• Located in Brown Deer, WI
• Started in 1967
• Acquired ABJ (SBR manufacturer) in 1995
• Purchased in 1999 by ITT Corp
• 2011 spun off to be Xylem
• Approximately 60 employees
• Leader in diffused aeration and SBR technology
Sanitaire Aeration Experience

- Over 20,000,000 fine bubble diffuser units installed in thousands of treatment plants throughout the world.
  - Small Systems: < 10 diffusers
  - Average Systems: 1,000 – 10,000 diffusers
  - Large Systems: 25,000 – 50,000 diffusers
  - Huge Systems: > 100,000 diffusers

- Over 1,000,000 coarse bubble diffuser units installed in thousands of treatment plants throughout the world.

Over 150 Billion Gallons of Wastewater Treated per Day
Aeration System Design
Aeration 100 – Foundation Class

- Reasons to Aerate
  - Deliver oxygen to support and encourage biological process and discourage foul odors
    - Oxygen typically governs in Aeration Basins due to the higher oxygen demand
  - Provide mixing to keep particles in suspension
    - Mixing typically governs in Aerobic Digesters
Aeration accounts for 25-60% of the total energy consumption of a wastewater treatment plant.

Large savings can be gained with an energy efficient aeration system.
Aeration in Wastewater Treatment

1. EQ Basin
2. Channel Aeration
3. Biological Treatment (Aeration Basins)
4. Post Aeration
5. Aerobic Digester
6. Storage of Digested Sludge (Sludge Holding)
Types of Aeration Systems

Mechanical Aeration
- Low Efficiency
- High Maintenance

Jet Aeration
- Moderate Efficiency
- Moderate Maintenance

Coarse Bubble Diffused Aeration
- Low Efficiency
- Low Maintenance

Fine Bubble Diffused Aeration
- High Efficiency
- Moderate Maintenance
Measuring Aeration Energy Efficiency

Standard Aeration Efficiency (SAE) = \frac{\text{Amount of oxygen transferred}}{\text{Amount of energy added}}
Diffused Aeration Systems

Coarse Bubble Aeration

Fine Bubble Aeration
Diffused Aeration in Operation

Coarse Bubble Aeration

Fine Bubble Aeration
Diffuser Types

- Fine Bubble Aeration
  - Membrane Disc
  - Ceramic Disc
  - Membrane Panel
  - Membrane Tube
  - Ceramic Dome

- Coarse Bubble Aeration
  - Wide Band
  - Single Drop
  - Other
Coarse Bubble Aeration

Stainless Steel Fixed Header (SSFH)
- Made from 304L / 316L SS
- Low Maintenance

Applications:
- Small Aeration Basins, SBRs
- Digesters
- Aerated Channels
- Equalization / Post Air
- Industrial
- Chicken Feeder
Coarse Bubble Aeration Header
Coarse Bubble Aeration

Spiral Roll Configuration
Coarse Bubble Aeration Pattern
Coarse Bubble Aeration

Example of Coarse Bubble Diffuser Configurations

- Spiral Roll
- Mid-width
- Dual Side-Spiral
- Dual Mid-Spiral
Aeration Layout Efficiency

- Efficiency increases as the distance between diffusers decreases and the more uniform the diffusers are laid out.
- This is expressed as either $A_t/A_d$ (fine bubble) or bandwidth (coarse bubble).

Options:

a) Side Roll
b) Mid Roll
c) Dual Mid Roll
d) Full Floor Coverage
What makes Full-Floor-Coverage, Fine Bubble Aeration so efficient?

**Wide Band Configuration**
- Water circulation cells are large
- Induces high water velocity and pumping effect
- Shortens bubble detention time

**Full Floor Coverage**
- Water circulation cells are small
- Reduced water velocity and pumping effect
- Bubble detention time maximized
Aeration Device Efficiency

- **Mechanical Aeration**
  - Efficiency: 2.0 – 3.5 lbs O₂ / BHP-hr

- **Coarse Bubble Aeration / Jet Aeration**
  - Efficiency: 3.0 – 4.0 lbs O₂ / BHP-hr

- **Fine Bubble Aeration**
  - Efficiency: 7.0 – 10.0 lbs O₂ / BHP-hr

*Increasing SAE*
The COST of an inefficient aeration system

• For a 2.0 MGD facility the added annual energy cost for 25% lower aeration efficiency is $15,000 - $20,000 per year.*
  • Does not take into account the added energy cost of mixing during aeration.

*Comparison based on full floor coverage at 8 lb O₂/BHP-hr vs. peripheral aeration at 6 lb O₂/BHP-hr
Estimated energy cost of $0.075/kWh
Fine Bubble Aeration

Full Floor Coverage
• Provides Highest Oxygen Transfer Efficiency
• Increased Surface Area of Small Bubbles
• Effective, Low-Energy Mixing

Applications
• Aeration Basins (Reactors)
• SBR’s, Oxidation Ditches
• Aerobic Digesters, Sludge Holding Tanks
• Removable Aeration
• Swing Zones
• Post Aeration
Fine Bubble Aeration Grid Systems
Aeration in Operation
**Fine Bubble Disc Diffuser Types**

**Ceramic**
- Aluminum oxide
- Lower operating pressure
- Lower operating cost
- Higher capital costs
- Continuous air supply required
- Material unaffected by WW
- Clog/foul potential
- Can be cleaned in-situ

**Membrane**
- EPDM or other materials
- Higher pressure
- Higher operating costs
- Lower capital cost
- On/off air supply OK
- WW may affect; finite life
- Clogging less likely, fouling possible
- In-situ maintenance less effective
Aeration System Maintenance

Coarse Bubble (Minimal)
• Blower

Fine Bubble (Moderate)
• Blower
• Diffuser Cleaning (~2-5 years)
• Membrane Diffuser Change Out (~8-12 years)

Jet Aeration (Moderate)
• Blower
• Motive Pump
• Nozzles

Mechanical (Moderate to High)
• Motor
• Gear Box
Estimating the Process Oxygen Demand & Air Requirement

Loading → AOR → SOR → Air

mg/l, MGD  →  lb O₂/day  →  lb O₂/day  →  scfm
Actual Oxygen Requirement (AOR – lbs/day)
What Is AOR?

In general terms:

- Oxygen required to sustain biological activity ("What the bugs need")
- Also termed "in waste" or "field" conditions
- Factors
  - Tank dimensions (volumes)
  - Flows (including side streams)
  - Loadings (BOD, COD and NH₃-N)
  - Available air rate/pressure
  - Required Dissolved Oxygen (D.O.) concentration
  - Wastewater temperature
Basic AOR Formula

AOR = (y) BOD$_5$ + (z) NH$_3$-N

lbs O$_2$/day = (lb O$_2$/lb BOD) x (lb BOD/day) + (lb O$_2$/lb NH$_3$) x (lb NH$_3$/day)

• ‘y’ is the oxygen required for BOD Oxidation
  • Varies between 0.8 – 1.5 lbs O$_2$ / lb BOD
    • Depends on process type and operation
    • 1.0 – 1.2 lbs O$_2$ / lb BOD is typical

• ‘z’ is the oxygen required for NH$_3$ Oxidation (nitrification)
  • Is assumed to be a constant 4.6 lbs O$_2$ / lb NH$_3$
Standard Oxygen Requirement (SOR – lbs/day)
Why Determine SOR?

- Data generated in clean water testing
- Corrected to standard conditions (20°C, 1 atm, 36% RH)
- Estimating dirty water performance difficult
- Clean water performance can be guaranteed
- Eliminates number manipulation
- Allows for equal comparison between devices or manufacturers (level playing field)
The Formula
(AOR/SOR Ratio)

\[
\frac{AOR}{SOR} = \alpha \theta^{(T-20)} \left[ \beta C_{sat20}^* \left( \frac{P_{site}}{P_{std}} \right) \left( \frac{C_{surfT}}{9.07} \right) - D.O. \right]
\]

- **Alpha (Mass Transfer Coefficient)**
  - Varies by bubble size, location in tank, flows
  - Typically 0.5-0.8

- **Beta (Saturation Factor, ~0.98)**

- **Theta (Temperature Correction Factor, ~1.024)**

- **D.O. (Dissolved Oxygen Requirement, ~2.0 mg/L)**
- **Temperature (°C)**
- **Pressure / Elevation**
- **Saturation (mg O₂/L)**
Air Requirement (scfm)
Standard Oxygen Transfer Efficiency (SOTE, %)

- Based on Test Data
- Typically 0.5 – 2.5% SOTE per ft
- SOTE is dependent on:
  - Submergence
  - Diffuser Layout
  - Aeration Device
  - Amount of Air
The Triangle of Aeration

Once an oxygen requirement (SOR, lbs/day) and efficiency (SOTE, %) have been determined an air rate (scfm) can be calculated using the following formula:

\[
\text{Air Rate} = \frac{\text{SOR}}{(\text{SOTE})(25.056)}
\]

Unit Conversion Factor

\[
25.056 = 0.075 \times 0.232 \times 1440
\]

0.075 = approx density of air, lb/ft\(^3\)

0.232 = weight percent of oxygen in air

1440 = minutes per day
Oxygen Transfer Testing
Clean Water Oxygen Transfer Testing

- Conducted per ASCE standards
- Method of verifying specified SOTE performance for a given configurations
- Uses same diffuser density, SWD, submergence, and diffuser air rate as full scale installation
- De-oxygenate water with sodium sulfite then aerate and measure rate of D.O. rise
Mixing Air
(scfm / ft² or scfm / kcf)
Mixing Limited Air Rate

- Mixing Air Rate is defined as the amount of air required to adequately mix the tank
- Values typically found in literature

**Fine Bubble Mixing**
- Aeration Basin – 0.12 scfm/ft²
- Digester – 0.25 scfm/ft² (<1.5%) or 30 scfm/kcf (>1.5%)

**Coarse Bubble Mixing**
- Aeration Basin – 20 scfm/kcf
- Digester – 30 scfm/kcf
Conclusion

• Aeration is used to deliver oxygen and mix the content of the tanks
• Fine bubble full floor coverage is the most efficient at transferring oxygen
• Experience and layout affect aeration system performance
Questions