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Activated Sludge Aeration

CSWEA – Quick Talks
Elgin. IL

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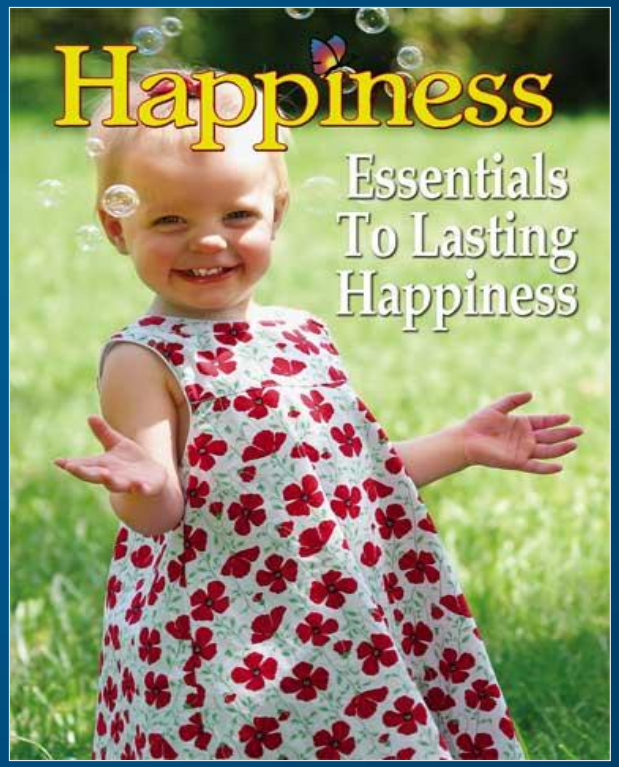
References / Acknowledgements/Disclaimers

Engineers, Operators and Equipment Manufacturers throughout my 25 year Career at an estimated 500 Plant Locations (TNTC)

Although I have no one else to blame but me for this talk!

20 Mins Not Enough Time for this Topic



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Goal

- Practical Look at Diffused Air Systems for Activated Sludge from an Operational Perspective.

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Function of Aeration

- Primary= Supply's Oxygen to the Bacteria
  - BOD Removal (~1.0-1.1 lbs O2/ lb BOD Required)
  - Nitrification (~4.6 lbs O2/lb NH4 Required Portion of TKN may need to be included)
- Secondary = Provides Mixing of Suspended Solids
  - Depends on Tank Geometry

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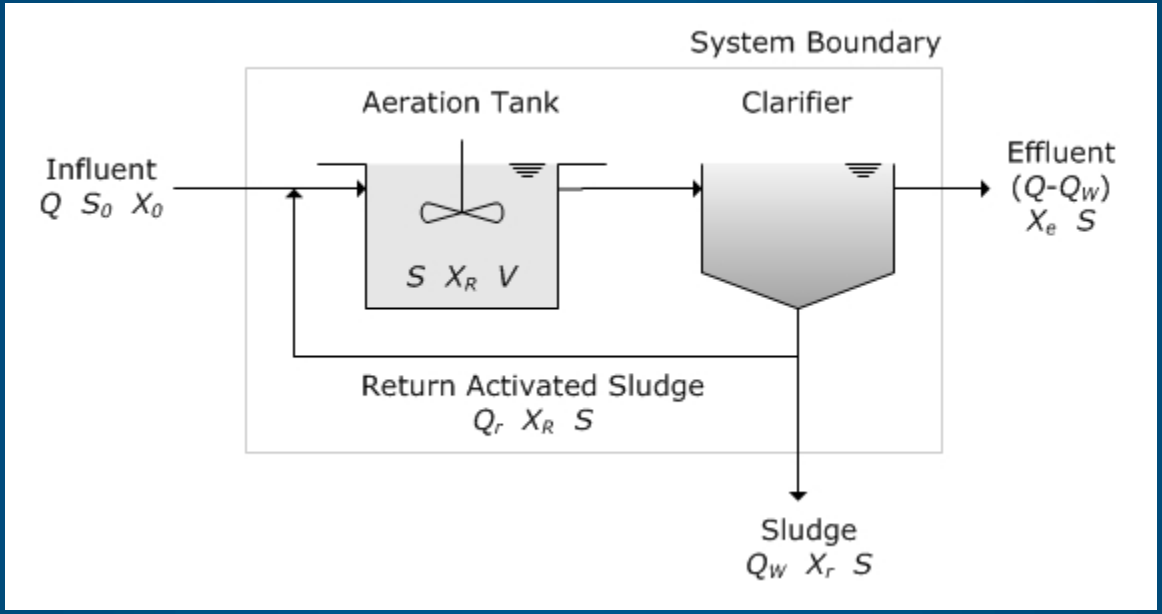
Activated Sludge

An Engineers View of Activated Sludge



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Activated Sludge

- An Operators View of Activated Sludge

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What Effects Air Need

- Tank Geometry and Depth
  - Mixing
- Process Loadings
  - DO
- Temperature (Winter/Summer)
  - Cold Water Holds More O2
- Wastewater Characteristic
  - MLSS
  - Salt, Particulates, Surfactants

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Methods of Aeration

- Diffused Air
  - Porous Diffusers= Ceramic, Membrane, Disc, tube
  - Non-Porous Diffusers= Fixed Orifice, Sparger, Coarse bubble
- Mechanical Air
  - Radial Flow- Low Speed (20-60rpm)
  - Axial Flow-High Speed (300-1200rpm)
- Others
  - Horizontal Rotor
  - Submerged Turbine

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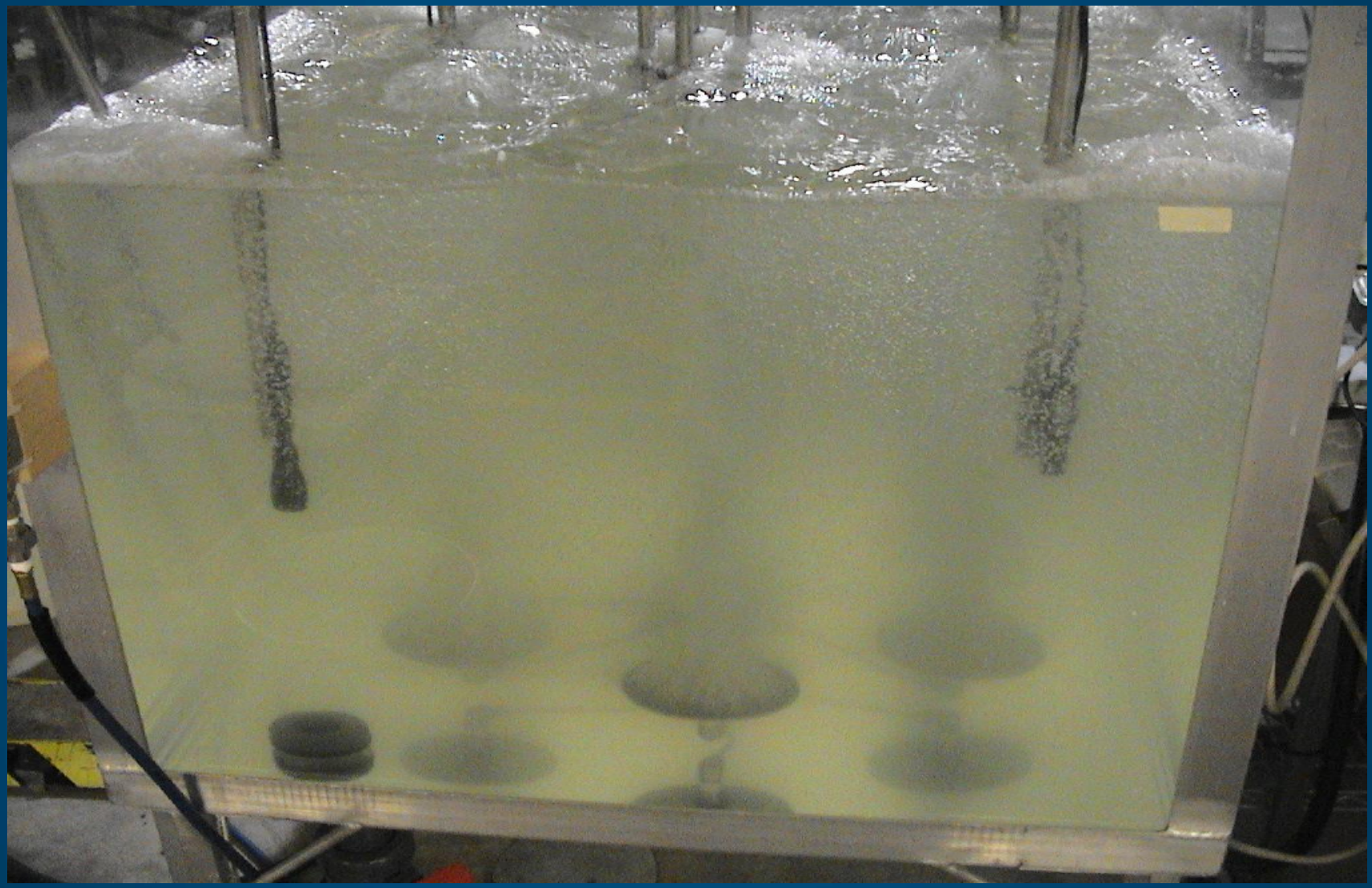
Our Focus Today Diffused Air



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Lets Think

- We're blowing bubbles
- The bubbles are Nitrogen 80% and 20% Oxygen
- The size of the bubble dictates its exposed surface area to the water
- The depth of the tank dictates the time it stays under water
- The ability of the bacteria as Oxygen Uptake Rate actually use the oxygen

- Optimizing Aeration has a direct impact on your bottom line costs $$$$$$$$$$$$$$$$ Air=Money ~40% of Power

Jims Practical Guide (Diffused Air)

- Air Does Three Things……..
  - 1) Needed Dissolved Oxygen for Bacteria
    - Deliver the Right Amount (Lbs of Air)
  - 2) Mixing (Know Your Tank)
    - Full Floor Coverage
    - Spiral Roll
  - 3) Ensures Diffusers Stay Clean and Do not Clog (Know your Diffuser= Coarse, Fine, Disk, Tube, Ceramic, Rubber etc.)

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Operators are Dealt a Hand

- By the Time the Operator gets there the Engineer has pretty much Dealt them a Hand!
  - Blower Capacity
  - Type and Number of Diffusers
  - Tank Depth and Geometry
- What Can the Operator Do? Answer = a lot!
  - Determine How Many Tanks Go On Line
  - Determine How Much Air is Delivered
  - Determine How Air is Distributed or Cycled
  - Determine if Diffusers need to be Changed, Capped or Added

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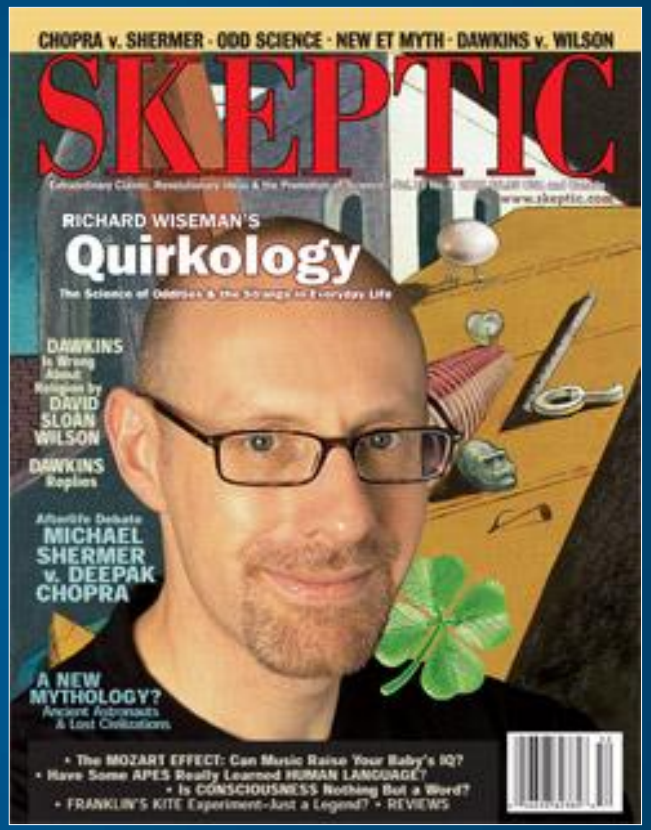
No 1 – Deliver the Right Amount of Air

- I can deliver 20 % Oxygen Transfer with Fine Bubble and cut your Aeration Rate in Half!
- I have a Bridge and Some Swamp Land I want to sell



Everyone Has a Little Skeptic in Them!

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Transfer Issues

- What will the Mixed Liquor Suspended Solids (MLSS) Be? Is it Limiting?
- What is the Tank Depth? 12, 15, 22, 28, 30 ft? If I have a Deep Tank do I need Fine Bubble?
- Other Plant Specific Issues?
  - Story Mamaroneck and 2000 SCFM to 1 of 6 tanks as blow off in a tank with City Water to Prevent Blower Surge.
  - Story Fine Bubble in a 28-30 ft Deep Tank.
    - Fine 2%/ ft of Submergence up to max 30%
    - Coarse 1 %/ft of submergence up to max 30%

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Simple Transfer Efficiency

Ever Wonder about what your Transfer Efficiency is?

- Step 1
  - Calculate the Lbs of O2 consumed by your Bacteria
  - Lbs of BOD Removed and Ammonia Nitrified
  - Flow (MGD) X 8.34 X (BOD in – BOD out)mg/L + Flow (MGD) X 4.6 (NH4in –NH4out)mg/L

Example:

1MGD X 8.34 X (200 -10)mg/L + 1 MGD X 8.34 X4.6 (20-0.5)mg/L

= 1,585 lbs + 748 lbs = 2,333 lbs O2

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Simple Transfer Efficiency

- Step 2
  - Calculate the Lbs of O2 you deliver
  - SCFM X 1440(Min/day) X .075(LB/FT3)X 20%= lbs O2

  Example: (Assume 1000 SCFM delivered)

  1000 SCFM X 1440 X .075 X 20%= 21,600 lbs O2

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Simple Transfer

- Step 3
  - Calculate % Transfer Efficiency
  - Step 1 (O2 Consumed) divided by Step 2 (O2 Delivered)

Example:

(2,333lbs O2) /(21,600lbs O2) = 10.8% Efficiency

Sounds Good, But Is this real?

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Transfer Issues

- Who Thinks they are getting 10.8 % efficiency?
  Actual Efficiency is an unknown most of the time:
  - Delivering 1500 SCFM means 7.2 %
  - Delivering 2000 SCFM means 5.4%

Real World Impacts:

- Alpha (Correction Factor for MLSS)
  - = $\frac{\text{Transfer Efficiency Field}}{\text{Transfer Efficiency Clean Water}}$

The Higher The Mixed Liquor the Lower the Alpha Lets Look……

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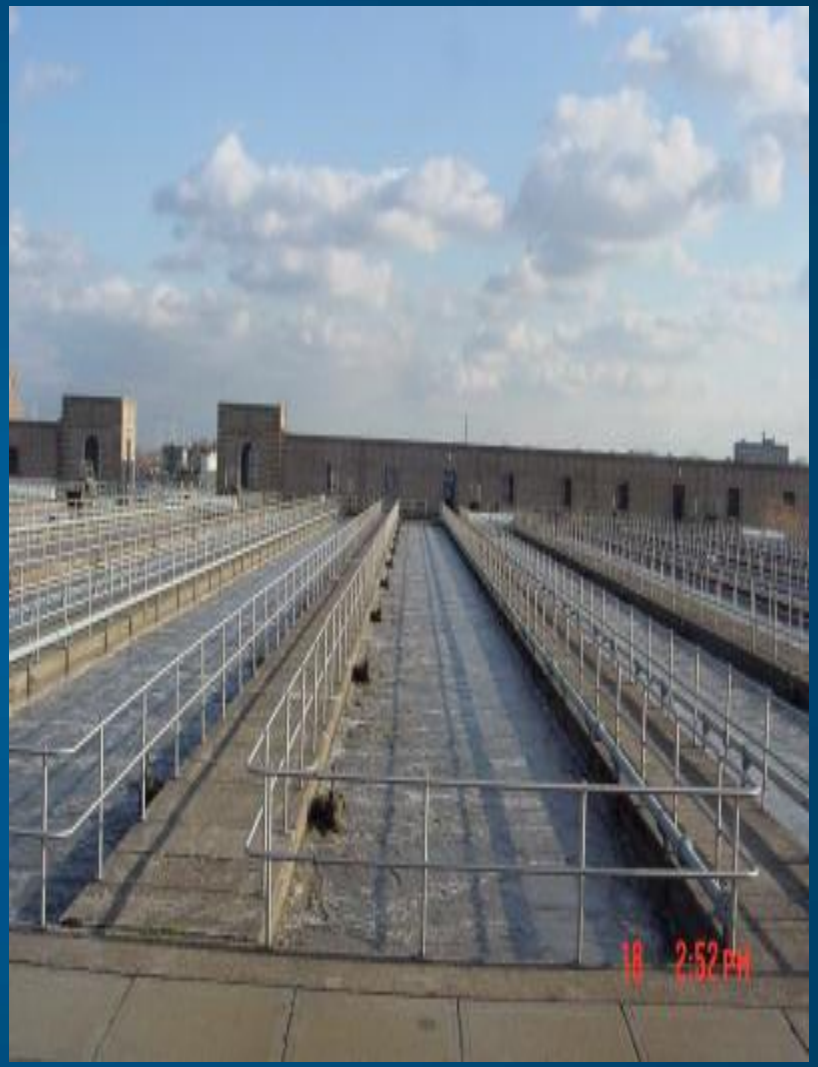
Alpha Factor

- Alpha Varies exponentially with MLSS Concentration
- 0 mg/L = 1.0 2500 mg/L =.95 5000 mg/L = .70 10,000 = .40

Air for Mixing

- Old Spiral Roll Tanks
  - Coarse Diffusers One Side
  - Y – Wall Construction used to develop roll action



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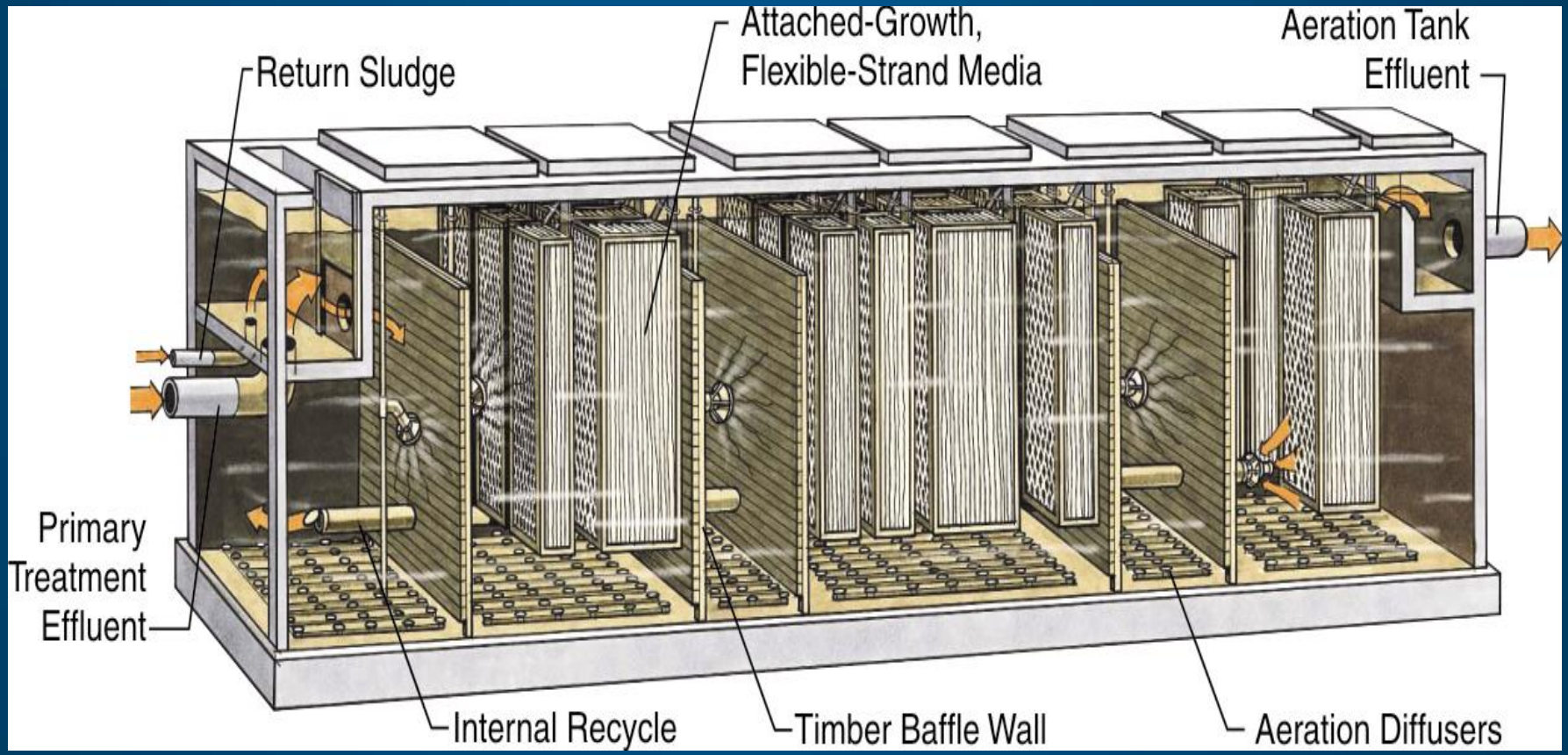
Air for Mixing

Full Floor Coverage



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Air for Mixing

- Spiral Roll (16-30) SCFM / 1000 Ft3 of Tank
  - OLD SCHOOL
- Full Floor Coverage 0.12 SCFM / FT2 of Tank
  - NEW SCHOOL (Minimum 5% of Area Diffuser Material)
- Example: 1 MGD Tank = 133.6 (1000 Ft3)
  - Compare Min
    - Spiral
      - 16 X 133.6 = 2,138 SCFM
    - Full Floor Assume Tank Depth 15 FT
      - Therefore Area = 8,900 Ft2
      - 8900 X 0.12 SCFM = 1,068 SCFM

Air for Diffusers

- Keep Diffuser from Plugging
  - Ceramic Disks 0.4 – 3.4 SCFM (Practice 1-2 SCFM)
  - Rubber Membranes (EPDM) – Reported as Less Sensitive to Clogging.
    - Used in Swing Zones to start and stop aeration

Example 1MGD Tank 15 ft Depth = 8,900 FT 2

- %5 Floor Coverage = 445 FT2
- 1- 9 inch Ceramic Diffuser = .44 ft2
- 445/.42 = 1,059 Diffusers
- 1-2 SCFM for Keeping Diffusers Clear = 1,059 – 2,118 SCFM

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Review

- Diffused Air
  - Load BOD, NH4
  - Tank Mixing
  - Diffuser Clogging (Ceramic)

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1 MGD Tank Examples

- Load = 1000 SCFM @ 10.8%
  = 1500 SCFM @ 7.2 %
  = 2000 SCFM @ 5.4%

- Mixing
  - Spiral = 2,138 SCFM
  - Full Floor = 1,068 SCFM

- Diffuser Clog
  - Ceramic (1-2 SCFM) 1,059 – 2,118 SCFM
  - EPDM Membrane 0 SCFM

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Last Points

- Dissolved Oxygen Measurements and Profiling
  - Process Need Dictates DO Need
    - CBOD 1-3 mg/L
    - Nitrification > 2 mg/L
    - Anaerobic for P removal < 0.3 mg/L or ORP
    - Anoxic for Denitrification < 0.9 mg/L
    - DO Sag will occur where Primary Effluent is introduced
- Never Dial Down Your Air Under Minimum Point for Mixing or Diffuser Clogging. If your DO is where you want it you're good. If you need to go up for process do so.
  - Remember Temperature