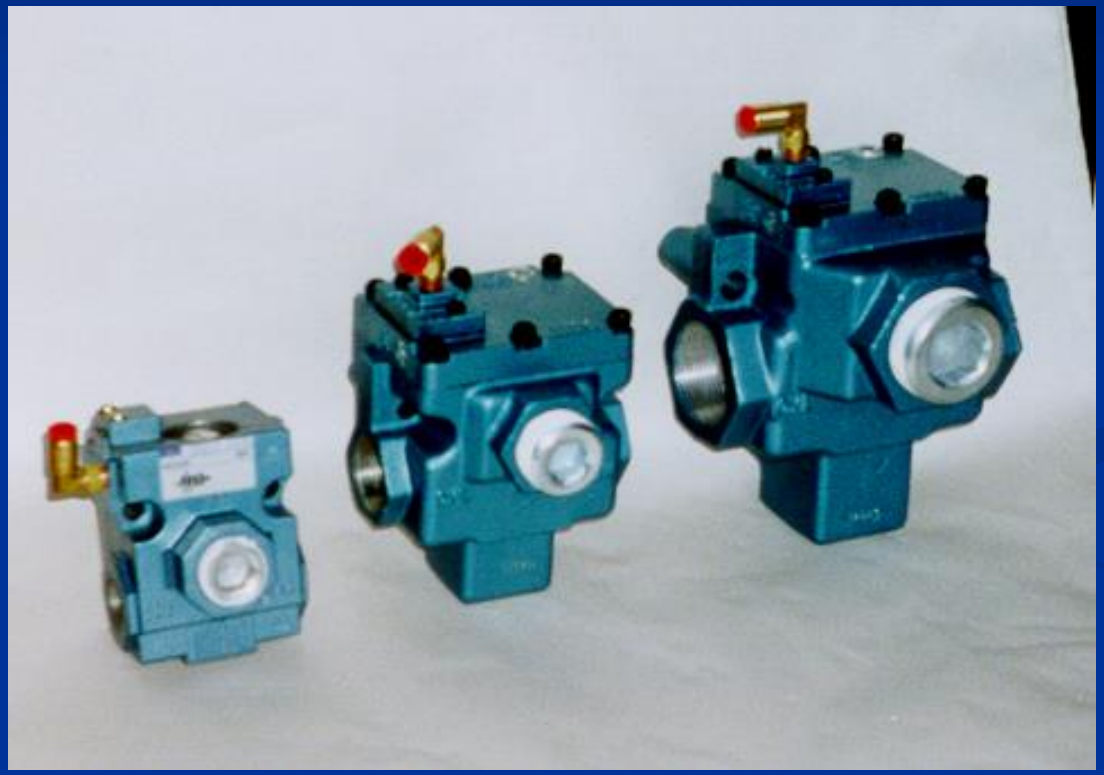
# Filter & Regulator


Large filters & regulators are used to keep up with the high ***momentary*** demand of the injection valves

# Injection Valves

- Injection Valves vary in size depending on the tank size, accumulator plate size, & number of accumulator plates
- MAC 67 series valves have a modular design so they can be easily removed for cleaning & maintenance

# Injection Valves

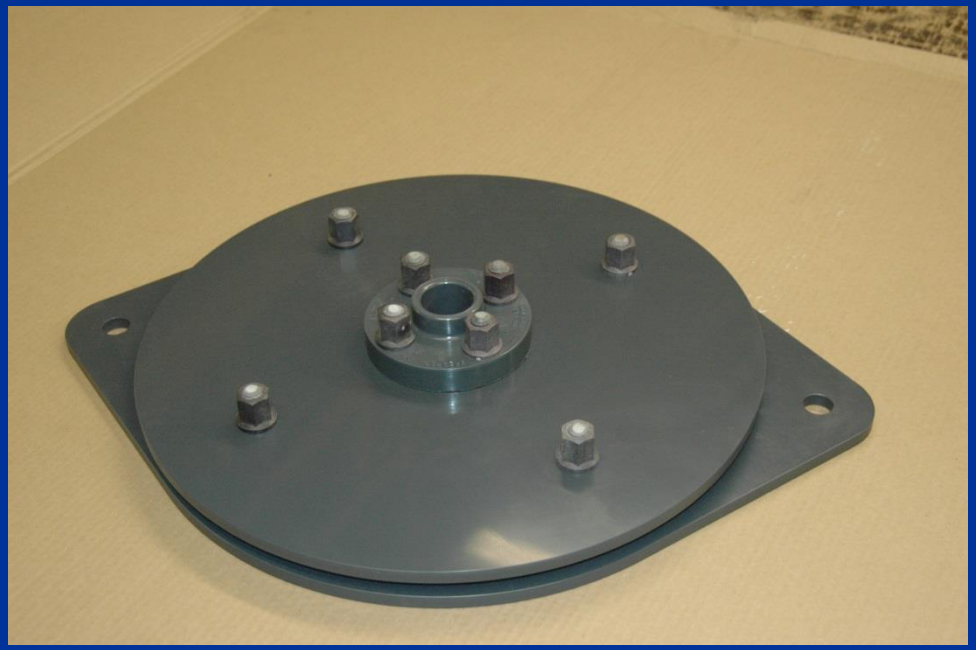


MAC 56, 57, & 58 Series valves are also used for their rugged design, fast response, & long life

# Accumulator Plates

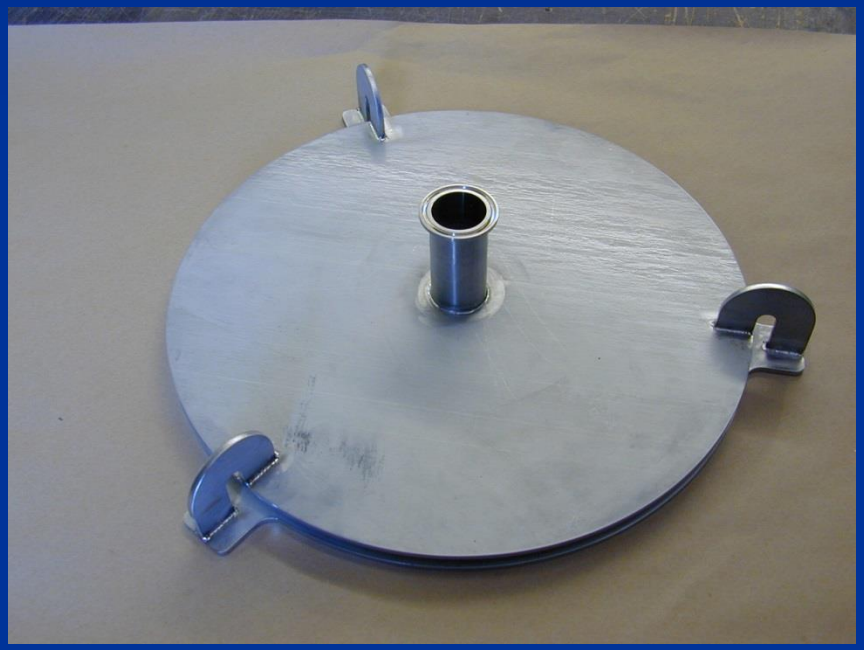
- Plate for flat bottom carbon or stainless steel tanks
- Plates typically are welded to the tank floor

PVC plates are used for corrosive liquids, & for polyethylene or FRP tanks. Plates can be bolted or secured with epoxy.



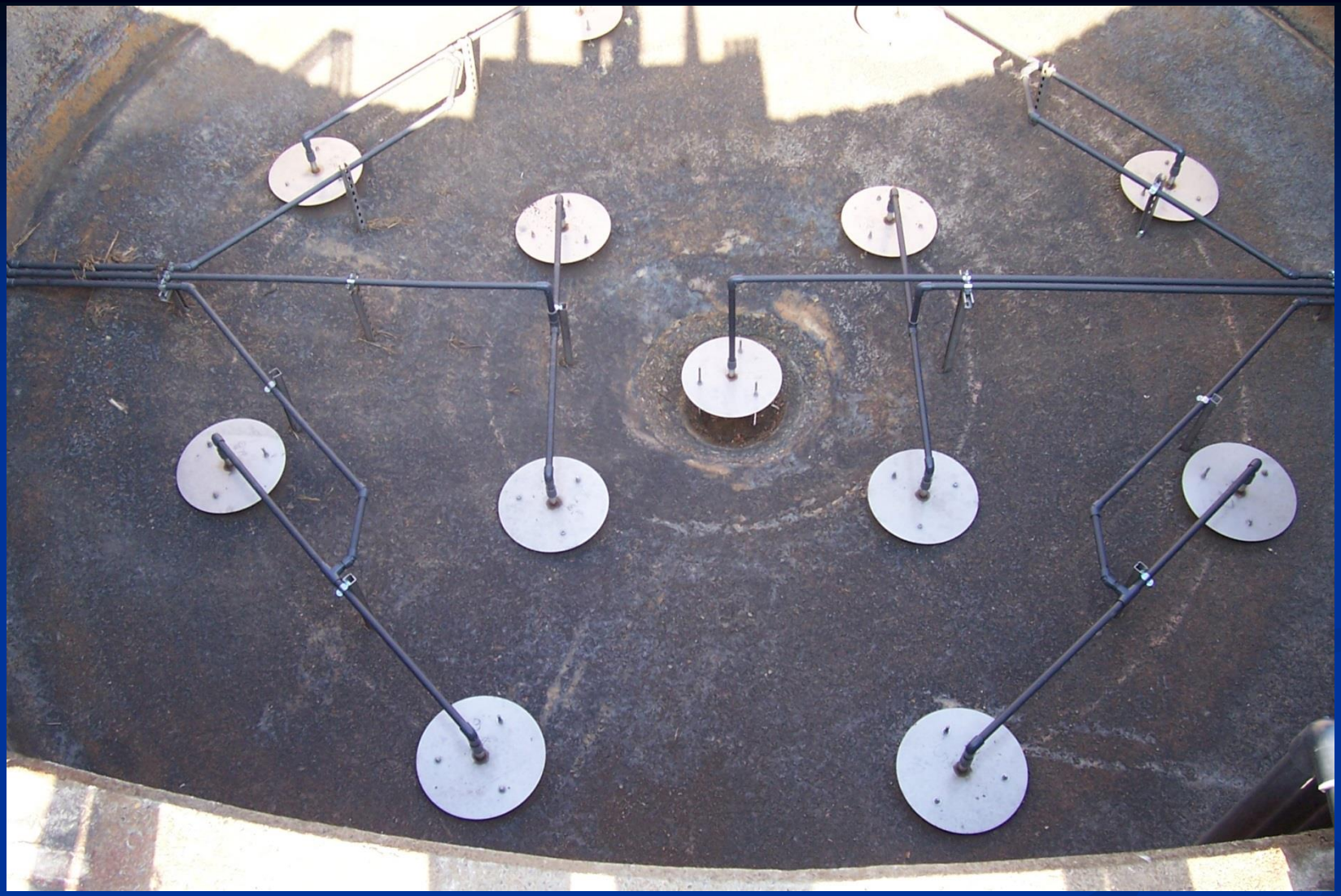
Double 16 inch PVC Accumulator Plate

# Plates designed for sanitary or NSF applications are available

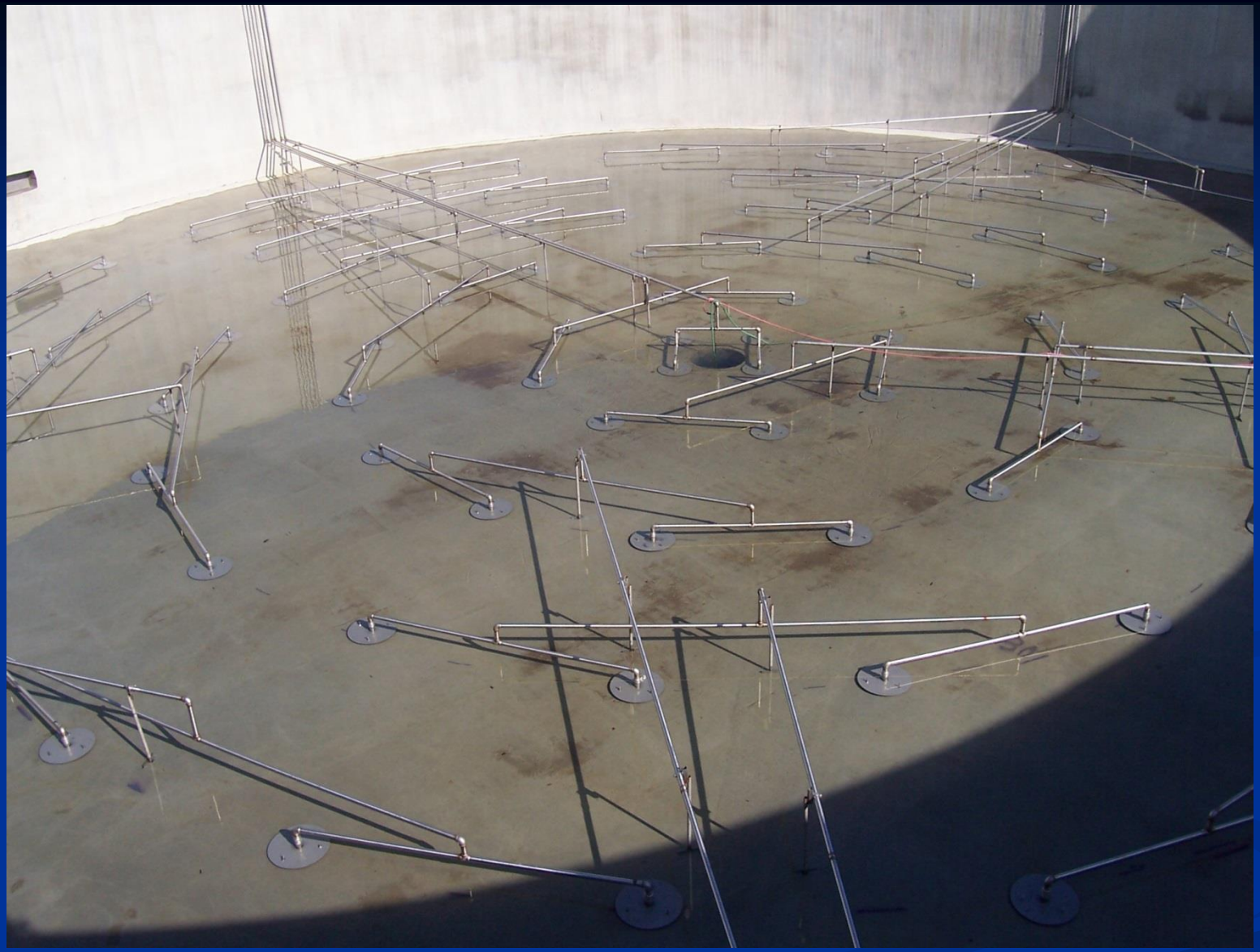


Carbon steel plates & piping on the floor of a 10ft diameter lube blending tank.

Accumulator plates on the floor of a 100ft diameter fuel storage tank



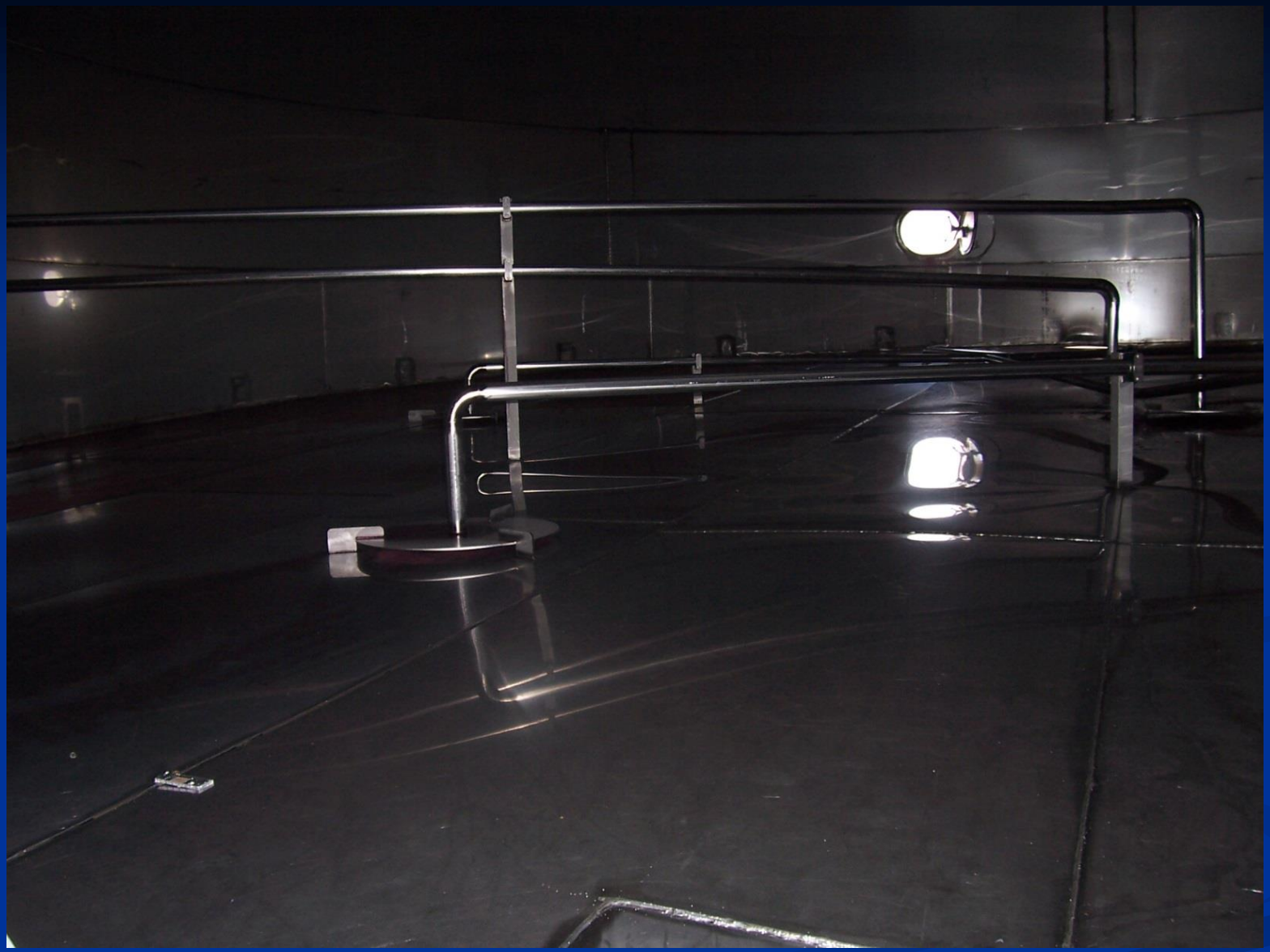
SS plates bolted to the concrete floor of a 28ft diameter sludge tank



SS accumulator plates bolted to the floor of a 125ft diameter sludge tank


PVC “double” plates secured with epoxy to the floor of an FRP tank.

SS “double” plates bolted to the floor of an anoxic zone in an aeration basin



SS plates welded to the floor of a 100,000 gallon wine blend tank

# Valve Enclosure Installation

Hardware enclosures are mounted close to the tank to minimize piping runs & improve performance

On the left, the enclosures are mounted on top of the tank; on the right they are at ground level

SS secondary enclosures mounted above anoxic zones at a municipal WWTP


Controllers can be mounted at almost any location that is convenient for operating the tank or tanks


Pulsair


The controller can be mounted inside the valve enclosure with the F/R & injection valves.

# Compressed Air/Gas Source



# A Word About Compressed Air

- Wet dirty air is the 'enemy' of a Pulsed Air Mixing system. All [Pulsair] systems are equipped with a main airline filter. Engineered systems include a 5-micron particulate filter in the EPI. This is sufficient for many applications.
- However, in areas of high humidity or high moisture, *a dryer should be installed upstream of the Pulsed Air Mixer.*
- Damage to a Pulsair mixer from wet dirty air is NOT covered under the warranty.

# Applications

Pulsed Air Mixing application Montage

# Wastewater Treatment

Industrial

Municipal

# Industrial Wastewater
## Battery Recycling

- Tank is 30ft diameter X 20ft high, 105,000 gallons
- Application is solids suspension & pH equalization of wastewater
- System controller is in a nearby building
- Valve enclosure is adjacent to the tank

# Industrial Wastewater
## Landfill in NJ

- Tank is 14ft diameter X 26ft high, 30,000 gallons
- Application is pH equalization of influent ground water prior to treatment
- System controller is in a nearby building
- Valve enclosure is on top of the tank

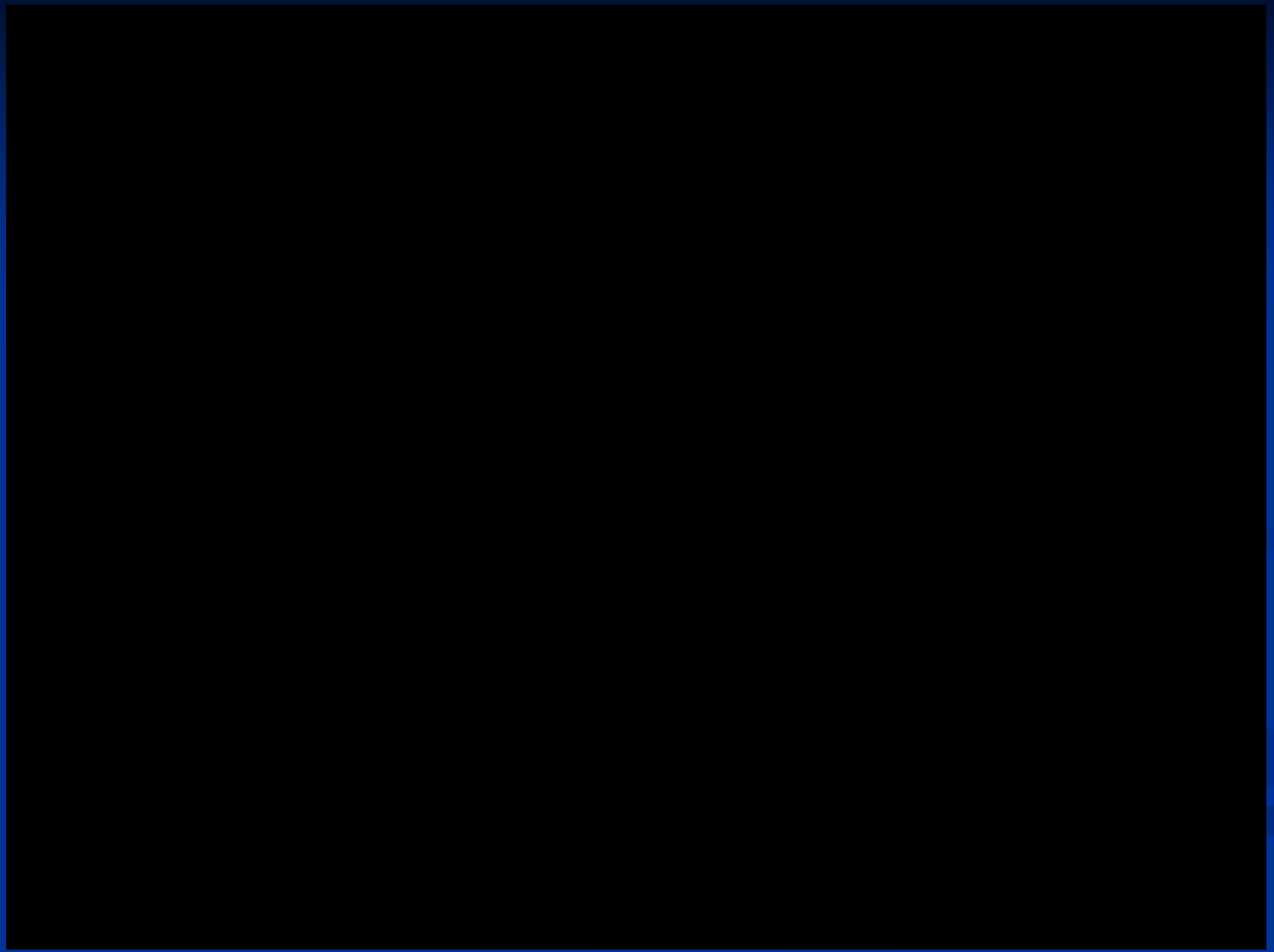
# Industrial Wastewater
## Hides & Tannery Processing Plant

- Application is treatment of primary sludge from hides & tannery processing
- Two adjacent 32ft diameter X 20ft high concrete tanks
- Sludge contains 3” X 3” pieces to fines
- Pulsed Air Mixing replaced an eductor system that left several *feet* of solids on the floor of each tank

# Industrial Wastewater

## Slurry Mixing

- Quarry wastewater
- Three tanks are 15ft diam X 20ft high, slurry is ~50% solids
- Pulsed Air Mixing system replaced a 60HP top entry mechanical mixer in each tank
- The Pulsed system uses ~20HP of compressed air for all three tanks & there is no in-tank maintenance…with better mixing



# Municipal Wastewater
## Sodium Hypochlorite

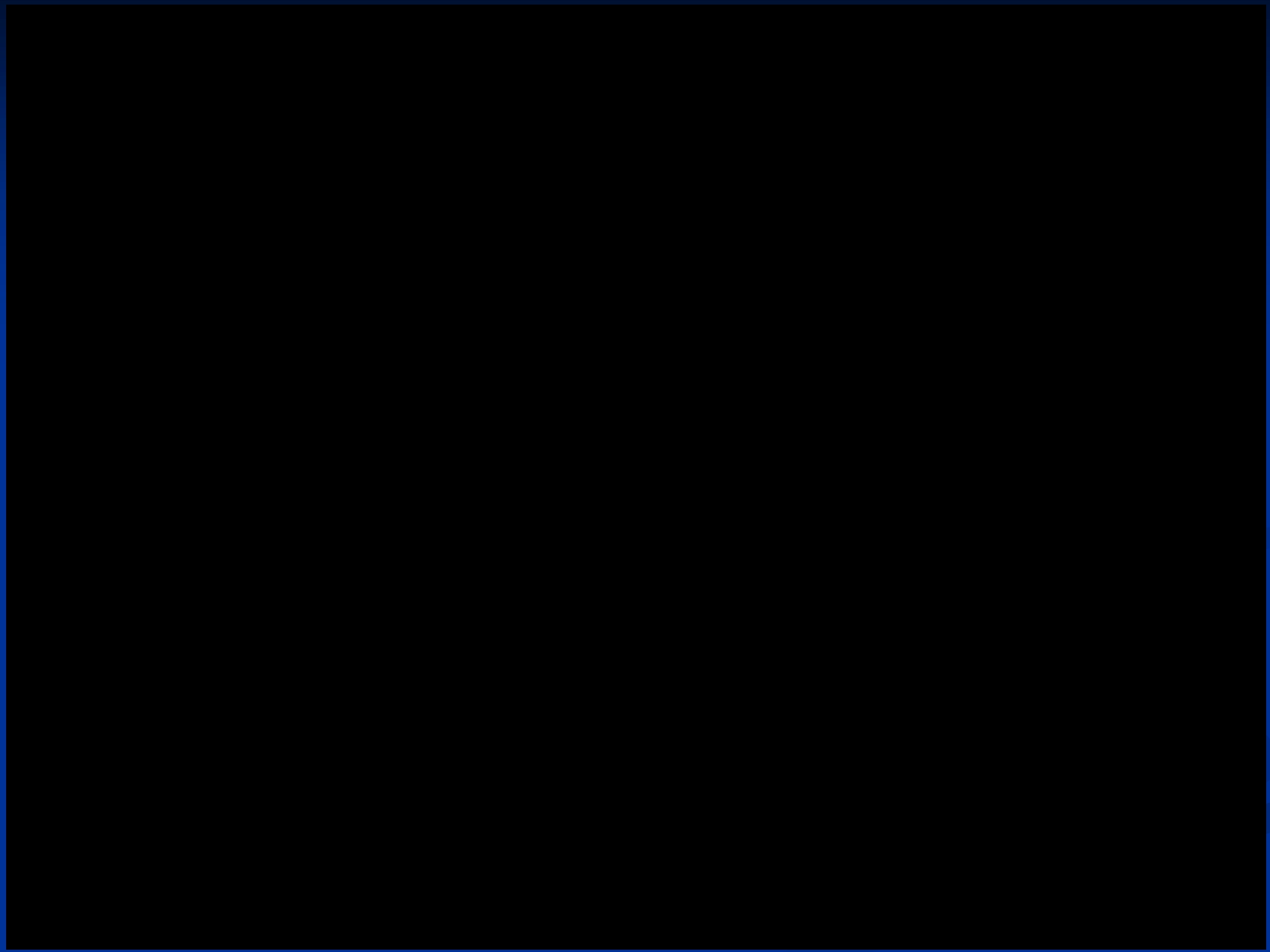
- A city in NC
- Two adjacent FRP hypochlorite tanks
- Pulsed Air mixes the tanks to prevent stratification & crystallization
- Two additional cities in NC also do hypochlorite mixing


# Municipal Wastewater
## Activated Sludge

- A city in NC
- Two 42ft diameter concrete sludge tanks
- Sludge contains 3.5% solids
- Results:  lower odor, lower chemical/polymer use, lower energy costs, & better, more consistent mixing compared to mechanical mixers

# Municipal Wastewater
## Sludge Mixing

Two adjacent municipal sludge tanks



# Municipal Wastewater
## Anoxic Zone Mixing


- Two identical circular aeration basins with 4 mixing zones [3 anoxic] in each, plus a wet well
- One 40HP compressor provides air for all nine mixing areas


Pulsed Air system for mixing a lift station

# Potable Water
# Pulsed Air Features & Benefits

# Features of Pulsed Air Mixing


Pulsair components for Potable Water meet NSF/ANSI 61 requirements & are NSF Certified

# Features of Pulsed Air Mixing

Pulsed Air mixers are not limited by tank shape, configuration, or size.

Pulsed Air can mix large ground reservoir tanks, standpipes, elevated pedestal, and hydrospheres.

# What are the benefits of Pulsed Air Mixing for Potable Water Tanks?

- **Pulsed Air is the fastest potable water mixing system in the world**
  - Mixes multi-million gallon tanks in minutes, not days
  - Can quickly respond to unforeseen events that require immediate mixing
- **Mixes 100% of the tank's contents without deadzones**
  - Mixes water that is out of reach of discharge pumps – e.g. at the very bottom of the tank
  - Eliminates the need for deep cycling

# What are the benefits of Pulsed Air Mixing for Potable Water Tanks?

- **Eliminates Thermal Stratification**
  - Vertical flow pattern breaks up stagnant layers
  - Colder water is pulled up from the bottom & into the tank, achieving uniform water temperature
- **Helps prevent the formation of THMs & other BDPs**
  - Thermal stratification & thermoclines are eliminated, reducing the formation of THMs
  - Disinfection chemicals are uniformly maintained throughout the tank & the need for disinfection boosting is reduced

# What are the benefits of Pulsed Air Mixing for Potable Water Tanks?

- **Prevents ice formation**
  - The vertical circulation & increased agitation at the water surface greatly reduces the formation of ice or freezing in tank
- **Zero in tank maintenance**
- **Efficient intermittent mixing reduces energy consumption**

# Questions & Answers – Open Discussion

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