OVIVO
Bringing water to life

Aerobic Digestion for the 21st Century

Presentation Overview

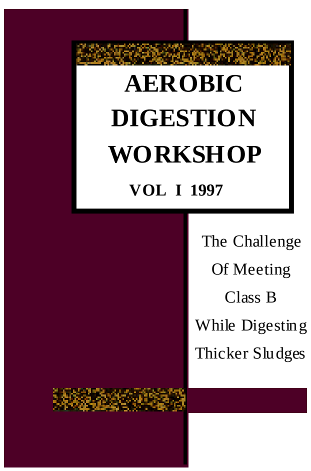
About Aerobic Digestion

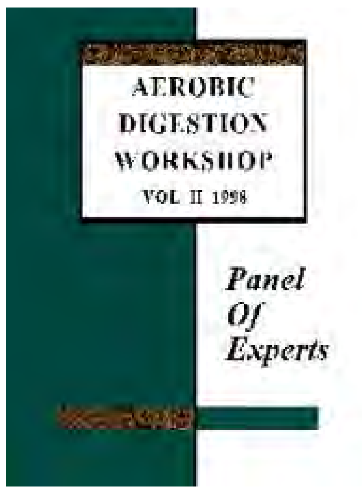
Aerobic Digestion Improvements

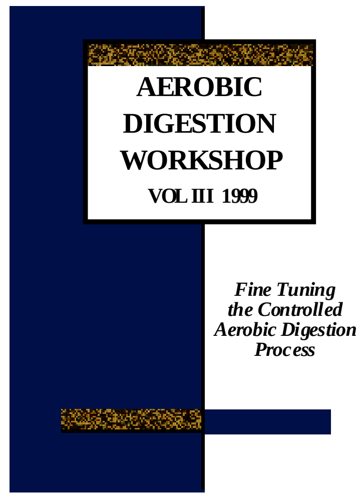
Aerobic Digestion in the Real World

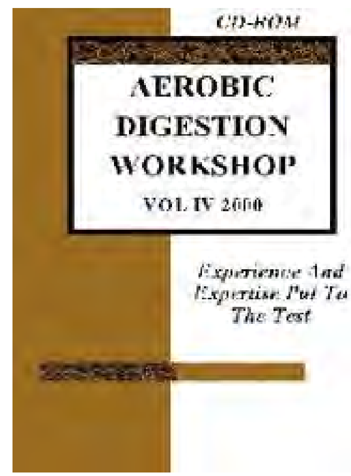
Digestion Expertise

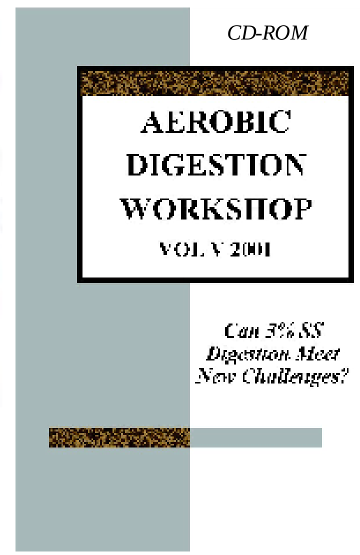
WEFTEC 1997 - 2001











Digestion Expertise

MOP 11 Operation of Municipal WWTP

Volume III:

Solids Processes

Chapter 31:

Aerobic Digestion

Author:

Elena Bailey

Digestion Expertise

MOP No. 8 5th Ed., 2009 Design of Municipal WWTPs

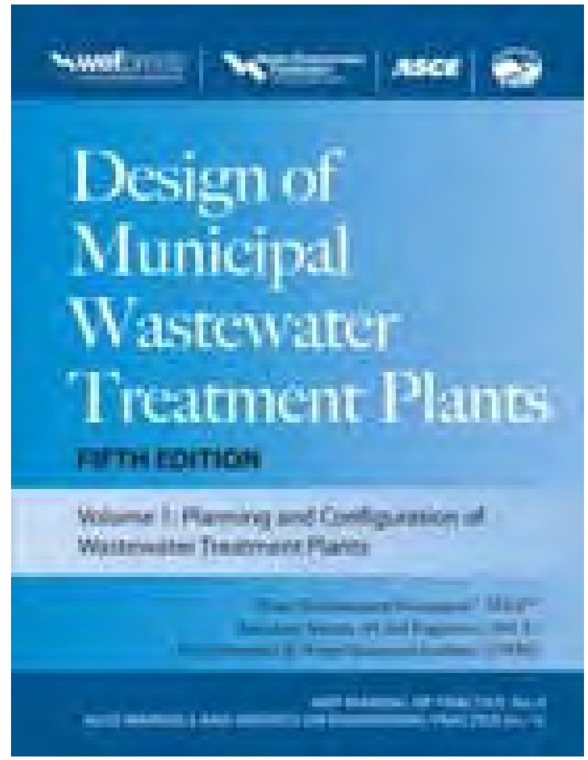
Volume III:

Solids Processing and Management

Chapter 25: Stabilization

Section 3 : Aerobic Digestion

Author: Miguel Vera



About Aerobic Digestion

What is Aerobic Digestion?

Aerobic Digestion is a process to:

1. Reduce the quantity of sludge for disposal. Bacteria continue metabolism as they do in the liquid process but without new food they use their own biomass (endogenous respiration).

2. Stabilize the sludge so that it is safer for human contact, does not attract vermin (vectors), and odors are reduced.

When is Aerobic Digestion typically used?

1. When it is required by local regulatory agencies
2. When the facility will be land applying their biosolids and needs to meet Class B requirements.
3. When the facility wants to reduce the volume of sludge for final disposal
4. When there are concerns about odors
5. When there is no primary sludge (think BNR)

Pluses and minuses of Aerobic Digestion

Pluses

1. Inherently safer than anaerobic digestion
2. Lower capital cost compared to anaerobic digestion
3. Ease of operation

Minuses

1. Higher energy costs
2. Temperature sensitive

Aerobic Digestion Chemistry

Aerobic Digestion is a biological process similar to Activated Sludge.

Activated Sludge = Growth
Aerobic Digestion = Decay

Process control is required to maintain healthy biomass

Biological Processes

1. Digestion:

$C_5H_7NO_2 + 5O_2 = 4CO_2 + H_2O + (NH_4HCO_3)$

Biomass **Ammonium Carbonate**

2. Nitrification:

$NH_4^+ + 2O_2 = H_2O + 2H^+ + NO_3^-$

Ammonia **Acid** **Nitrate**

3. Digestion with Nitrification:

$C_5H_7NO_2 + 7O_2 = 5CO_2 + 3H_2O + HNO_3$

Biomass **Nitric Acid**

Biological Processes

4. Digestion with Nitrification:

$C_5H_7NO_2 + 7O_2 = 5CO_2 + 3H_2O + HNO_3$

Biomass Nitric Acid

5. Denitrification:

$C_5H_7NO_2 + 4NO_3^- + H_2O = NH_4^+ + 5HCO_3^- + 2N_2$

Biomass Nitrate Ammonia N Gas

Alkalinity

6. Complete Nitrification / Denitrification:

$C_5H_7NO_2 + 5.75O_2 = 5CO_2 + 3.5H_2O + 0.5N_2$

Biomass N Gas

Factors affecting the rate of digestion:

1. Temperature

2. pH

3. Stability of the sludge

4. Biological diversity

Traditional Digester Design Prior to Class B Requirement

10 – 20 Days SRT (M&E, 1991)

Mixing Air - 30 scfm/1,000 cf

No Performance Requirements

503 Regs Change the Game

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EPA United States Environmental Protection Agency

Environmental Regulations and Technology

Control of Pathogens and Vector Attraction in Sewage Sludge

Aerobic Digestion – Regulatory Requirements

40 CFR Part 503

1. Class B with respect to Pathogens:
   - 60 Days @ 15 C or 40 Days @ 20 C

     OR

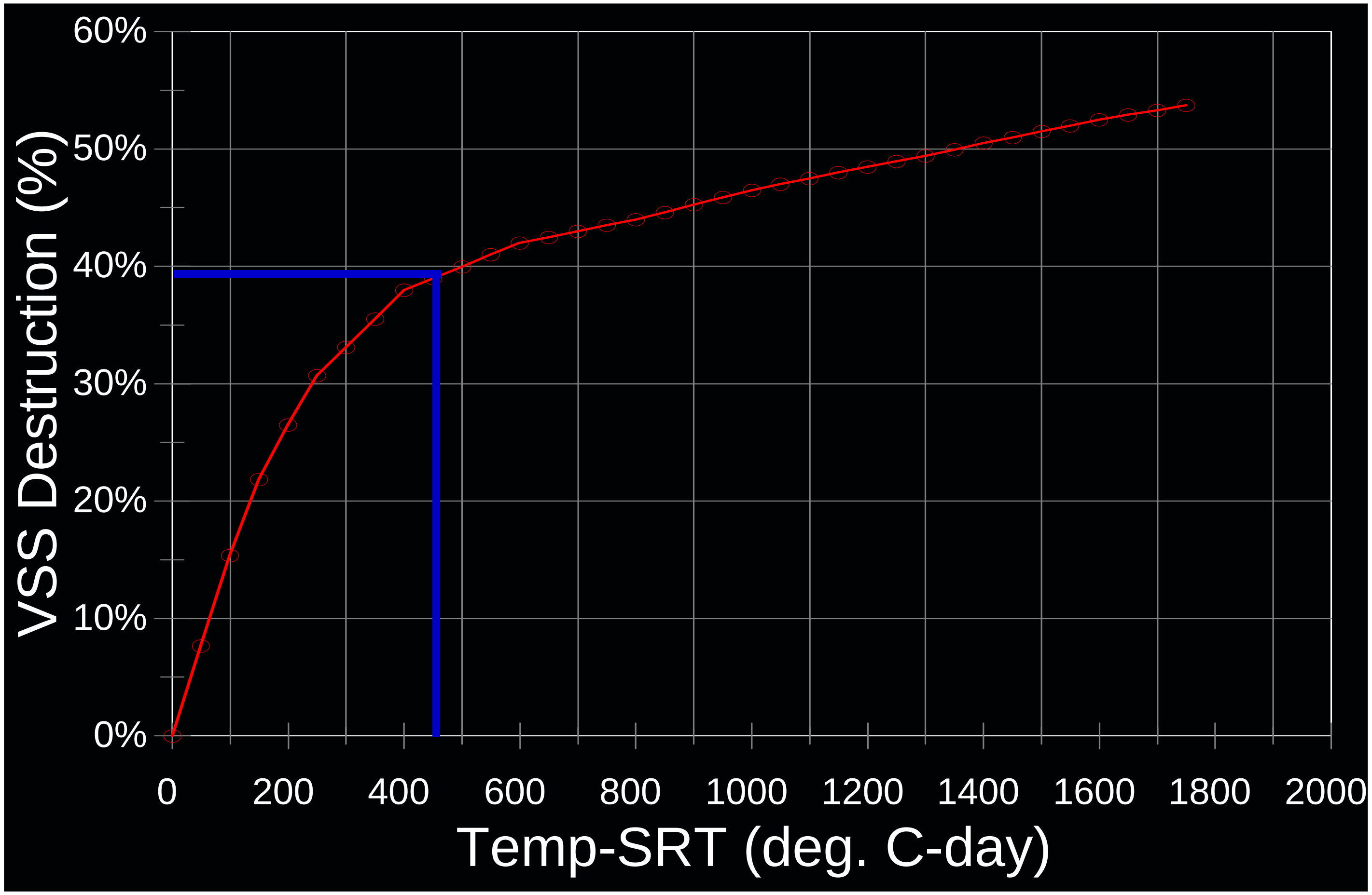
   - Pathogens ≤ 2,000,000 CFU

2. Class B with respect to Vector Attraction Reduction
   - Volatile Solids Reduction ≥ 38%

     OR

   - SOUR ≤ 1.5 mg/L O_2

Aerobic Digestion – Regulatory Requirements (cont.)



Aerobic Digestion Chemistry

18% Oxygen Savings:

3. Digestion with Nitrification:

$C_5H_7NO_2 + 7O_2 = 5CO_2 + 3H_2O + HNO_3$

Versus

6. Complete Nitrification / Denitrification:

$C_5H_7NO_2 + 5.75O_2 = 5CO_2 + 3.5H_2O + 0.5N_2$

Aerobic Digestion Chemistry

pH Cycle:

1. Digestion: (pH UP)

$C_5H_7NO_2 + 5O_2 = 4CO_2 + H_2O + NH_4^+ + HCO_3^-$

2. Nitrification: (pH DOWN)

$NH_4^+ + 2O_2 = H_2O + 2H^+ + NO_3^-$

4. Denitrification: (pH UP)

$C_5H_7NO_2 + 4NO_3^- + H_2O = NH_4^+ + 5HCO_3^- + 2N_2$

Aerobic Digestion Chemistry

Nitrogen Cycle:

1. Digestion:

$C_5H_7NO_2 + 5O_2 = 4CO_2 + H_2O + NH_4^+ + HCO_3^-$

2. Nitrification:

$NH_4^+ + 2O_2 = H_2O + 2H^+ + NO_3^-$

4. Denitrification:

$C_5H_7NO_2 + 4NO_3^- + H_2O = NH_4^+ + 5HCO_3^- + 2N_2$

Aerobic Digestion Temperature

- Optimum Range: 20°C – 30°C
- Rate (10°C) ≈ ½ Rate (20°C)
- Nitrification stops at ≈ 5°C

Techniques to Improve Process Performance

1. Series or Batch Operation
2. Sludge Thickening
3. Aerobic & Anoxic Operation
4. Temperature Control
5. Operational Flexibility

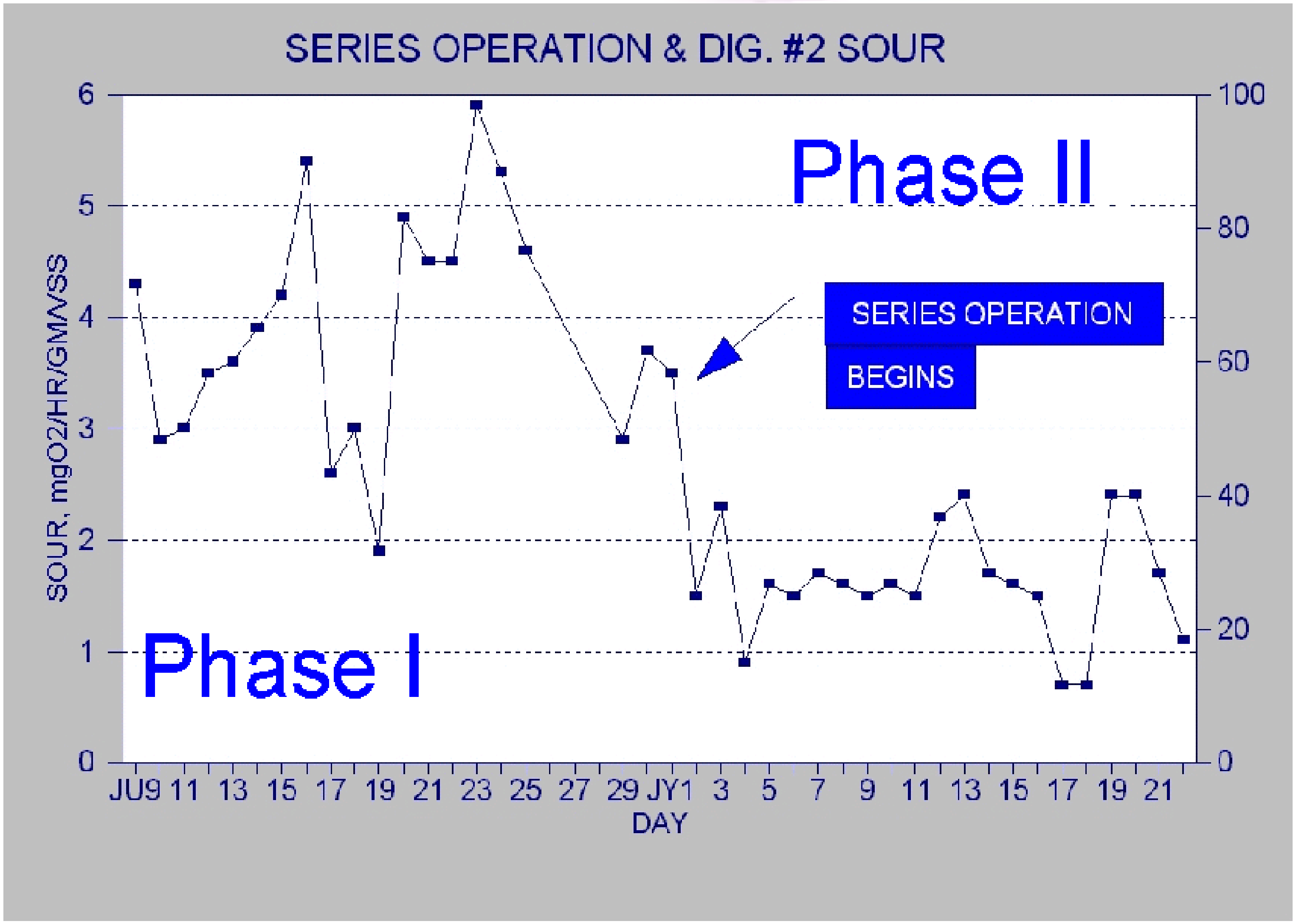
1. Series / Batch Operation

Advantages:

- Reduces short-circuiting of partially digested sludge

- Requires 50% less volume to achieve same volatile solids reduction

Series / Batch Operation



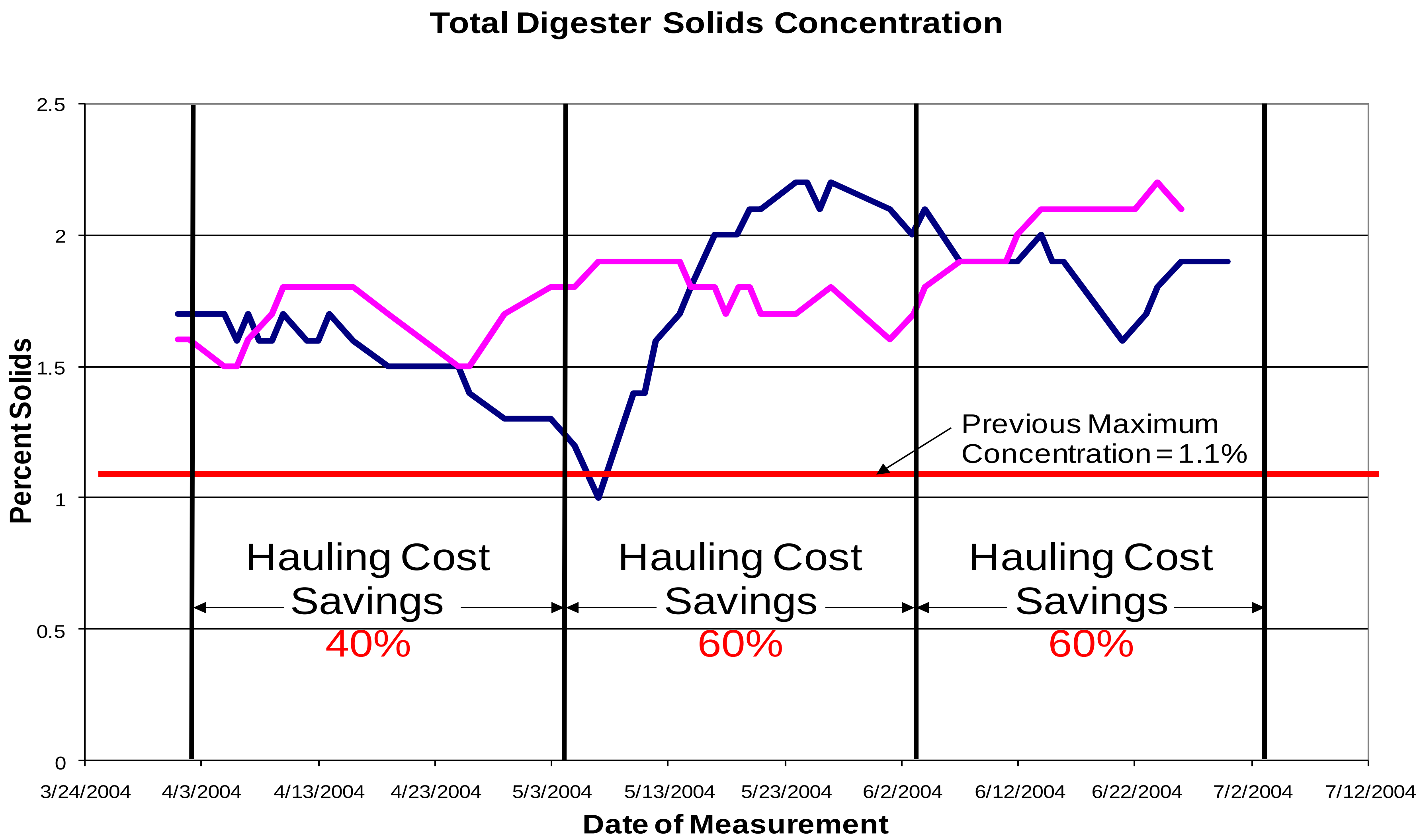
Clyde, OH 2.5 MGD WWTP

2. Thickening

Advantages:

- Smaller digesters
- Less digested sludge
- Higher sludge temperature

Thickening



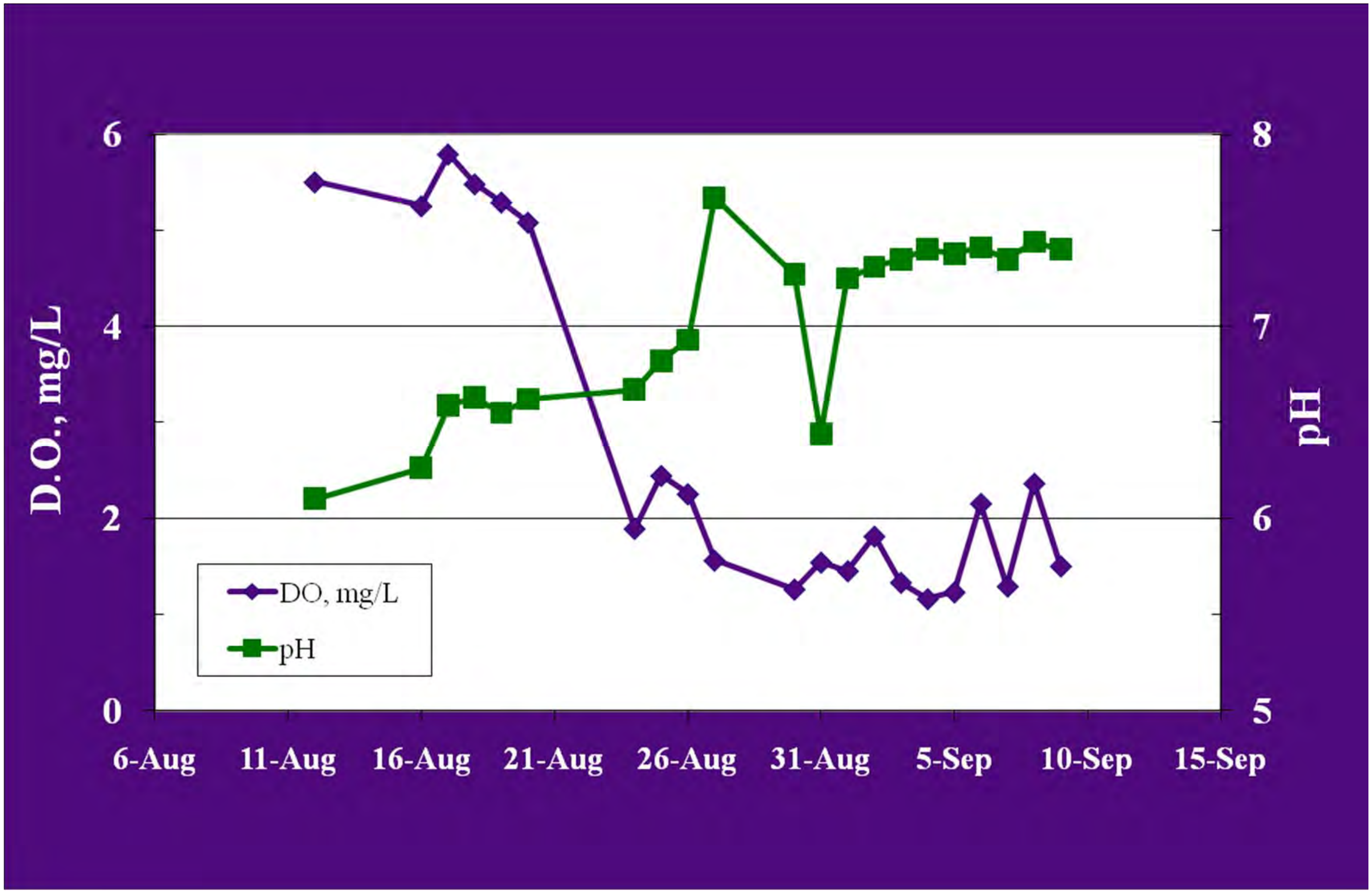
Total Digester Solids Concentration
2.5
2
1.5
1
0.5
0
Percent Solids
Previous Maximum Concentration = 1.1%
Hauling Cost Savings
40%
Hauling Cost Savings
60%
Hauling Cost Savings
60%
3/24/2004
4/3/2004
4/13/2004
4/23/2004
5/3/2004
5/13/2004
5/23/2004
6/2/2004
6/12/2004
6/22/2004
7/2/2004
7/12/2004
Date of Measurement

3. Aerobic / Anoxic Operation

Advantages:

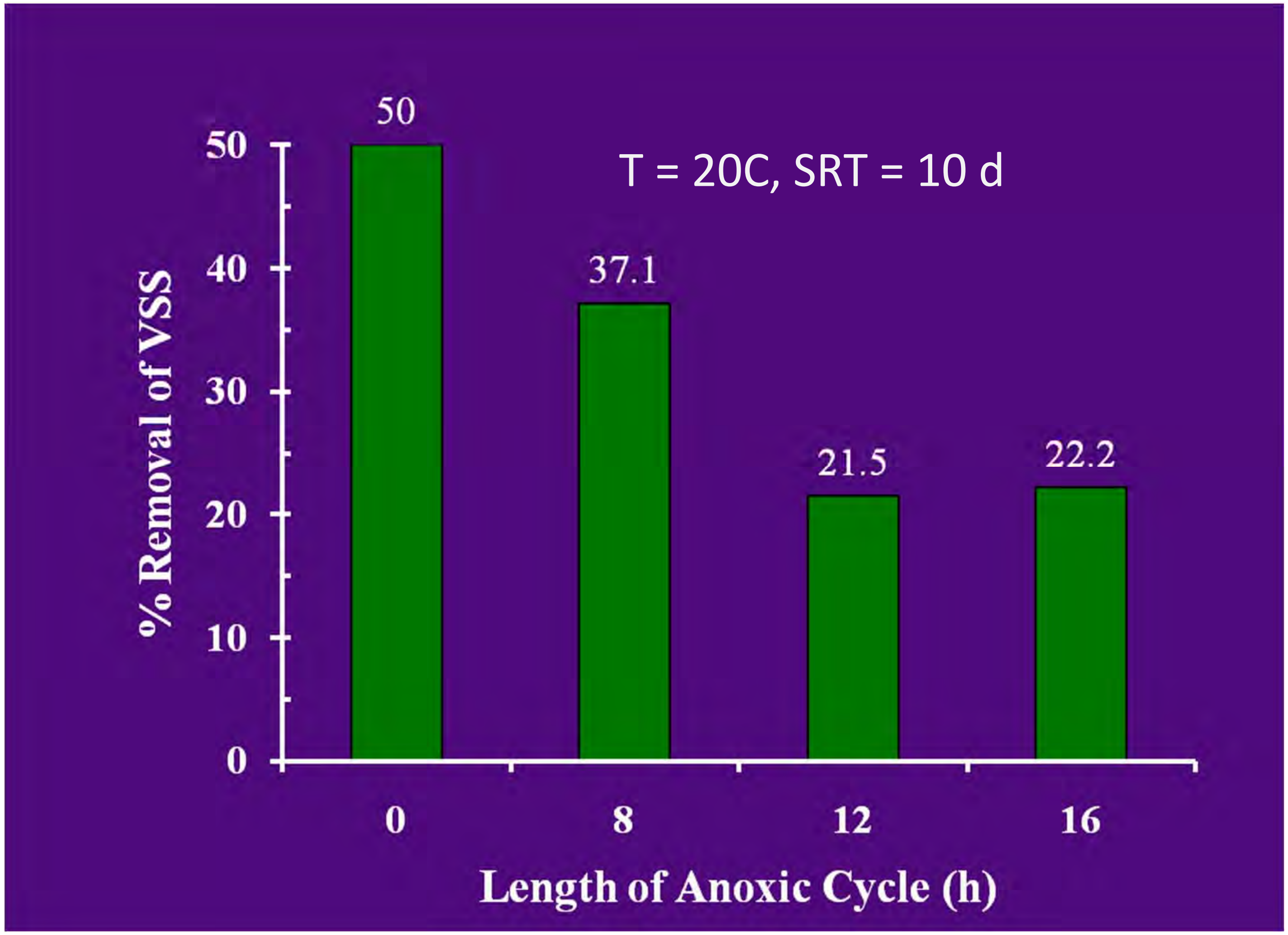
- Reduce O_2 requirements by 18%
- Preserve alkalinity
- Reduce total nitrogen

Aerobic / Anoxic Operation



Bellville, TX 0.95 MGD WWTP

Effect of AO/AX on VSR



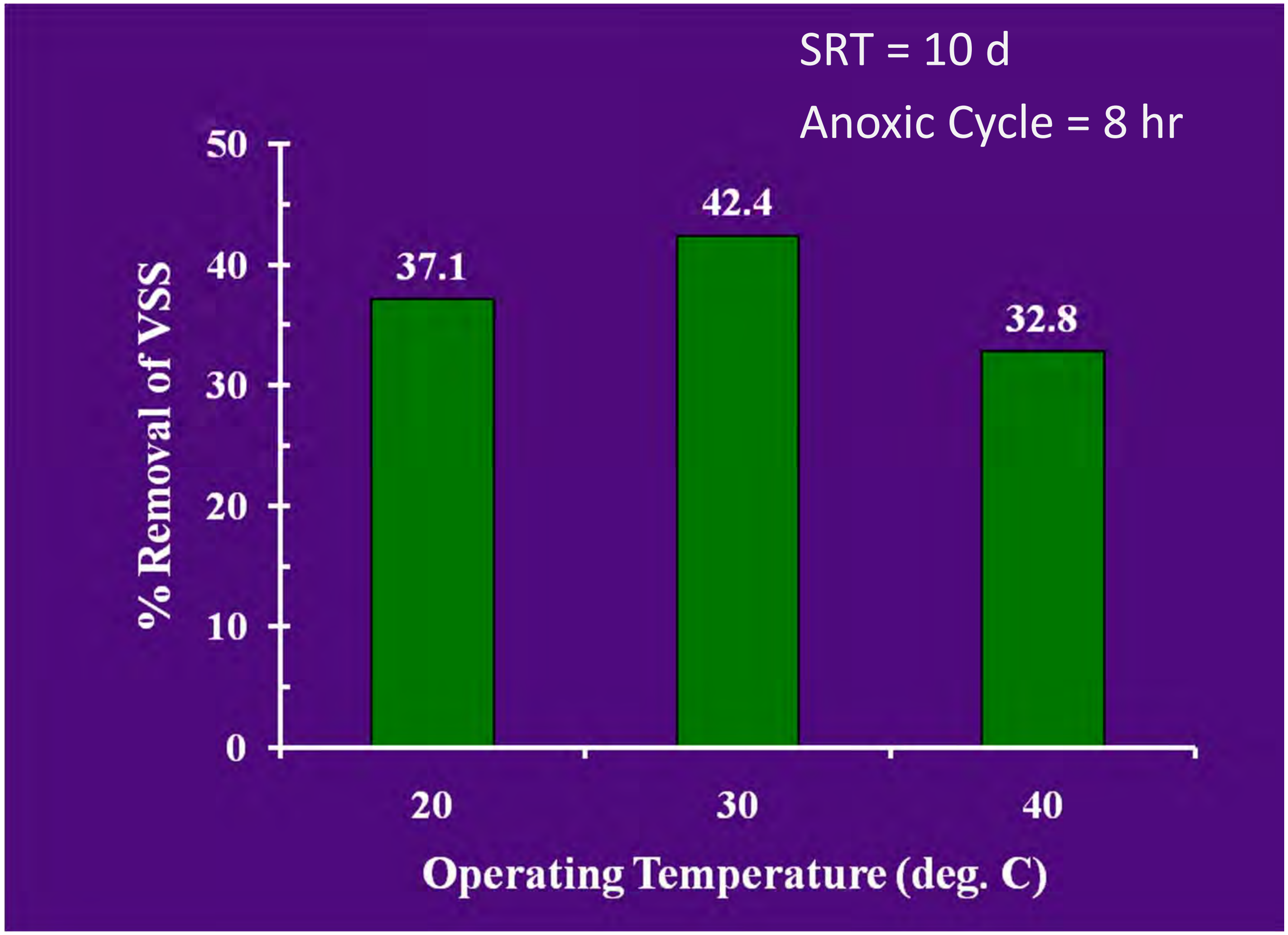
Ref.: I. Al-Ghusain, et. al., Environmental Technology, Vol. 25, 2004

4. Temperature Control

Advantages:

- Increased digestion rate
- Maintains healthy biomass
- Provides consistent operation and performance year around

Effect of Temp on VSR



Ref.: I. Al-Ghusain, et. al., Environmental Technology, Vol. 25, 2004

5. Flexibility

Designs should incorporate the following as much as possible:

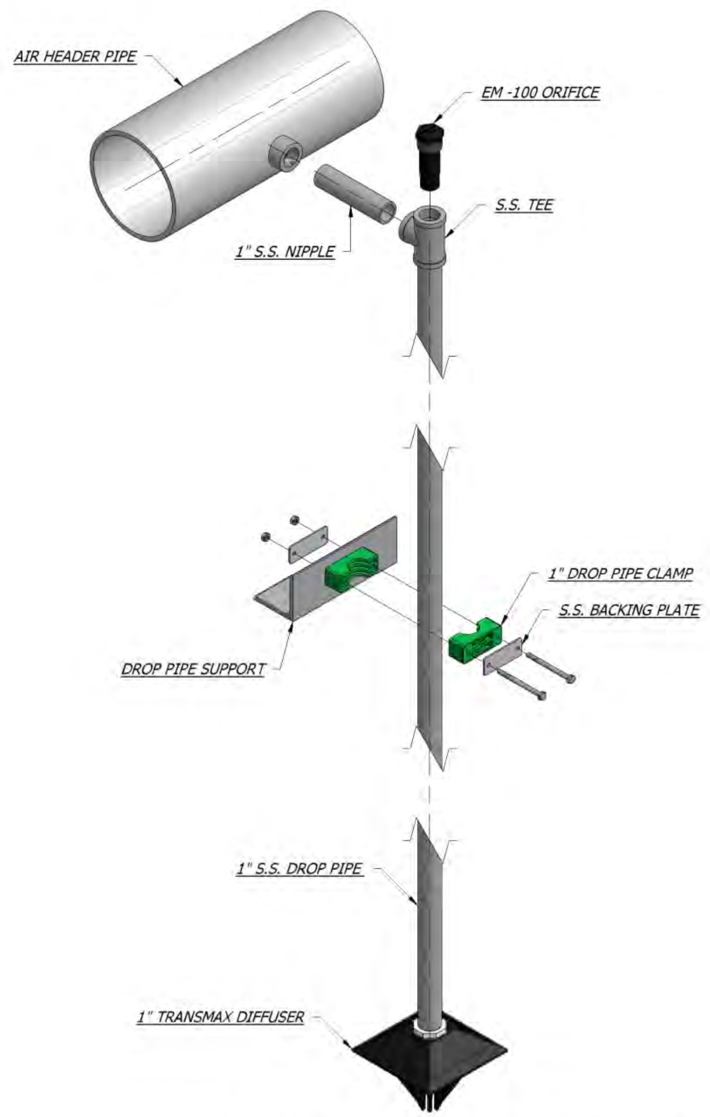
- Ability to control sludge thickness in digesters
- Ability to control air flow to each basin
- Ability to monitor pH, DO, & T

Aerobic Digestion Improvements

Effects of Thickening on Aeration

1. Lowering of alpha values
2. Mixing is as important as aeration
3. Seasonal *thinning* may be necessary

Product Features

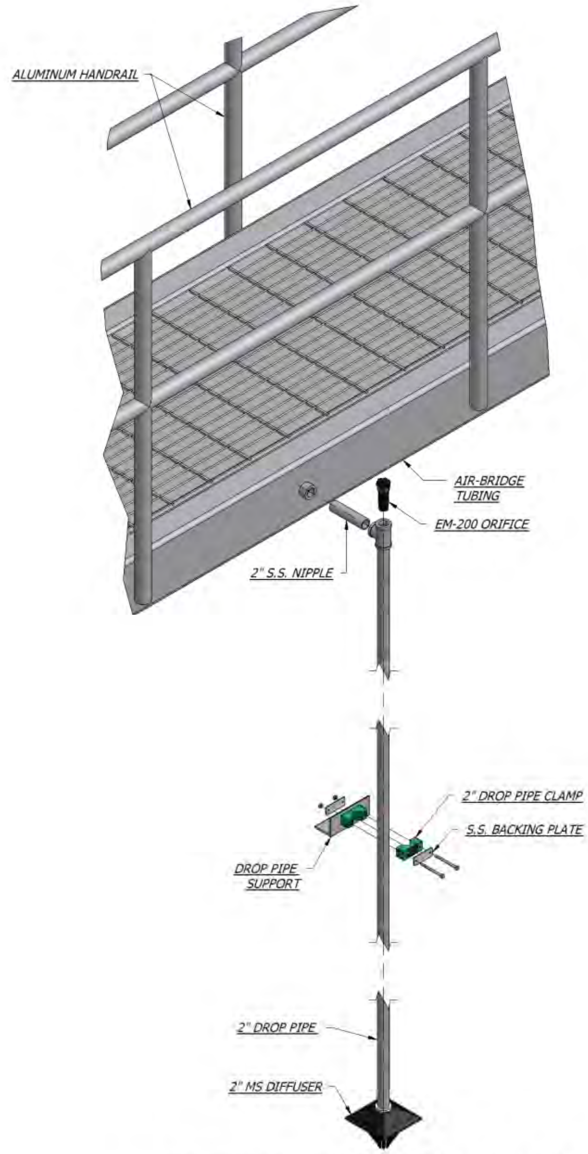


TRANSMAX DIFFUSER ASSEMBLY - TYPICAL

Above Water Orificing



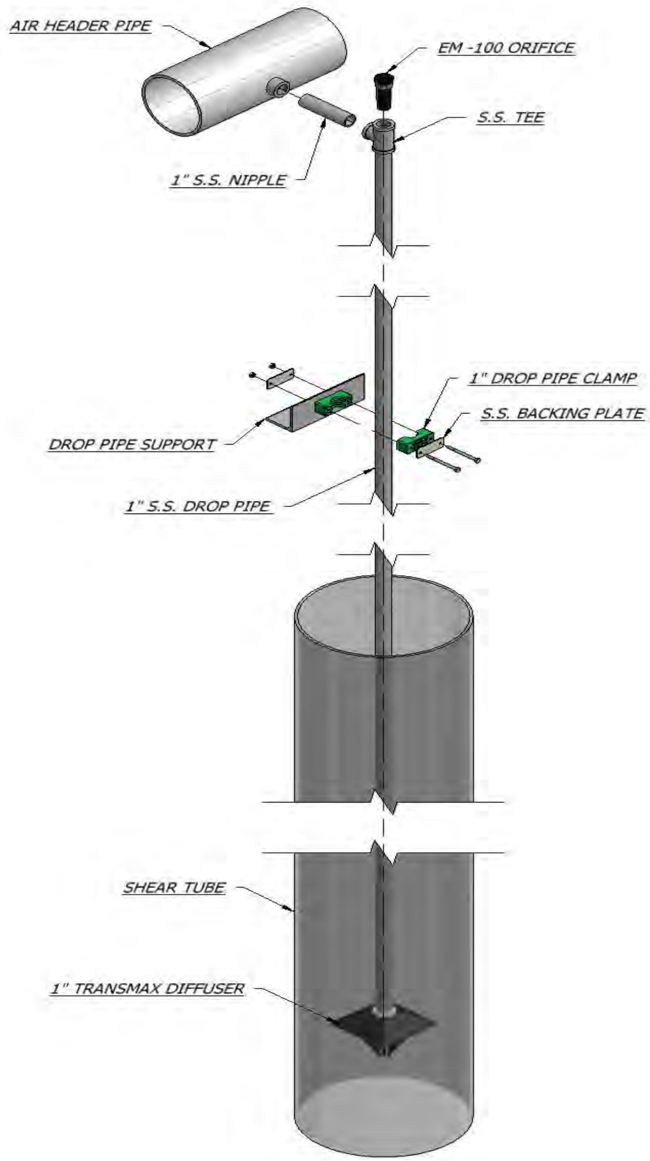

Ease of Access



MS DIFFUSER ASSEMBLY WITH AIR-BRIDGE TUBING
WITH MS AIR DIFFUSER, SHEAR TUBES, TRANSMAX AIR DIFFUSER

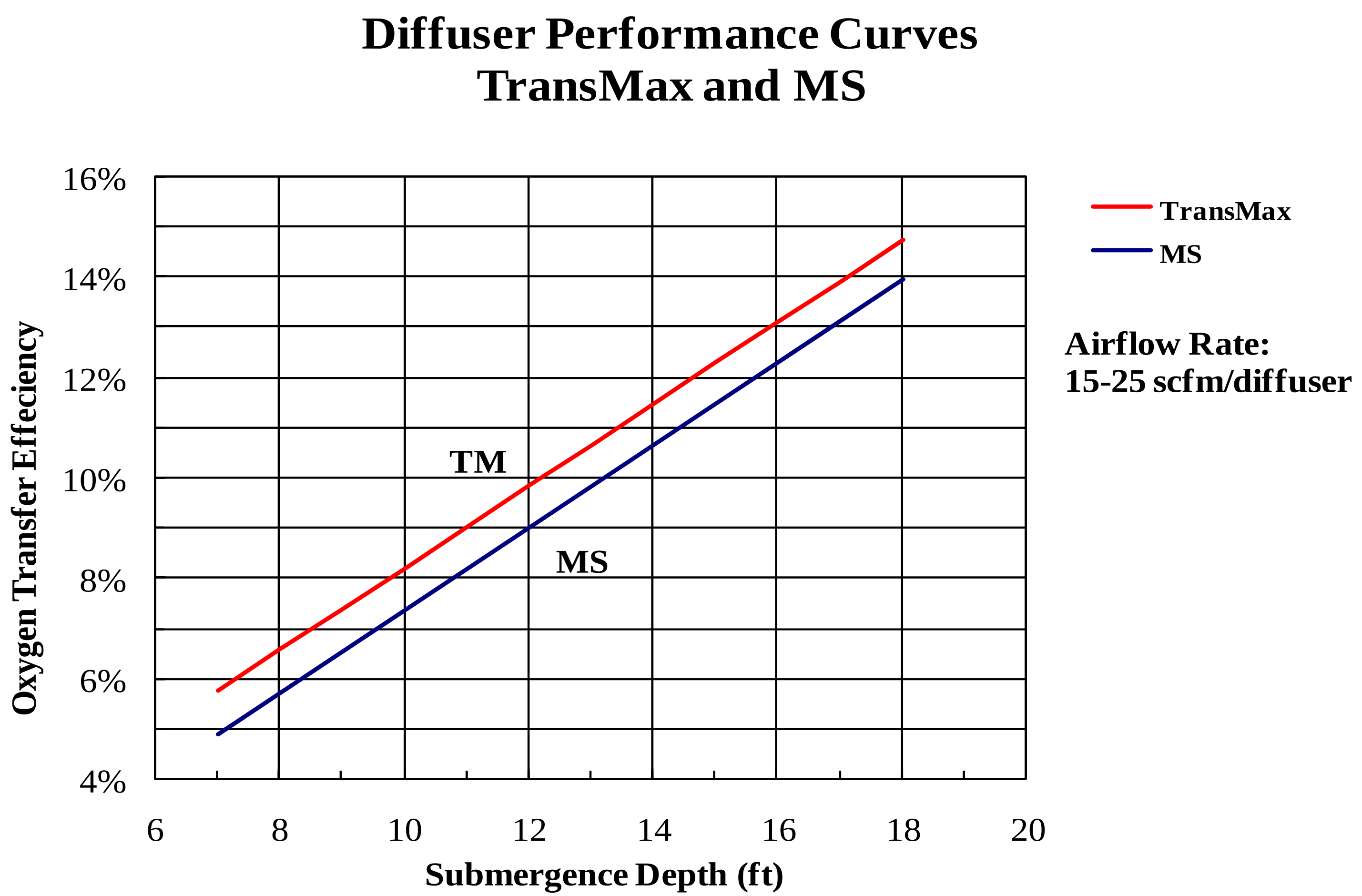
The Diffuser in Action

Improved Mixing Ability



TRANSMAX DIFFUSER ASSEMBLY - TYPICAL

Oxygen Transfer Efficiency



Tank Geometry

Abilities of the single drop diffuser must be kept in mind

1. Oxygen transfer efficiency improves with depth

2. Mixing ability increases with depth as well

3. Varying sidewater depths can be problematic for shear tubes, blowers, and header arrangements

G-TAD Process

G-TAD

stands for:

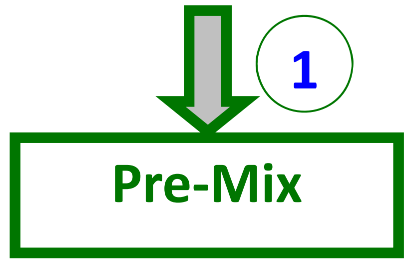
Gravity Thickened Aerobic Digestion

Gravity Thickener

Aerobic Digester

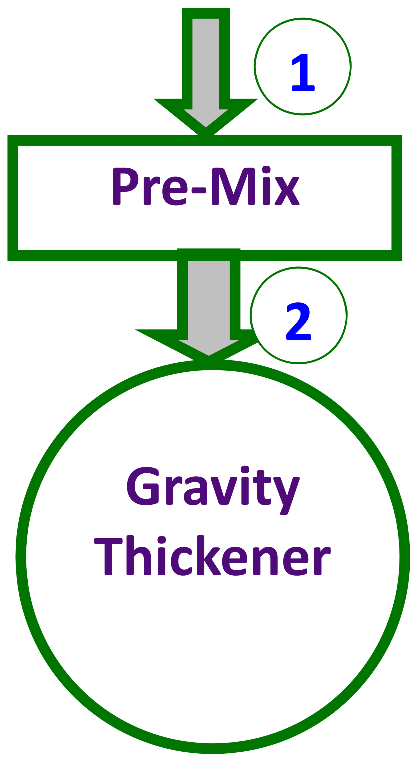
Working Together

G-TAD Process Flow



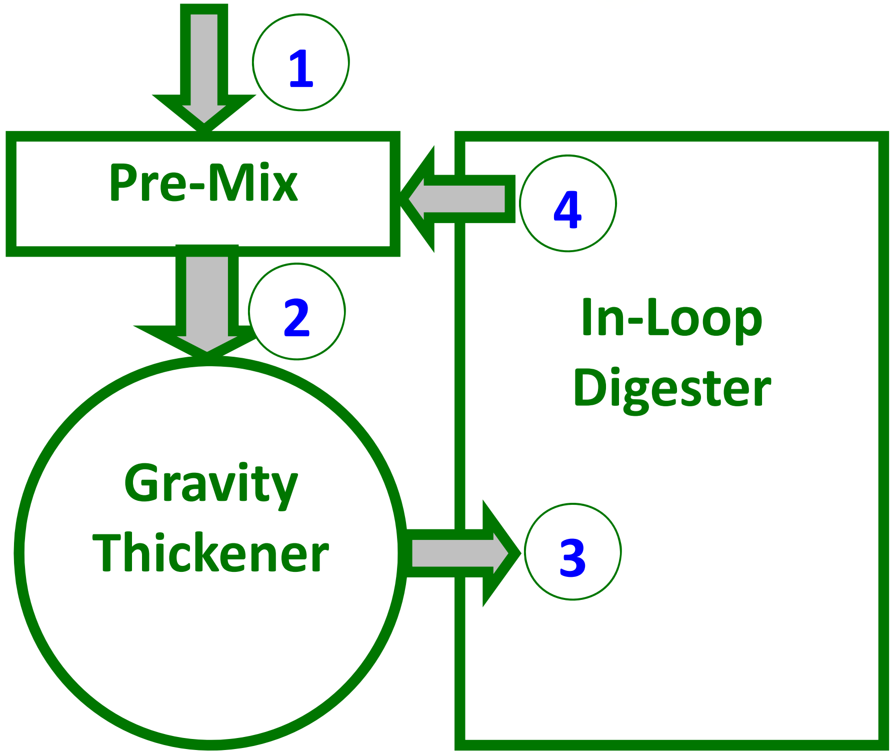
1. Waste sludge is pumped into Pre-mix

G-TAD Process Flow



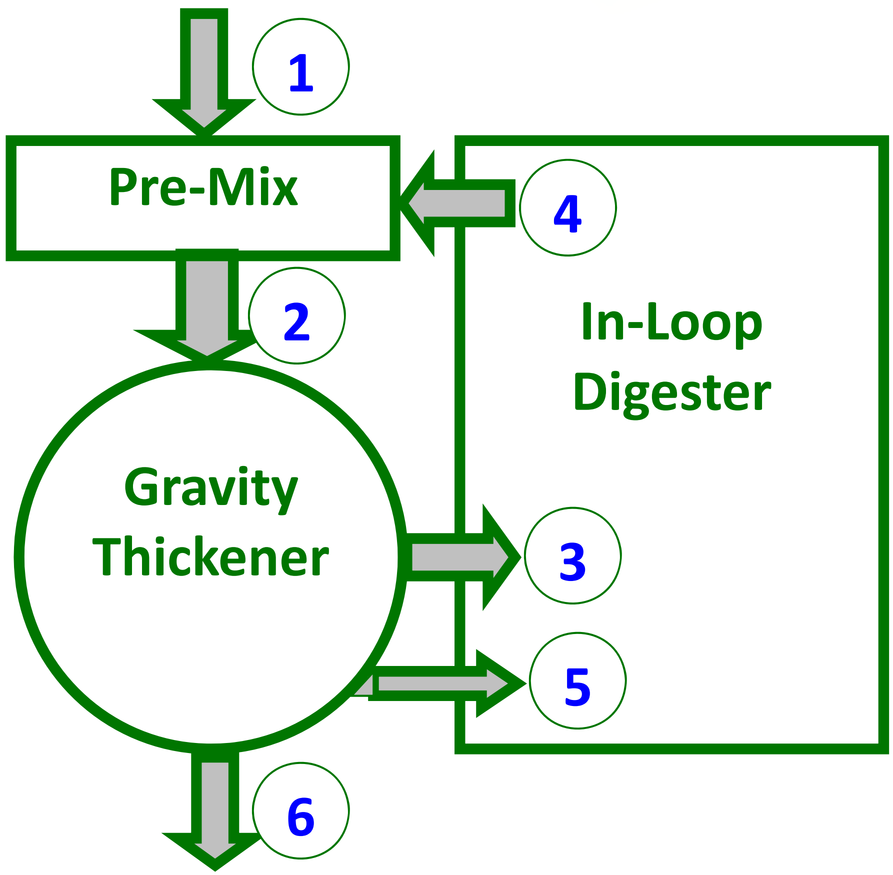
2. Sludge flows into Gravity Thickener

G-TAD Process Flow



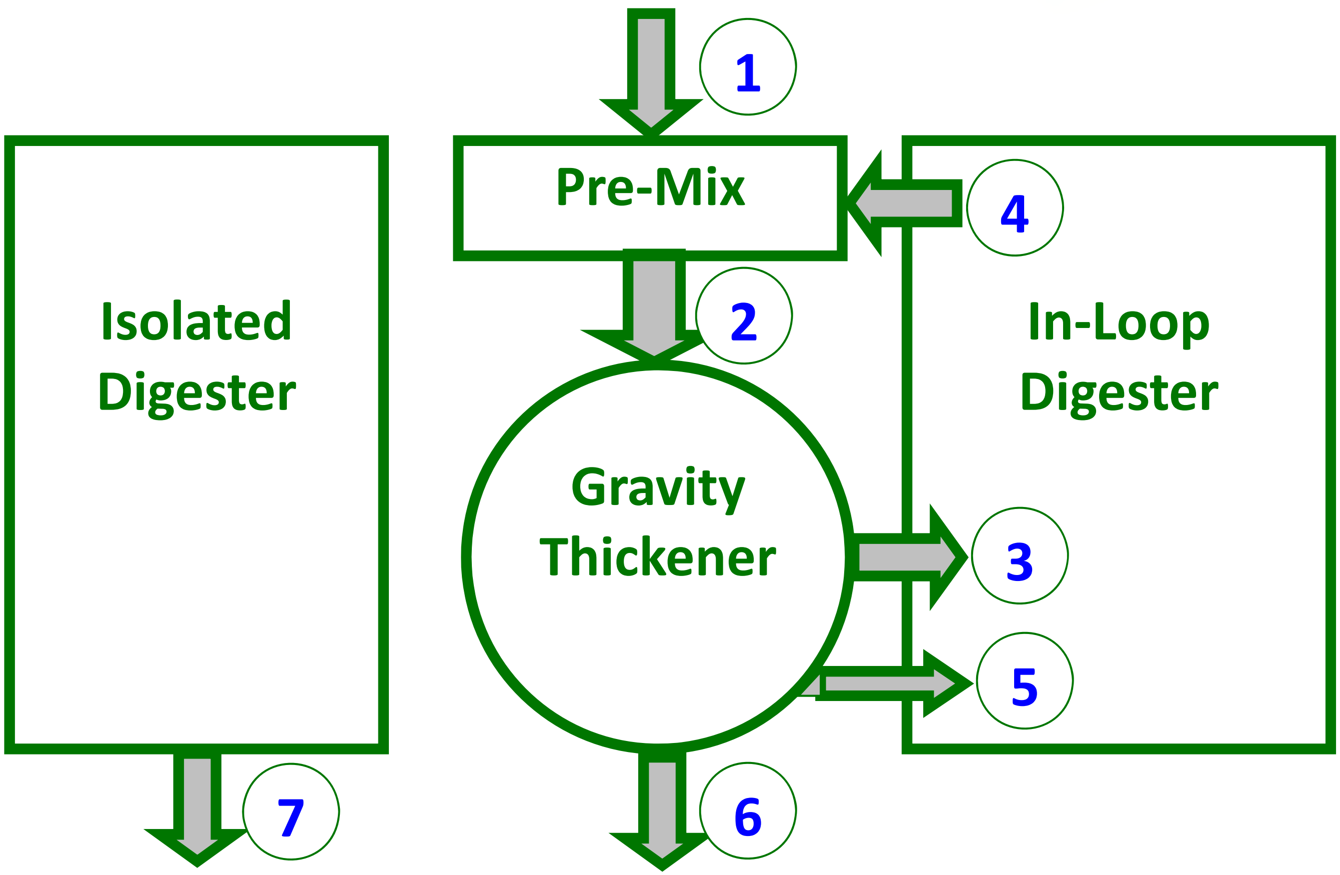
3. Thickened sludge airlifted into Digester
4. Nitrified sludge overflows into Pre-mix

G-TAD Process Flow



5. Scum airlifted into Digester
6. Supernatant returned to head of plant

G-TAD Process Flow



7. Class B sludge removed for disposal

G-TAD
Batch Operating Cycle

DIGESTER #1 CYCLE

Feed Stage

Day 1 - 2 Fill Digester #1

Day 3 - 14 In-loop Thickening

Batch Stage

Day 15 - 26 Isolation

Day 27 - 28 Draw down

DIGESTER #2 CYCLE

Batch Stage

Day 1 - 12 Isolation

Day 13 - 14 Draw Down

Feed Stage

Day 15 - 16 Fill Digester #2

Day 17 - 28 In-loop Thickening

G-TAD Process

G-TAD Installation References

Location	Design Flow	Plant Configuration	Commission Date
Stockbridge, GA	1.5 MGD	SBR	2002
Belleville, TX	0.95 MGD	Complete Mix	2002
Clermont, FL	2.0 MGD	Oxidation Ditch	2002
Gardner, KS	2.5 MGD	Oxidation Ditch	2003
Woodland, WA	1.3 MGD	SBR	2003
Myrtle Creek, OR	2.9 MGD	Oxidation Ditch	2004
Shelton, WA	2.5 MGD	Oxidation Ditch	2004
Amherst, OH	6.1 MGD	Oxidation Ditch	2004
Blue Mtn. Lake, PA	0.14 MGD	RBC	2004
Brenham, TX	3.55 MGD	Complete Mix	2004

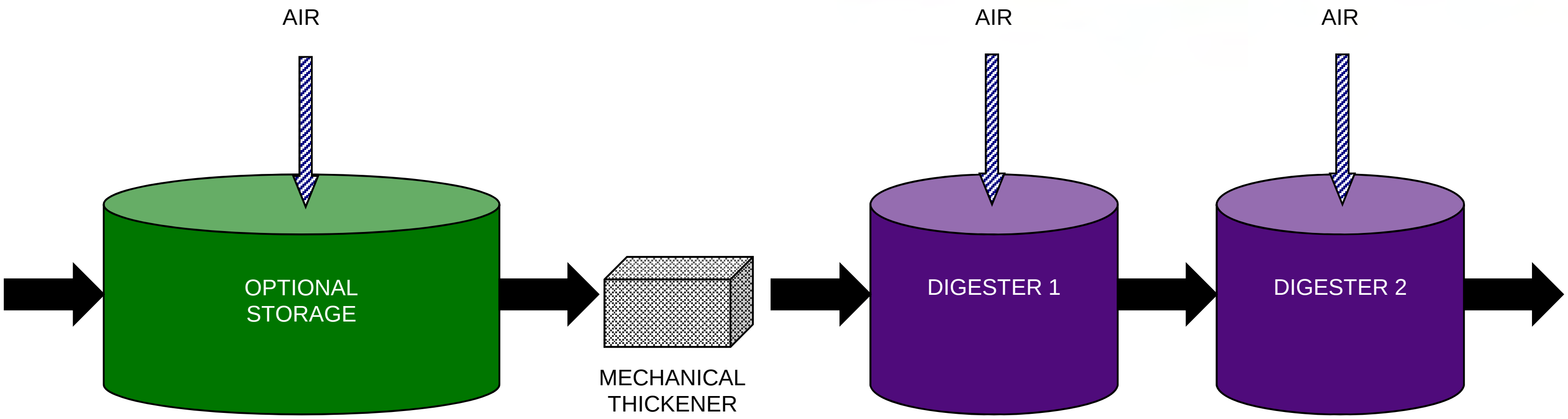
M-TAD Process

M-TAD

stands for:

Mechanical Thickened
Aerobic Digestion

M-TAD Process



REDUCE VOLUME

VOLATILE SOLIDS REDUCTION

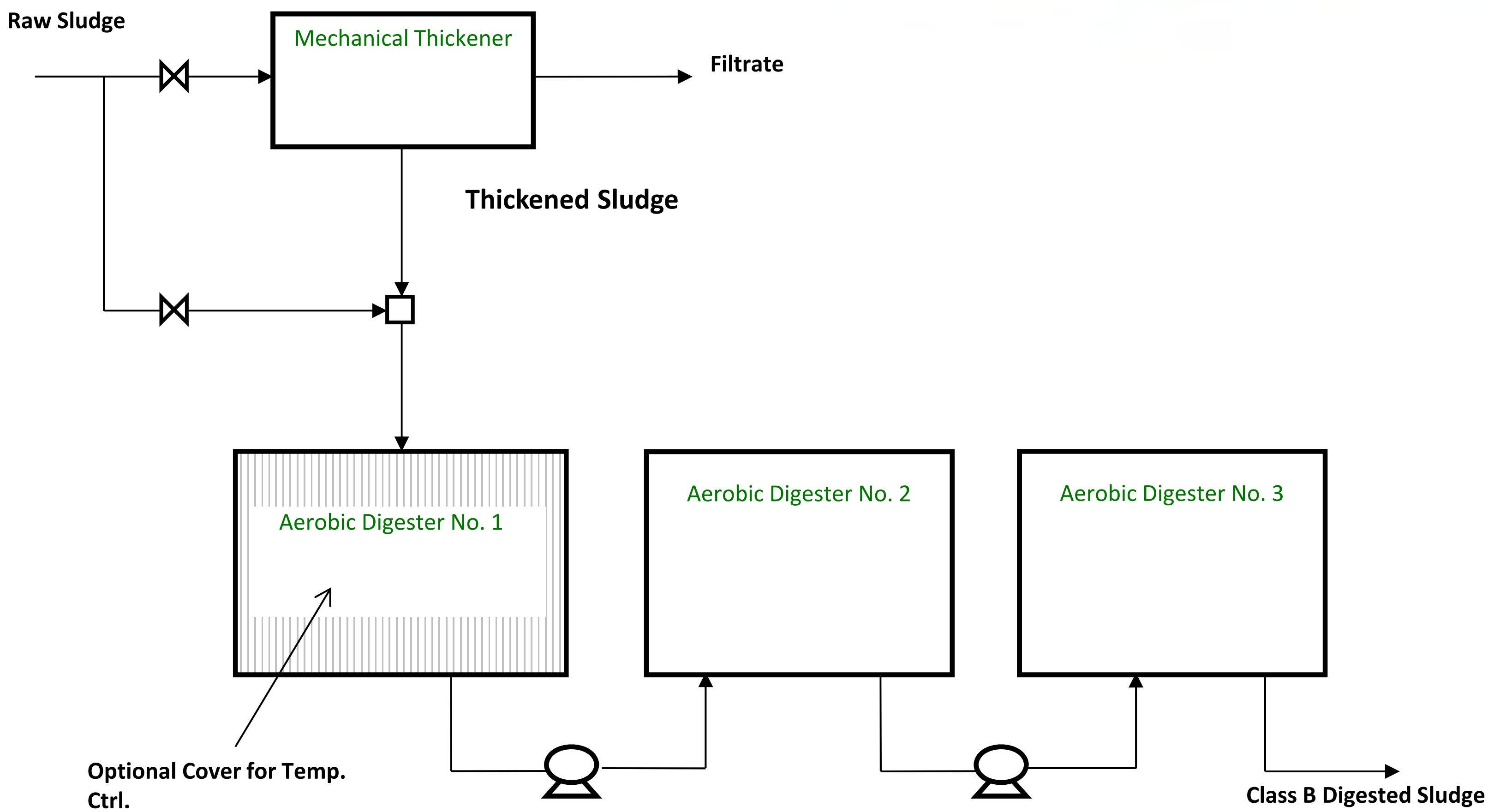
ENSURES PATHOGEN REDUCTION

The PAD-M process is…

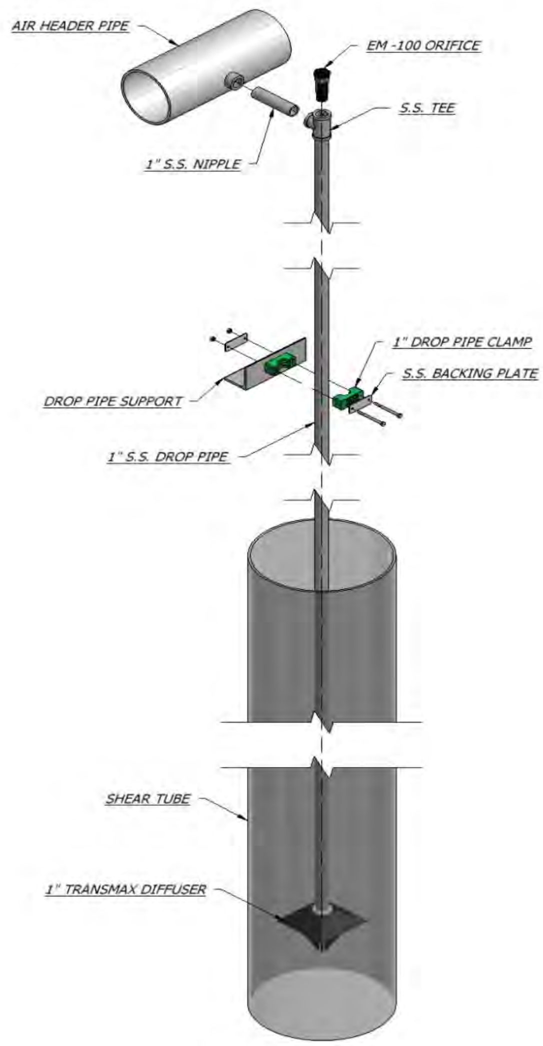
An enhanced digestion process to achieve guaranteed Class B biosolids

- with conventional equipment
- in a reduced volume,
- using less energy.

M-TAD Process

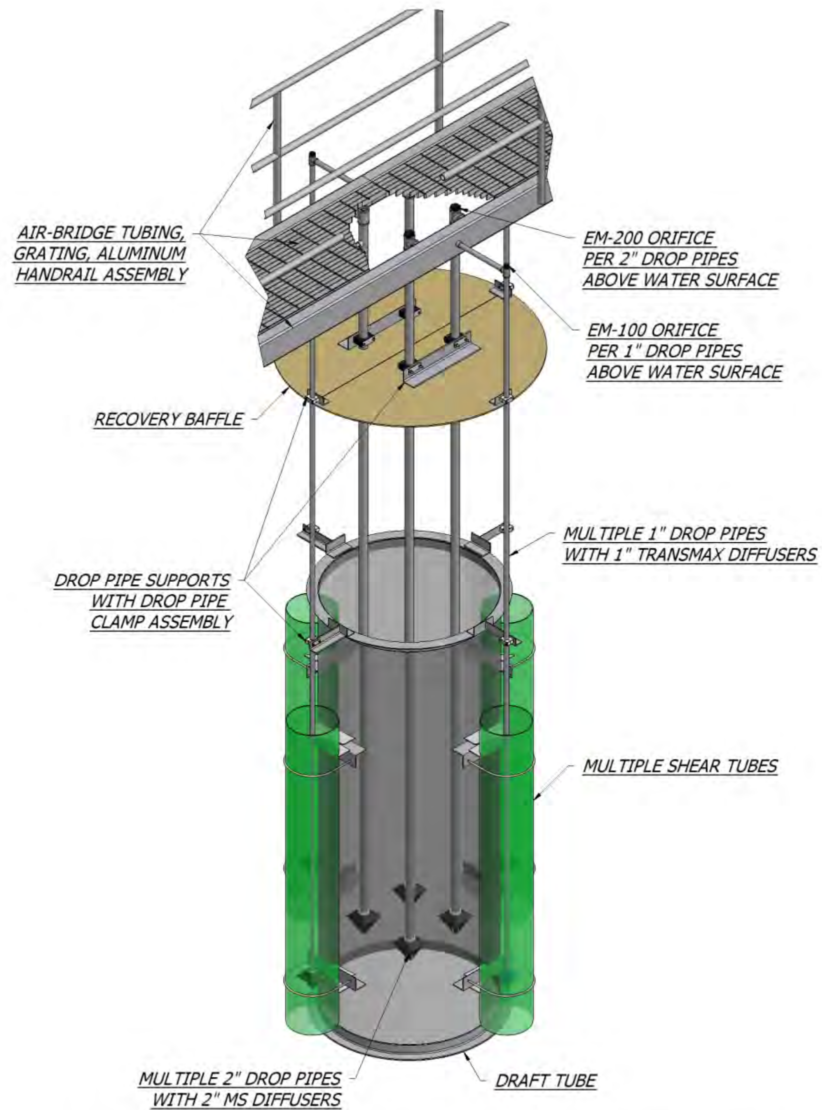


Diffusers with Shear Tubes



TRANSMAX DIFFUSER ASSEMBLY - TYPICAL

Diffusers with Draft Tube



MULTI-EDUCTOR DRAFT ASSEMBLY WITH AIR-BRIDGE TUBING

M-TAD Process

M- ITADnstallation References

Location	Design Flow	Plant Configuration	Thickening Method
Clyde, OH	1.9	Oxidation Ditch	GBT
Los Lunas, NM	0.7	Extended Aer.	GBT
Paris, IL	1.4	1° & 2° Sludge	GBT/BFP
Myrtle Beach, SC	12.6	Ext. Aer. & RBC	RDT
Sanford, FL	7.2	Extended Aer.	GBT
Lynden, WA	1.8	Oxidation Ditch	RDT
Warsaw, IN	3.9	Oxidation Ditch	GBT
Burlington, IA	7.6	C.A.S.	DAF

Ideal for:
Larger WWTPs
Conversion of existing anaerobic and holding tanks

Bellefonte M-TAD Process

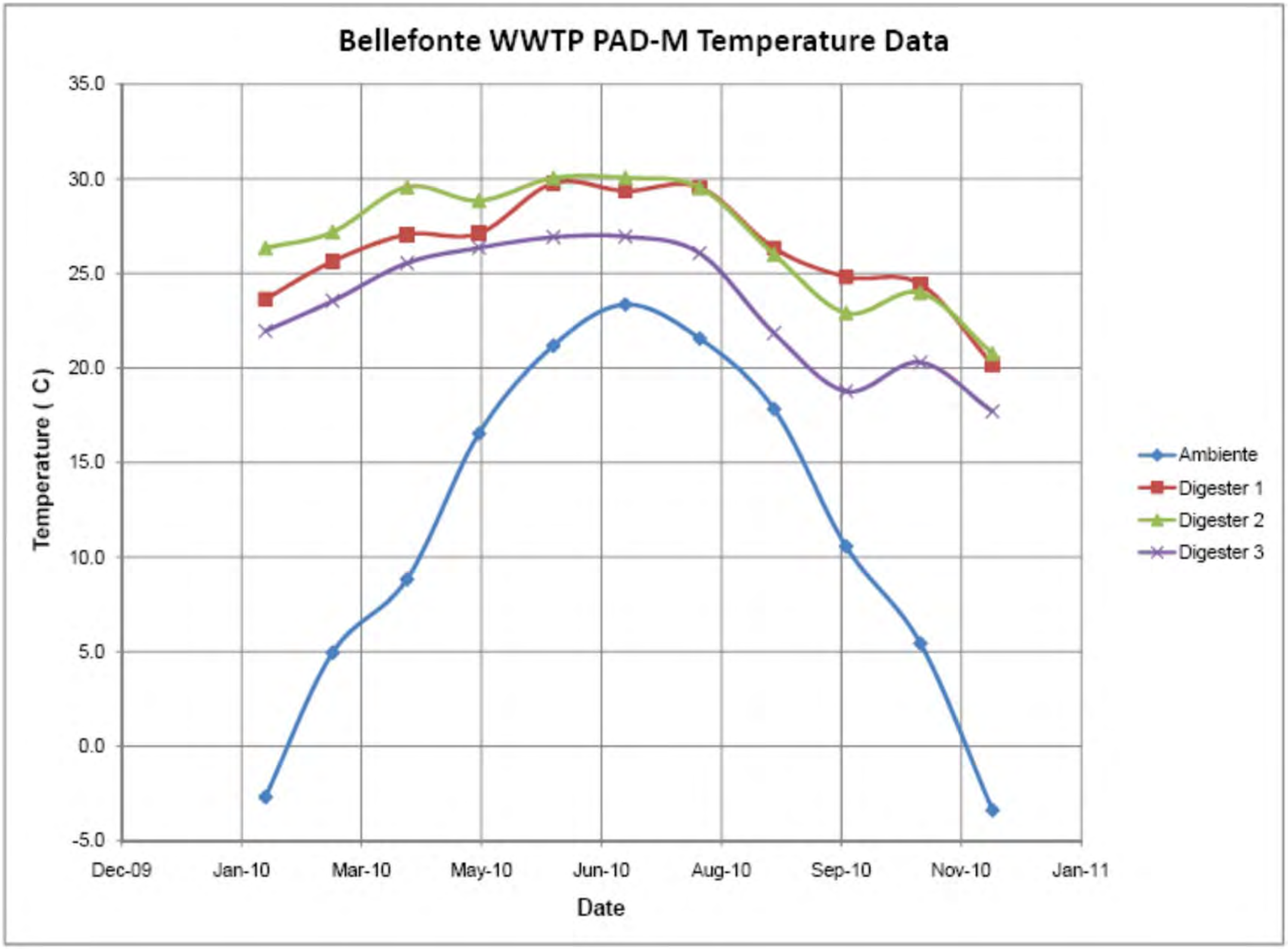
Rotating Biological Contactor followed by M-TAD Process

Engineer: Nittany Engineering

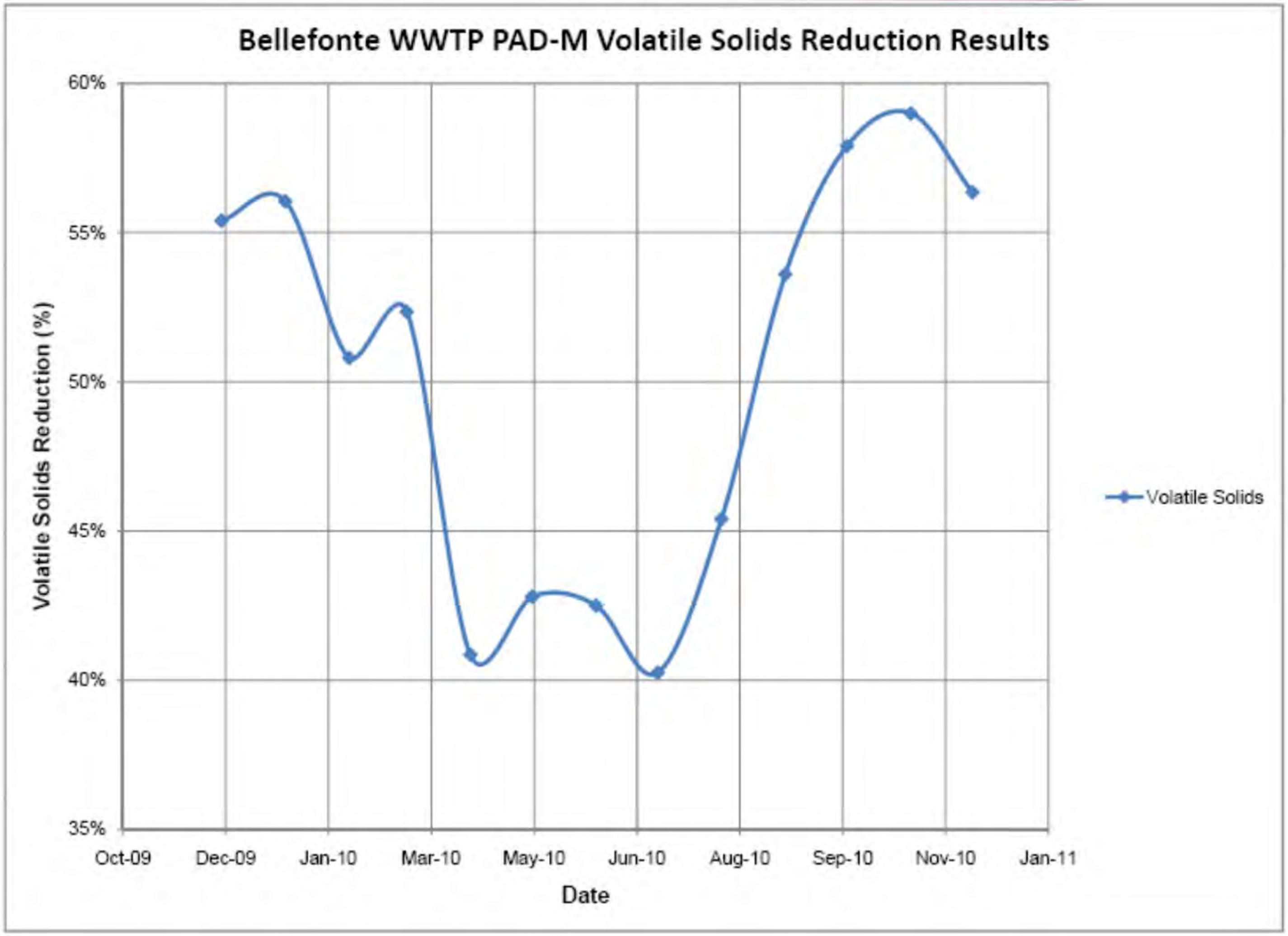
History:

- Objective was to produce Class B biosolids for land application
- Retrofit of equalization basin into three aerobic digesters in series.
- PAD-M process designed for solids loading increase from 2 MGD to 3.2 MGD.
- Thickening to 4% solids was required to meet Class B criteria without having to build additional tanks at 3.2 MGD flow.

Bellefonte M-TAD Process



Bellefonte M-TAD Process



<u>Longer SRT from thickening complimented by outstanding temperature control results in outstanding VS reduction</u>

Bellefonte M-TAD Process

Pathogen Data

First Quarter 2010		Second Quarter 2010	
Rep Number	**CFU/Dry Gram**	**Rep Number**	**CFU/Dry Gram**
1	175	1	268
2	4,715	2	704
3	934	3	1,622
4	173	4	1,679
5	1,117	5	2,370
6	970	6	2,647
7	5,048	7	414
Geometric Mean	**956**	**Geometric Mean**	**1,040**
Third Quarter 2010		**Fourth Quarter 2010**	
Rep Number	**CFU/Dry Gram**	**Rep Number**	**CFU/Dry Gram**
1	2,360	1	268
2	2,785	2	83
3	164	3	380
4	976	4	269
5	179	5	633
6	602	6	10,400
7	<59	7	<57
Geometric Mean	**480**	**Geometric Mean**	**364**

Mem-TAD Process

Mem-TAD

stands for:

Membrane Thickened Aerobic Digestion

Mem-TAD Process

Combines a Membrane Thickening Tank with two Aerobic Digesters

Guaranteed Class B Biosolids

Capable of between 3% & 5% solids

No polymer required or attention to decanting

Continuous thickening - independent of wasting schedule

Reuse quality permeate

MEMBRANE TECHNOLOGY OVERVIEW

Definitions

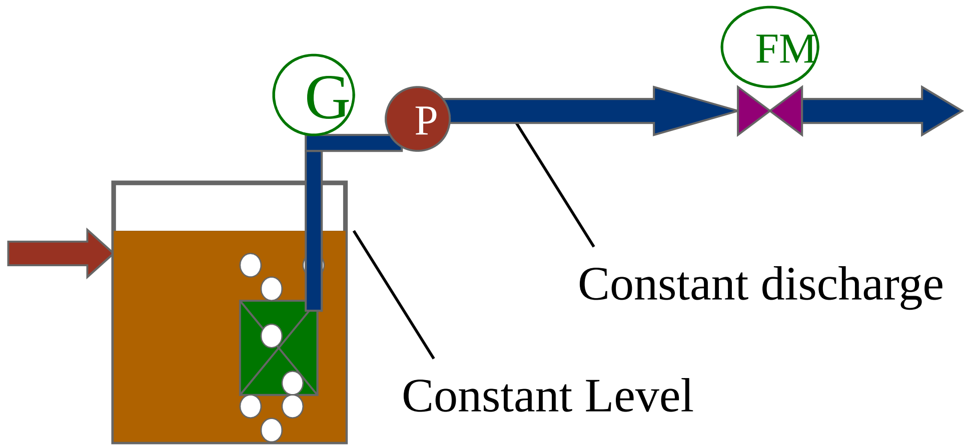
FLUX: The rate of filtration per unit area of membrane material is called flux.

TMP: The pressure difference across a membrane during filtration is called transmembrane pressure (TMP).

PERMEABILITY: The ratio of flux to TMP is referred to as permeability.

TMP

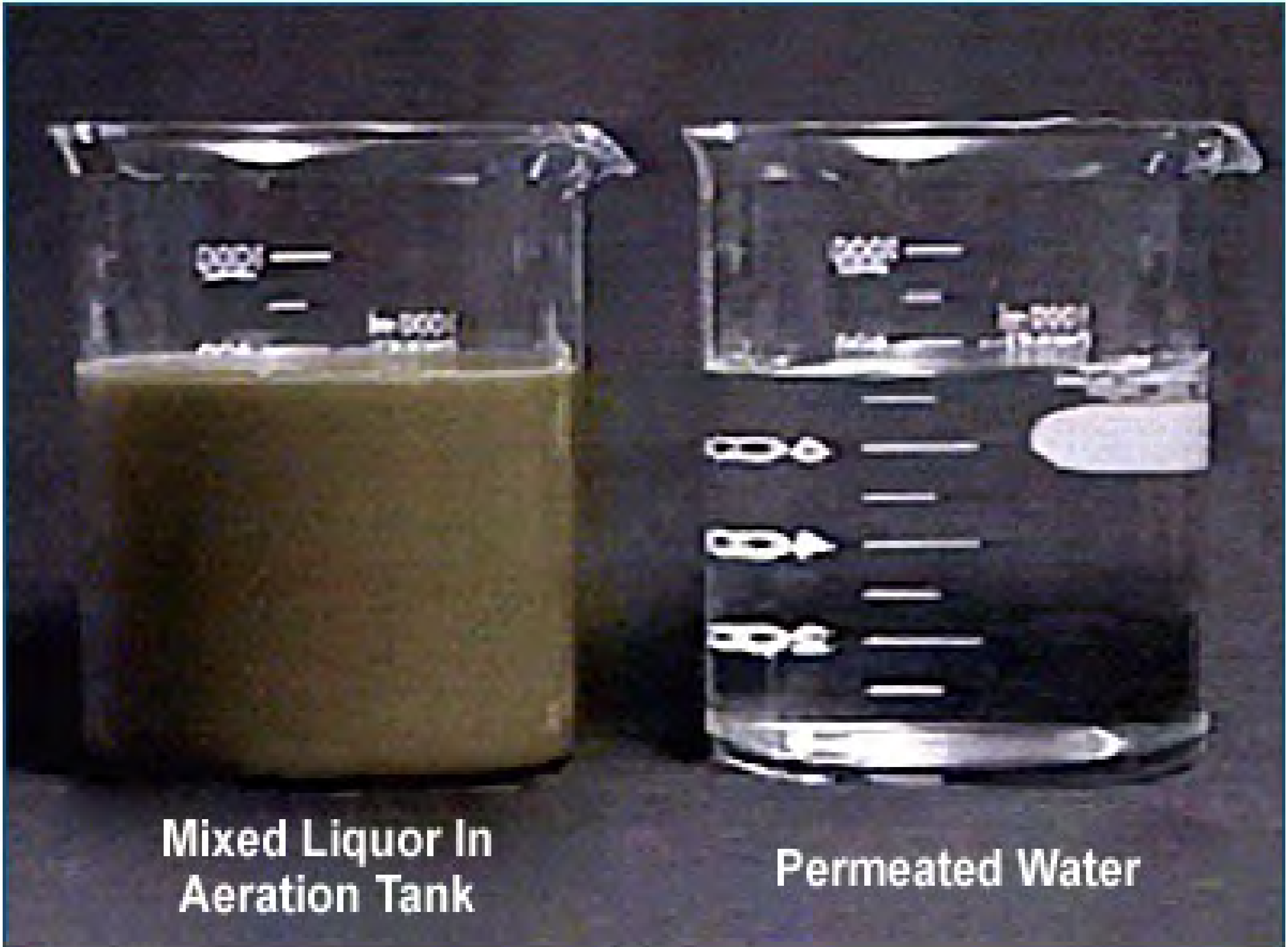
Suction method



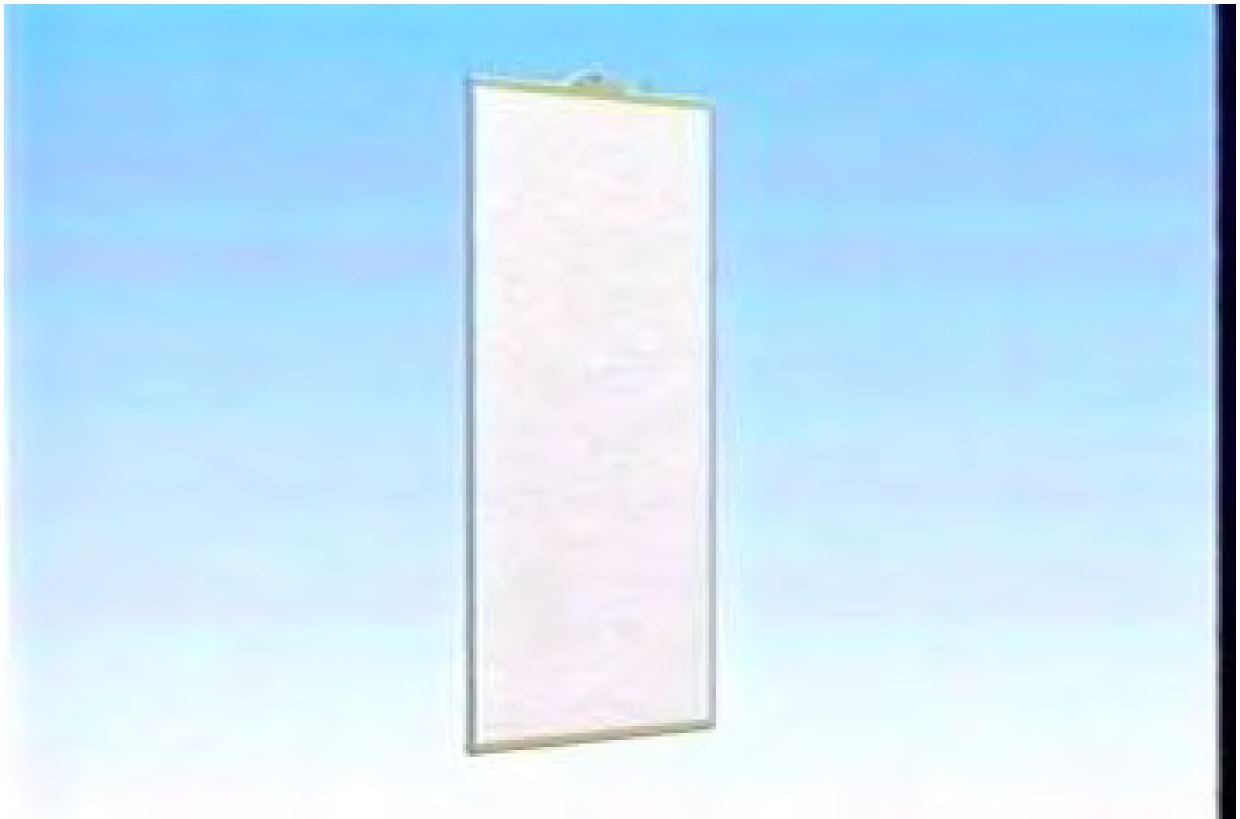
Pressure when permeate suspended

- Pressure when permeating time
- Head loss in piping (Friction , fittings, etc)

= TMP


Mixed Liquor In
Aeration Tank
Permeated Water

Membrane Cartridges

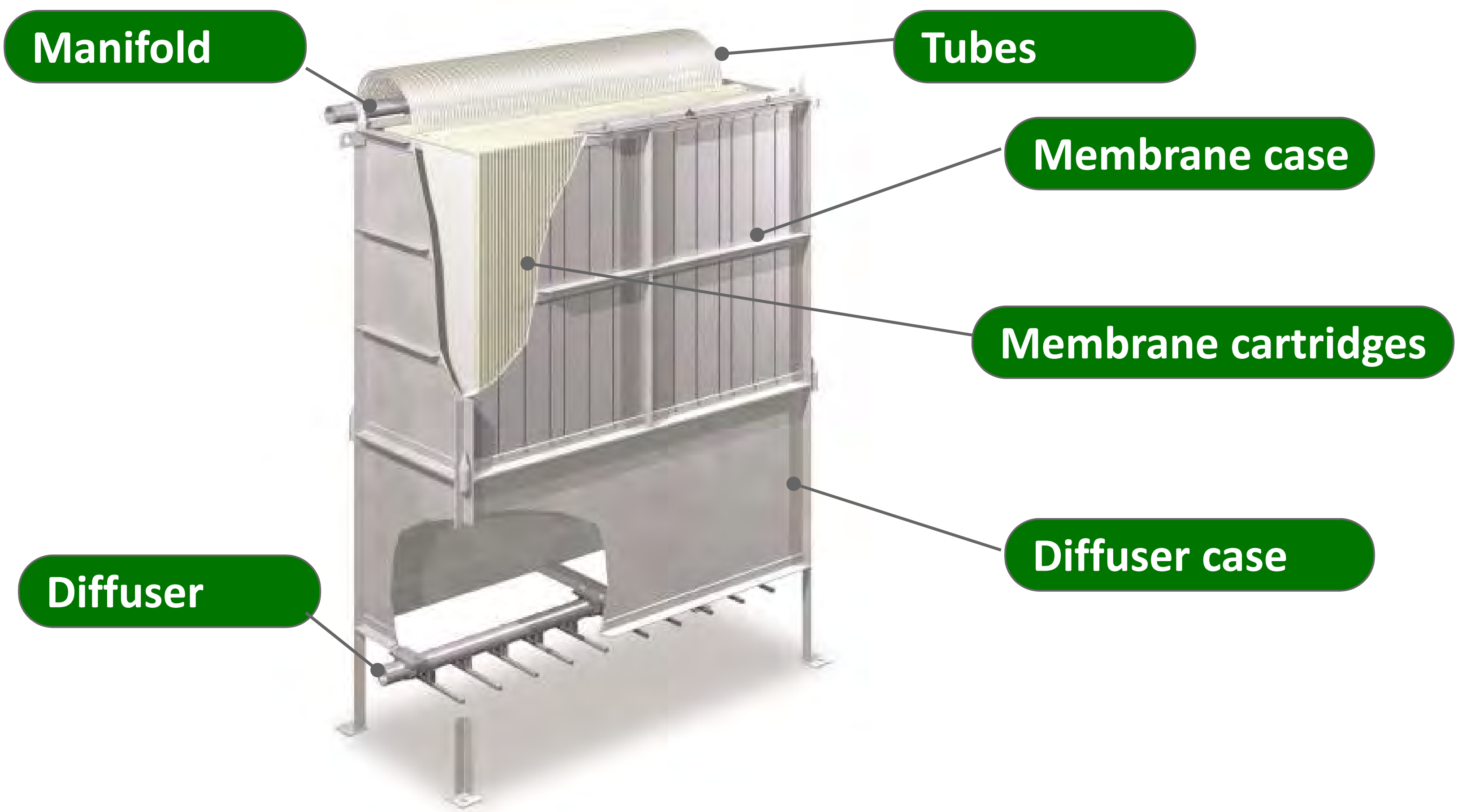


Chlorinated Polyethylene membrane; ultrasonically welded to both sides of an ABS plate

Membrane Thickener Data

- Nominal pore size 0.4 micron, effective pore size 0.1 micron
- Effective filtration area 8.6 ft^2 to 15.1 ft^2 per cartridge
- MBT Design flux 5 gfd @ 20° C
- MBT Cross flow velocity is 2.25 ft / sec

Submerged Membrane Unit (SMU)



Physical Responsibility

Design of The Submerged Membrane Unit (SMU)

- Acts like an air lift pump
  - •Continuous Course bubbles at the bottom
  - •Fully enclosed
  - •Air scour in constant contact with membrane through full range of travel
  - •Continuous movement of mixed liquor, keeps tank contents well mixed and in suspension

Biofilm - Basics

All submerged membranes have a biofilm.

What is a biofilm?

- A complex dynamic matrices comprised of microorganisms, EPS/SMP, non-biological solids, substrates, metabolites, interior pores and channels

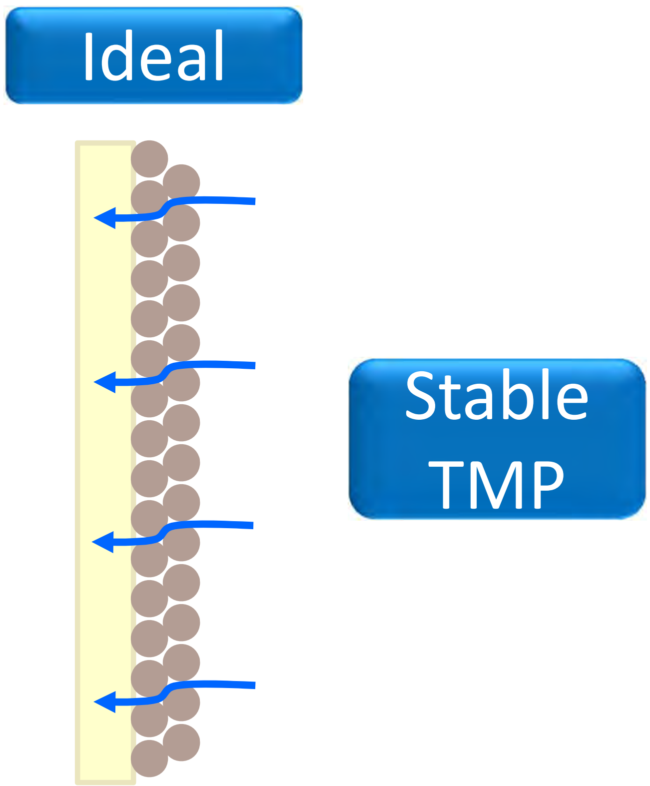
What do biofilms do?

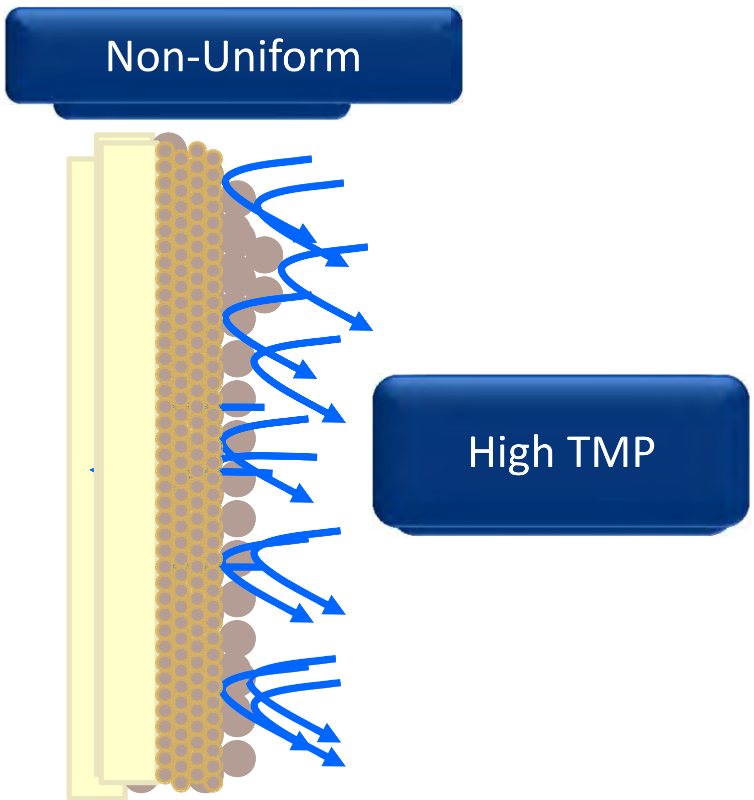
- Create a dense secondary membrane that can allow for enhanced nutrient removal and degradation of refractory organics

Why do we care?

- Biofilms serve as the primary filter and represent a changing resistance to filtrate flow (affects plant ops.)

Biofilm Conditions

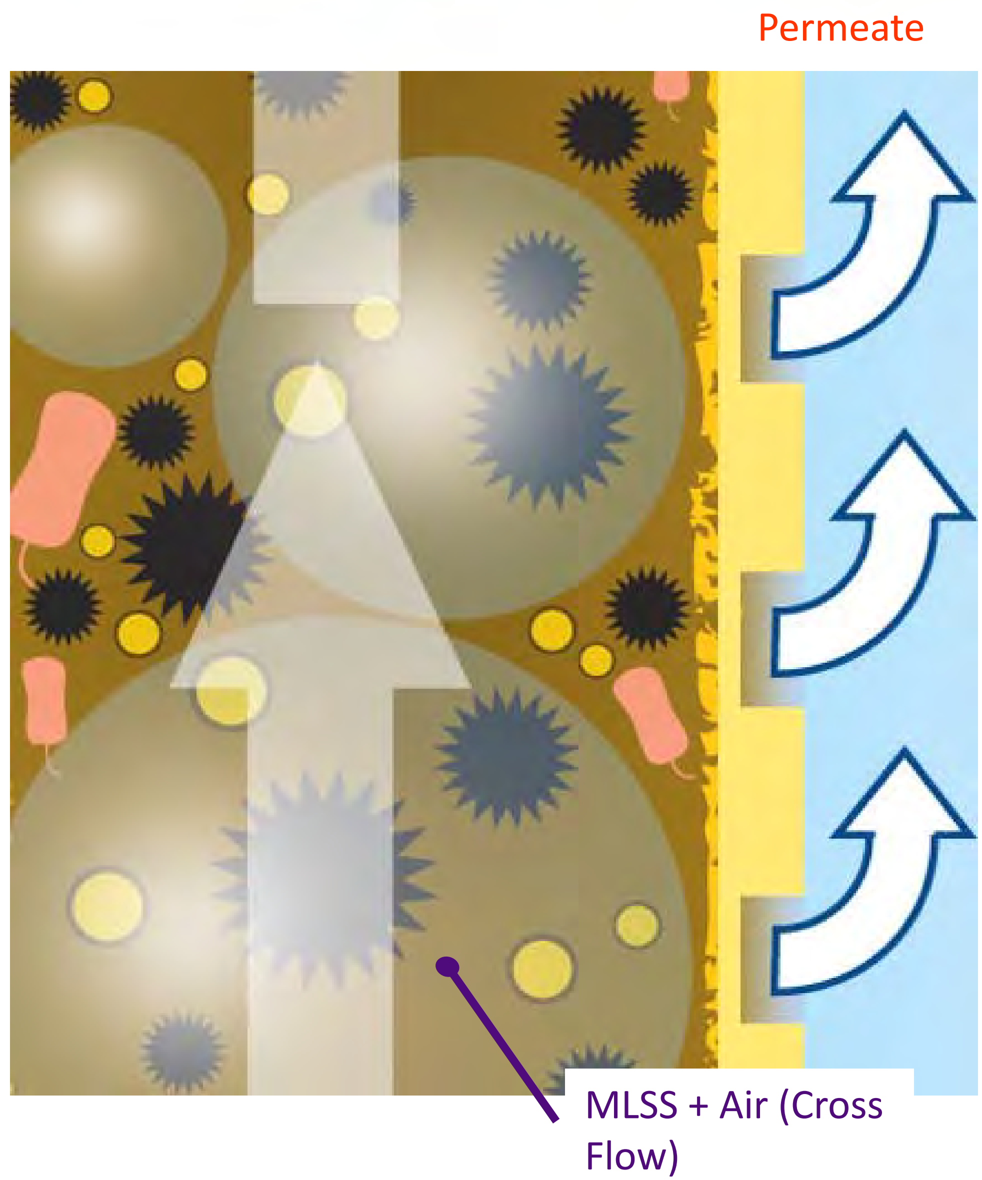




The Biofilm (A Dynamic Membrane)

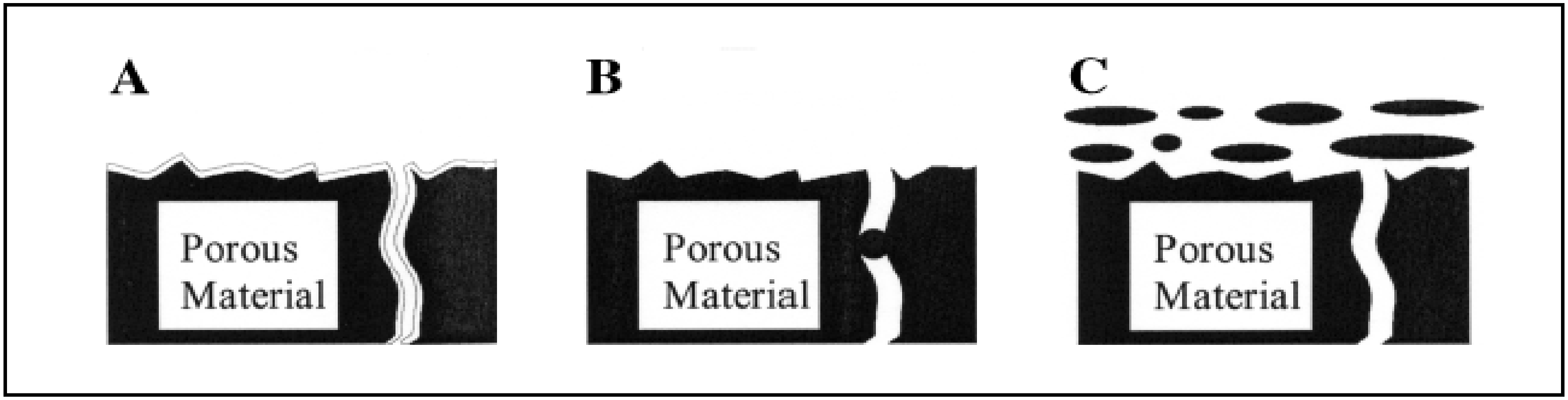
- Serves as primary filtering mechanism (0.1 μm)

- Biofilm control is key to membrane performance in mixed liquor (*biohydraulics*)



Types of Membrane Fouling

adsorption pore clogging particle deposition



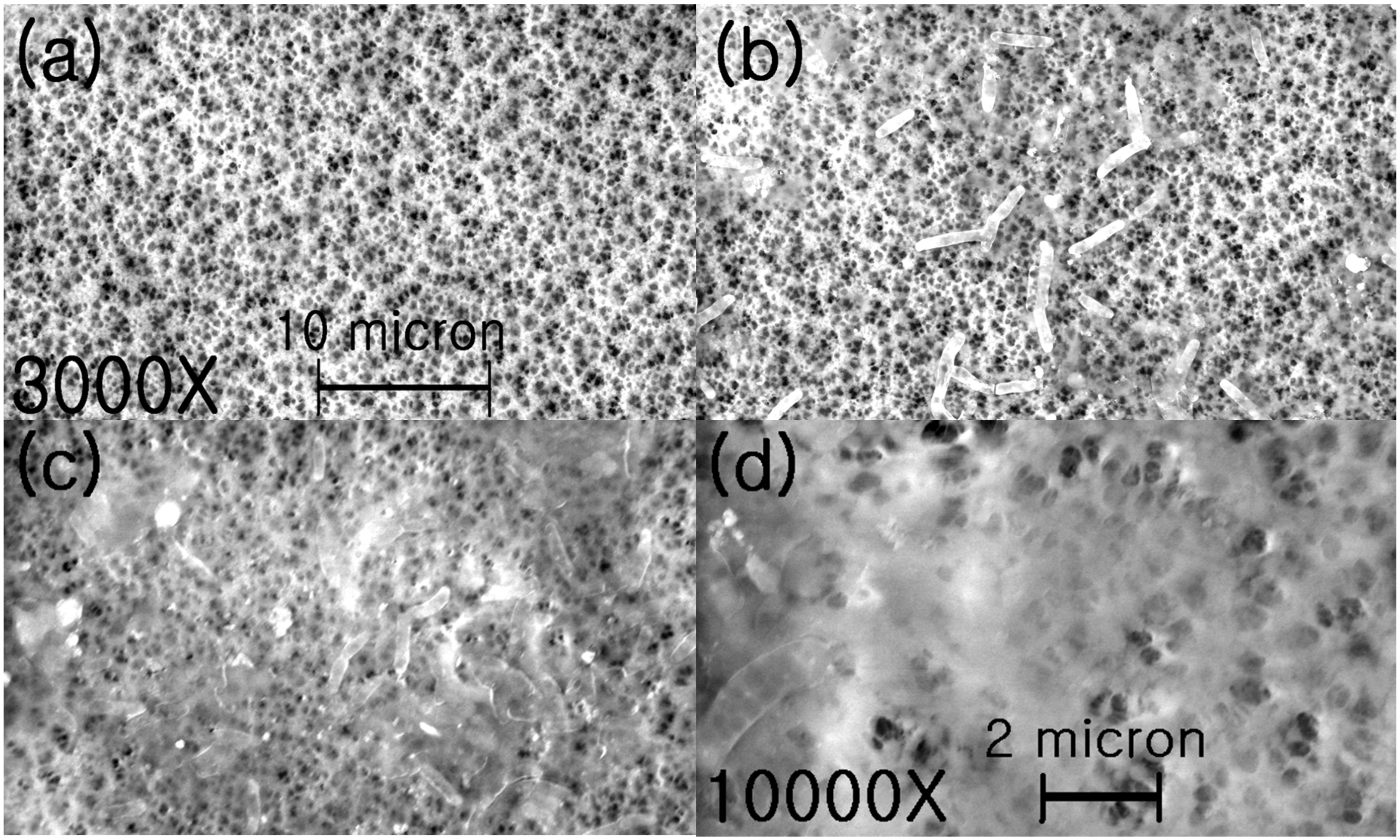
A: macromolecules on membrane matrix

B: macromolecules (aggregates) and cell debris

C: not serious if cells alone; serious w/ interstices filled by EPS (Extracellular Polymeric Substances)

Biofouling

In UF Membranes (Choi et. al., 2005)

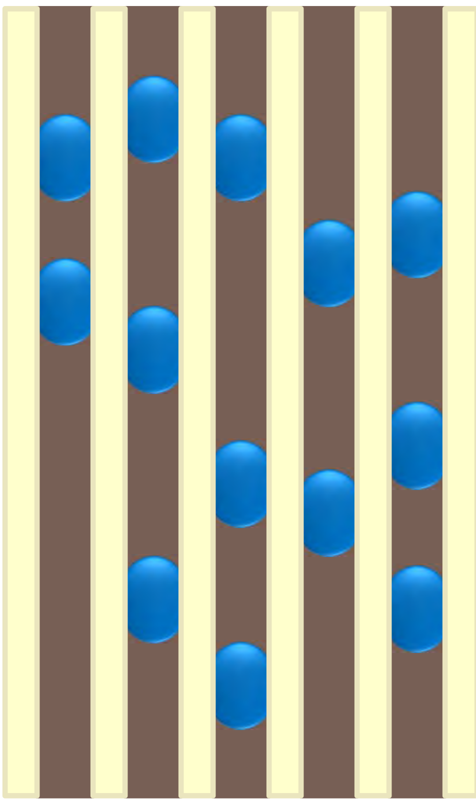


Biofilm Management

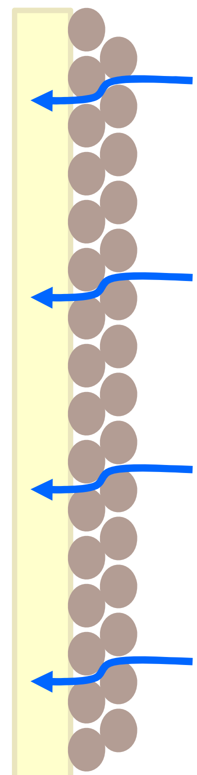
Air Scouring

- The rise velocity of bubbles impacts shear force and boundary layer thickness
- Rise velocity is a function of flowrate, geometry and flow resistance
- Intensity requirement is a function of deposition rate (flux) and fluid viscosity
- Defined air flow pathways promote even distribution
- Turbulent velocity (slug flow) maximizes effect

Air Scour



Ideal



Stable TMP (R_C)

How does SMU Air Scour work?

Continuous cross-flow of mixed liquor and air maintains optimum biofilm thickness

81

Chemical Cleaning (CIP)

Maintenance Cleaning

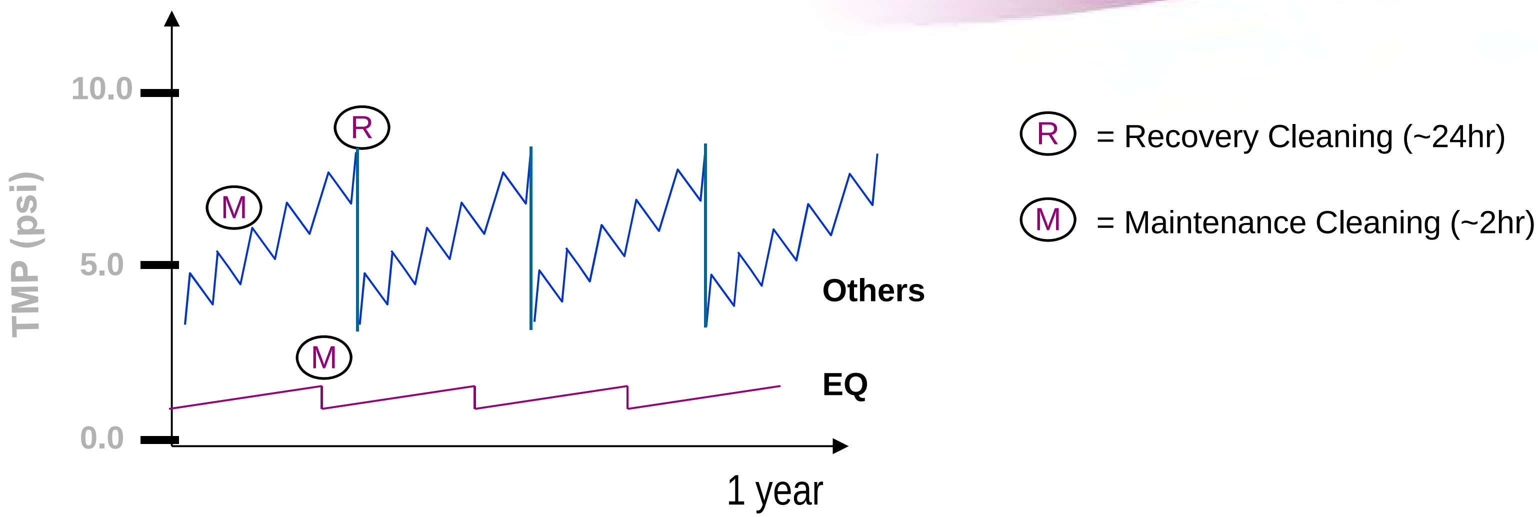
- Intended to remove surface (biofilm or cake) fouling.[1]
- Does not involve taking tanks out of service for extended periods of time (~1-4hr)
- Routine procedure
- Can return to MBR filtration mode in ~15 minutes

Recovery Cleaning

- Intended to "dislodge particles from membrane microstructure."[1]
- May take from >4-24hrs.
- Requires that membranes be soaked in concentrated chemical solution.
- Generally a non-routine procedure

[1] **Membrane Systems for Wastewater Treatment, WEF 2006.**

CIP Strategies



Enviroquip utilizes Maintenance Cleaning only (no Recovery Cleaning) to address *irreversible fouling.*

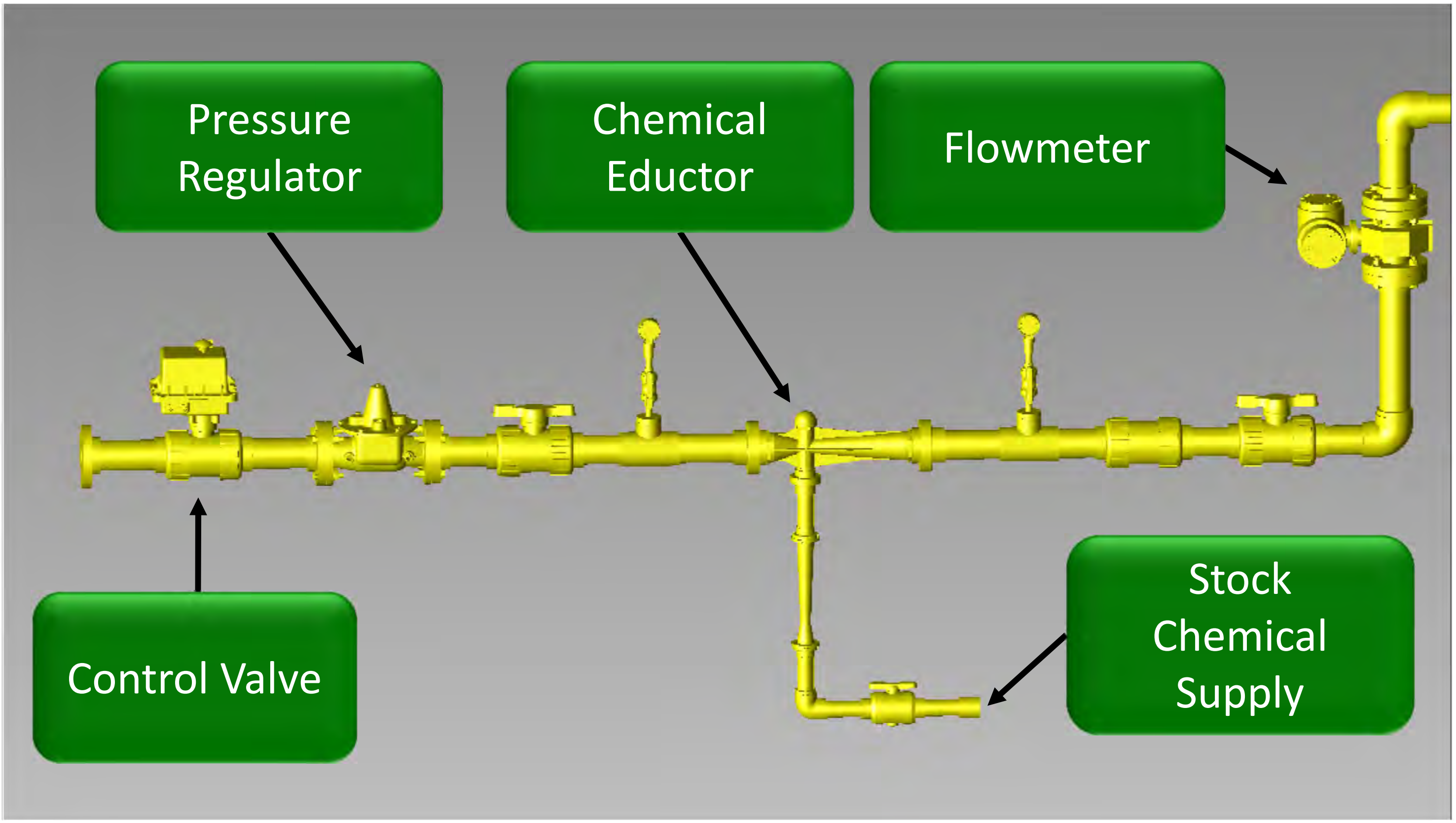
Operating at **low TMP** minimizes deep pore fouling and extends membrane service life.

High concentration, frequent dosing can impact sludge quality and increases TDS, making effluent less suitable as RO feed

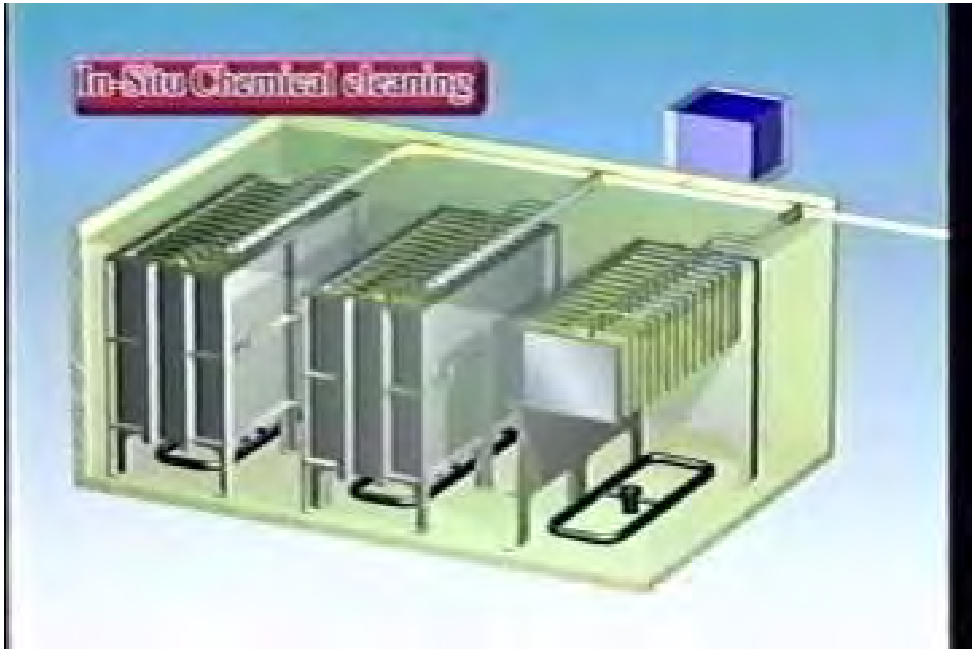
Minimizing chemical exposure minimizes membrane deterioration and **extends membrane service life**.

Reducing downtime also **reduces owner risk** while improving system flexibility.

Enviroquip Maintenance Clean



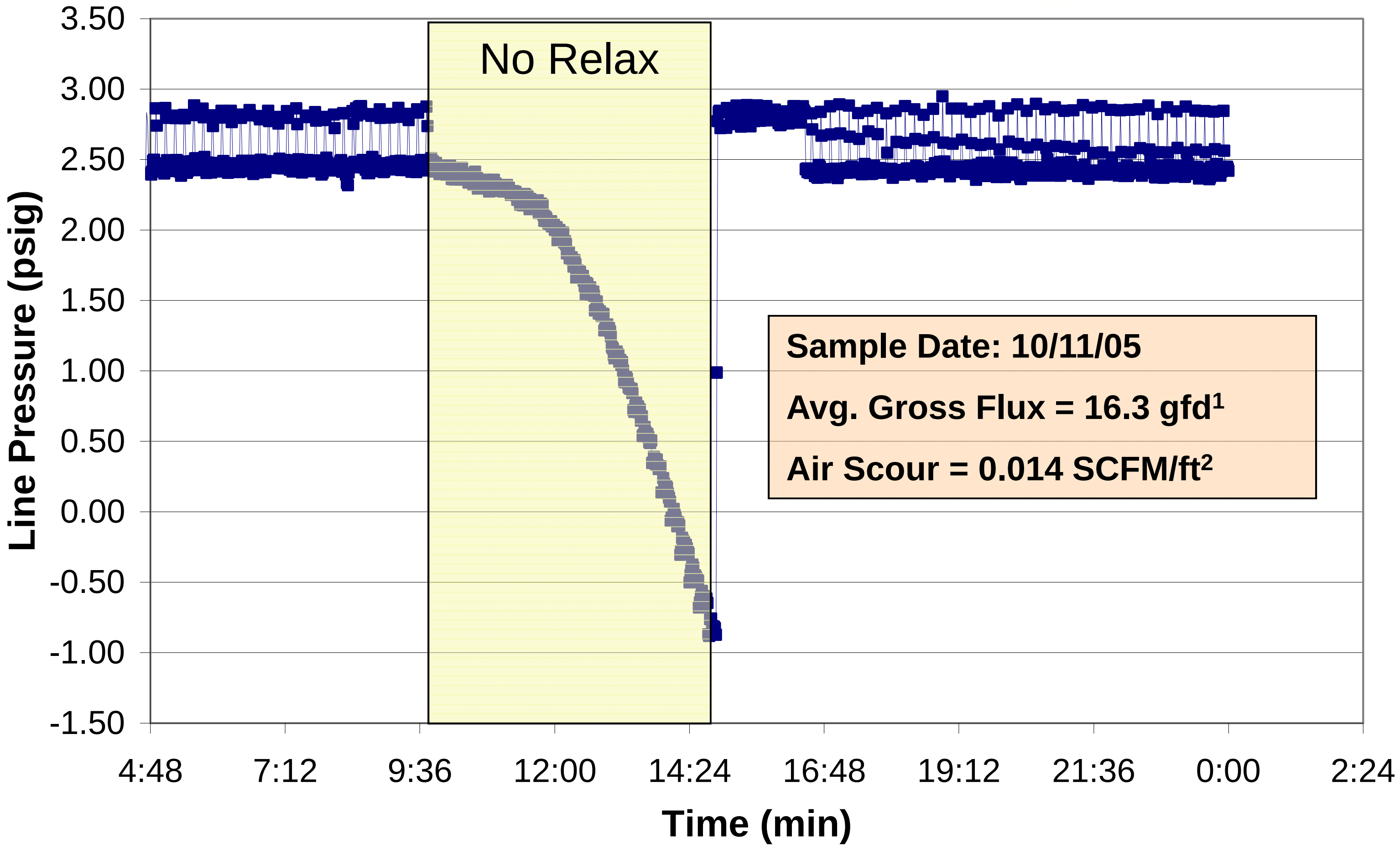
CIP Cartridge Distribution



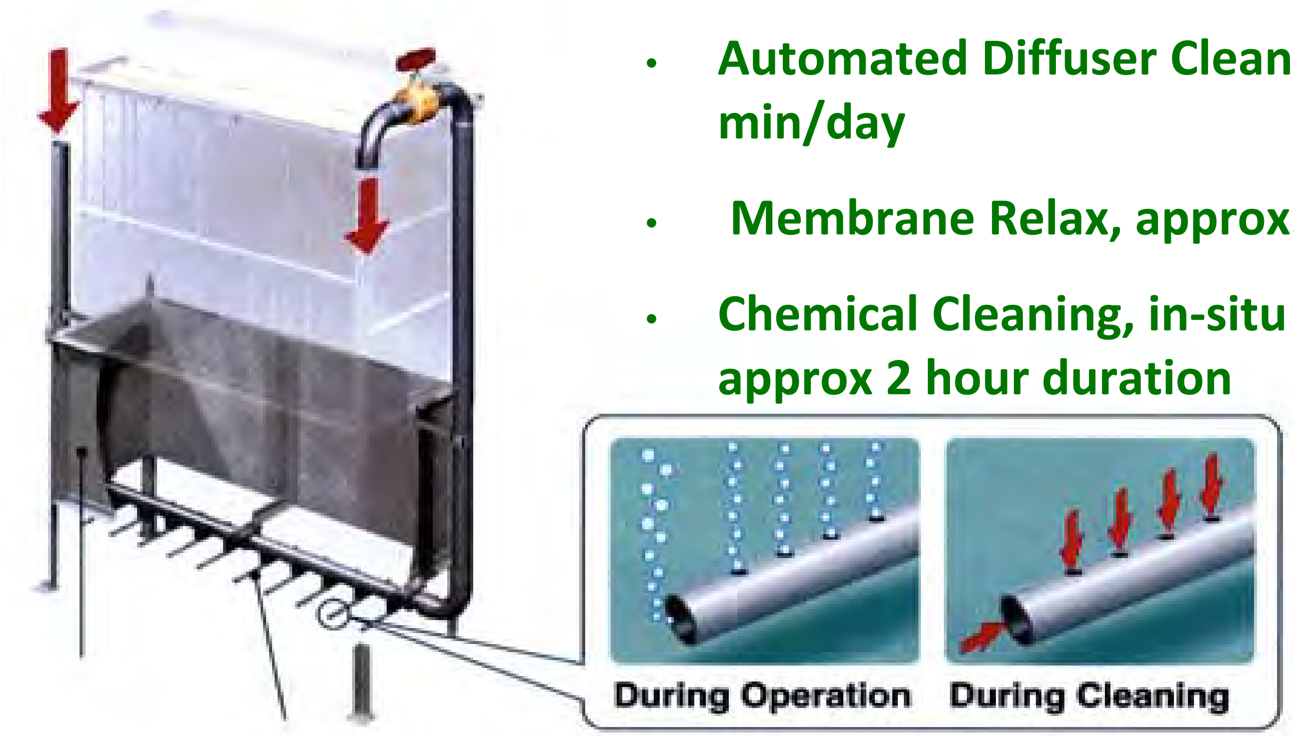
- Cleaning takes approximately 2-4 hour / MBR basin, using a dilute solution of 0.5% Sodium Hypochlorite or Citric Acid
- In-situ cleaning of membranes without draining MLSS
- Chlorine dosage less than that typically used for filamentous microorganism control
- No tank liners required

85

Relaxation
(King County DNR EW200 Pilot)



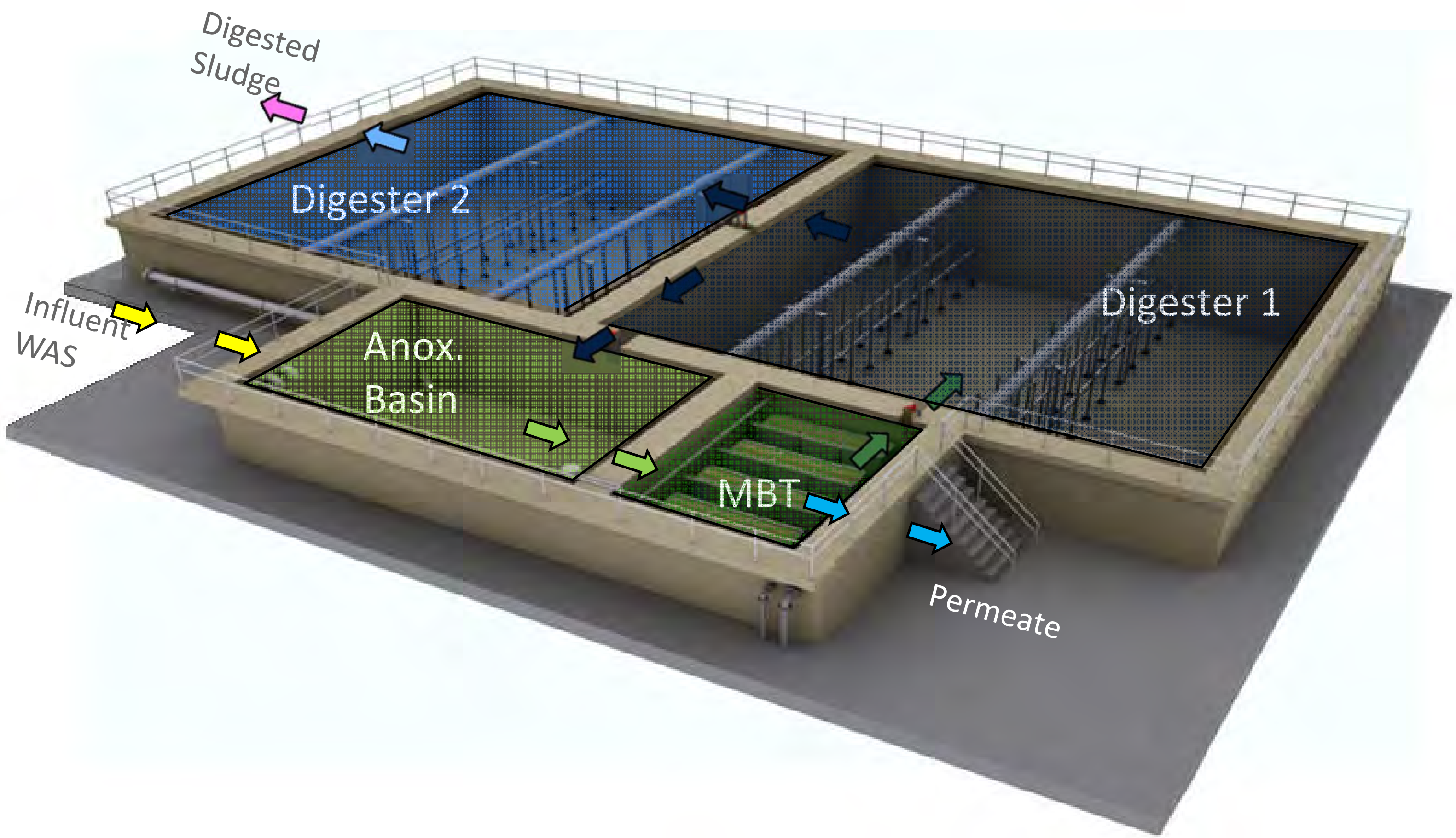
Minimum Maintenance Of Membrane Thickener



- **Automated Diffuser Cleaning, approx. 30 min/day**
- **Membrane Relax, approx. 1min/10min**
- **Chemical Cleaning, in-situ clean every 6 months, approx 2 hour duration**

NO NEED TO DRAIN TANKS OR TAKE OUT OF SERVICE FOR CHEMICAL CLEANING!

Mem-TAD Process

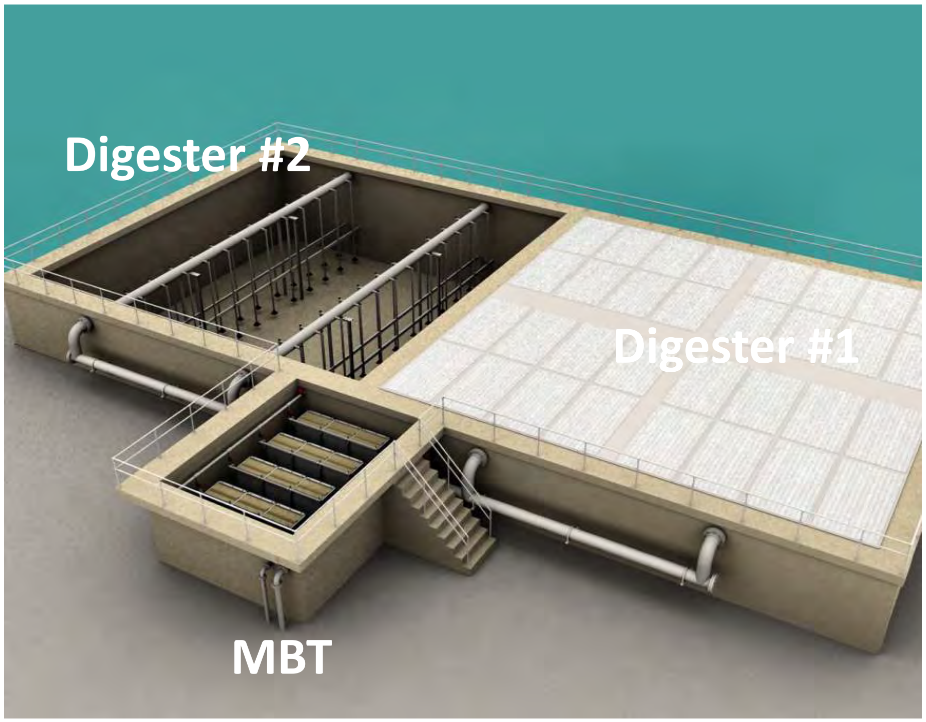


Case Studies of Aerobic Digestion Processes with Membrane Thickening

Dundee WWTP, Michigan

MBR and Mem-TAD

Dundee WWTP, Michigan



Engineer: Arcadis

History:

- Objective was to reduce the hauling to 2 times per year. Tanks are designed to store 180 days at 3% solids.
- Operator friendly when compared to other systems.
- Enviroquip's Aerobic Digestion experience rated higher when evaluated against other vendors/technologies.

Membrane Thickener Tank

92

Digester 1

OVIVO
Bringing water to life

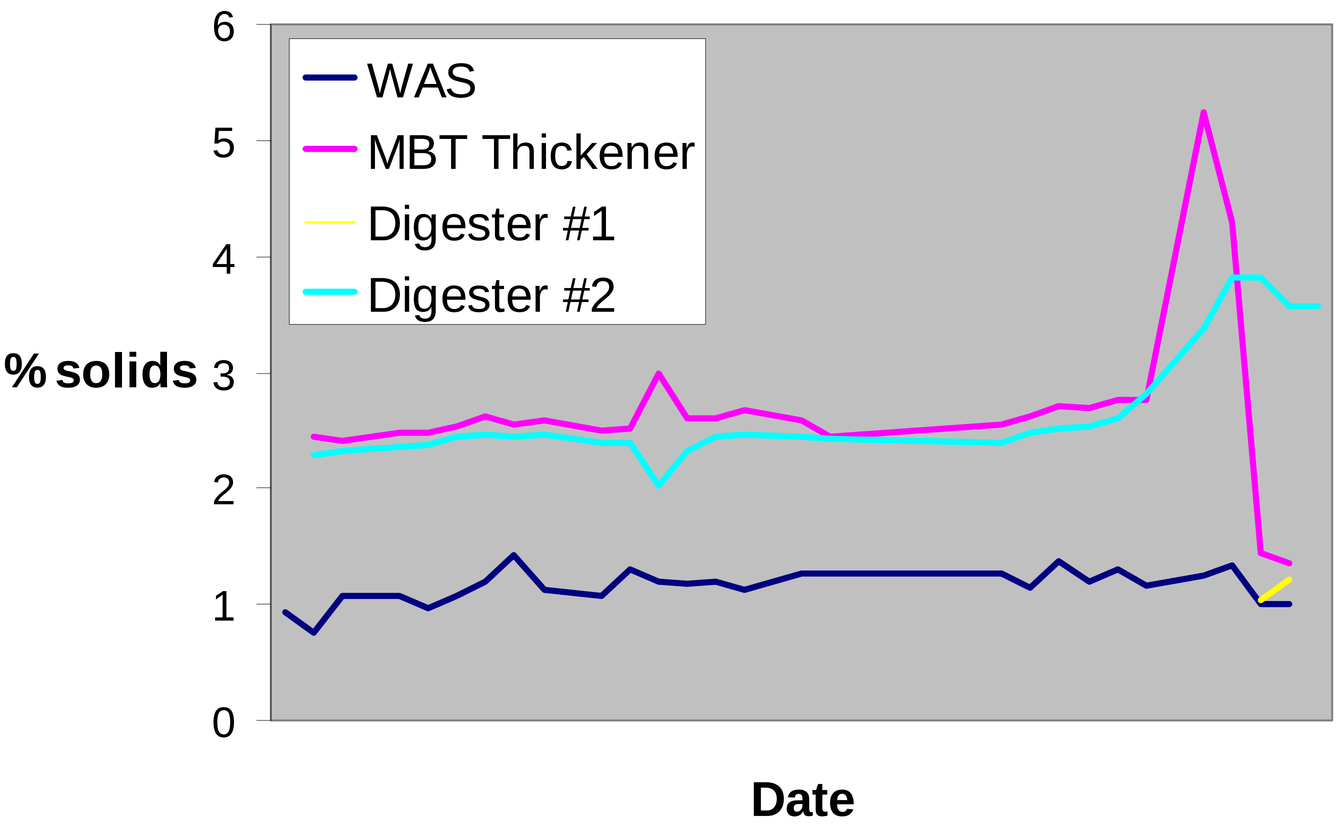
93

Digester 2

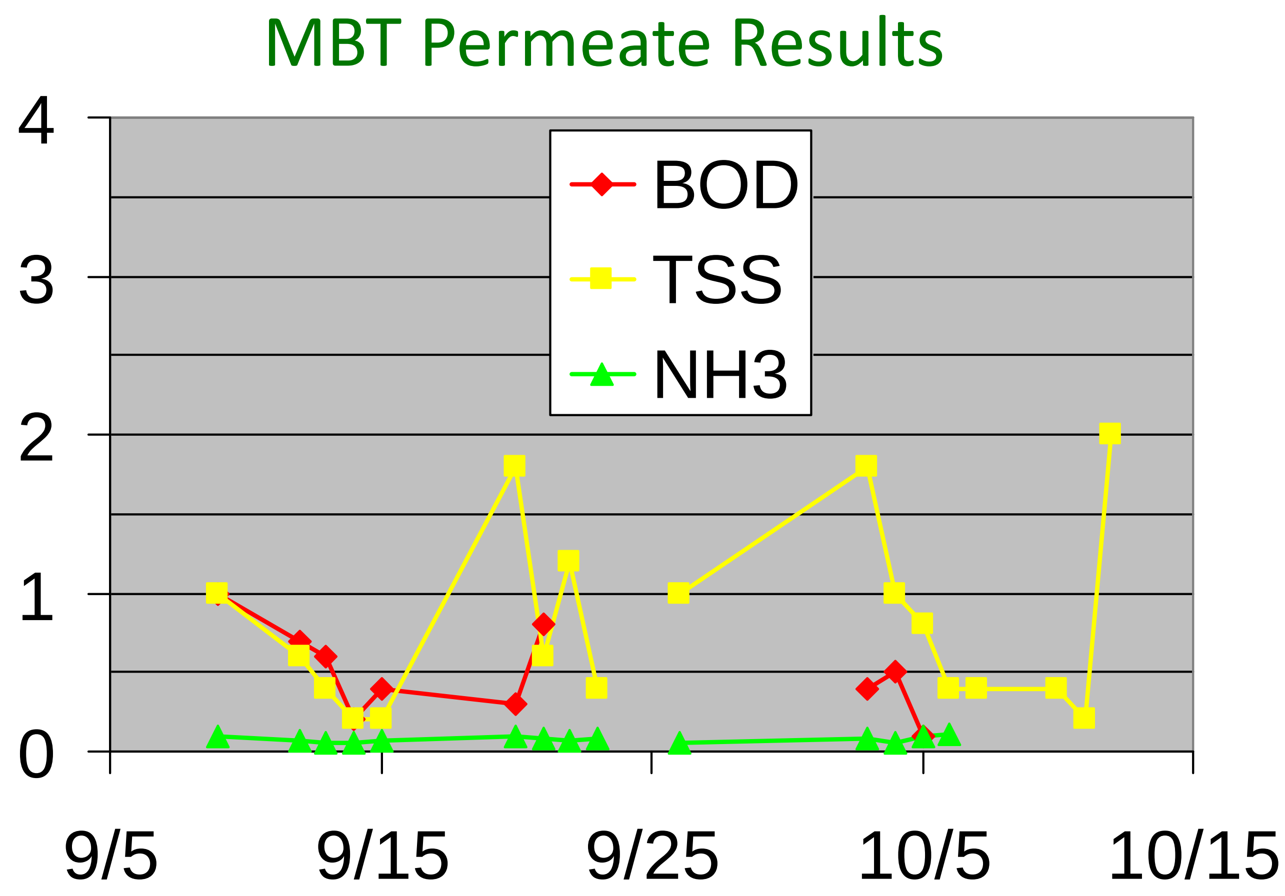
Dundee WWTP, Michigan

Thickening Performance

Sep & Oct 2005 Operation



Dundee WWTP, Michigan



Dundee WWTP, Michigan

January 2007 to June 2008 Data

Sustainable Permeate Quality

before it's blended with MBR effluent

BOD:	**1.12 mg/l**
TSS:	**2.00 mg/l**
NH_3-N:	**0.22 mg/l**
NO_3-N:	**0.03 mg/l**
TP:	**1.09 mg/l**

Dundee WWTP, Michigan Sludge Hauling Cost Summary

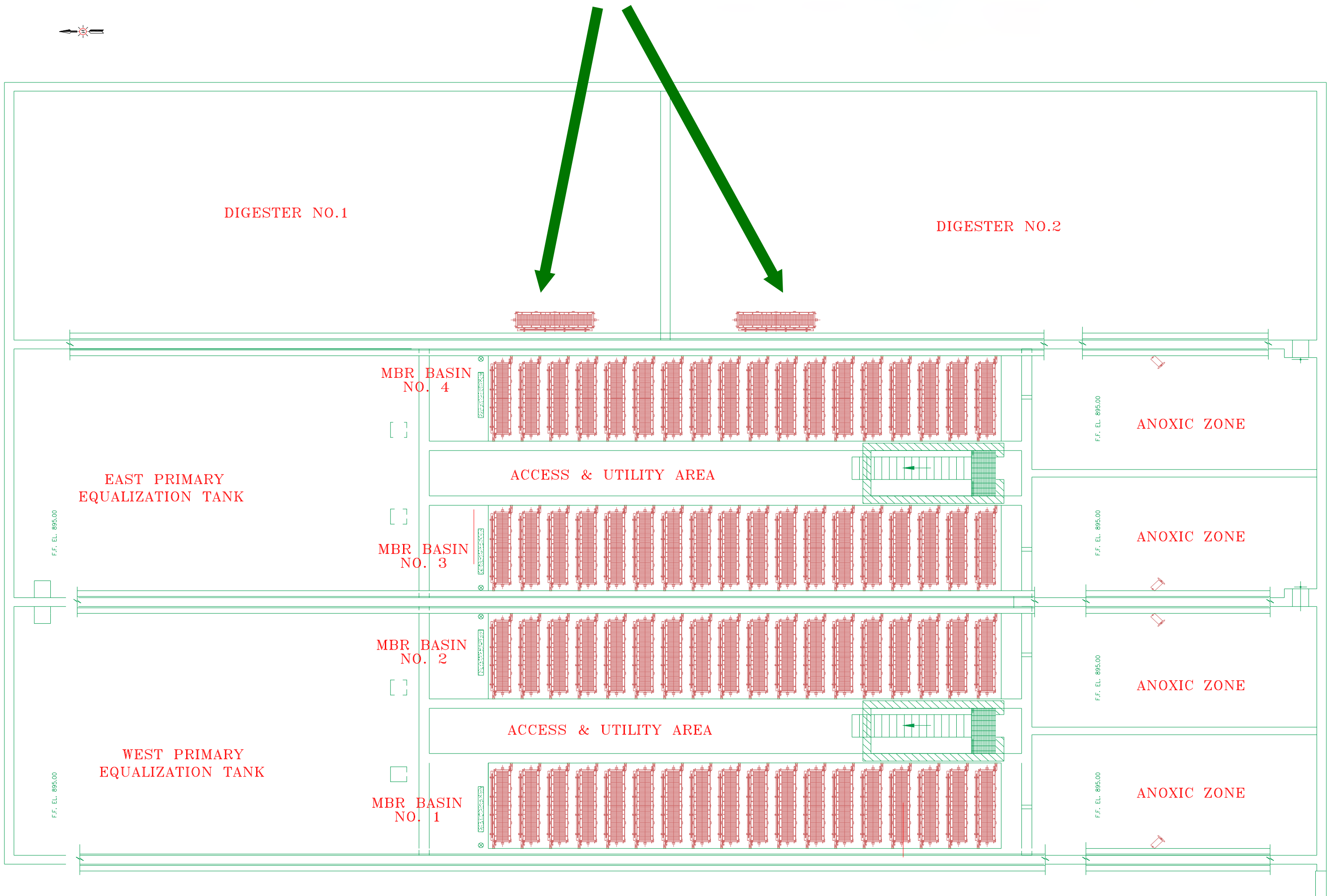
Years	Gallons Hauled	Dry Tons	Yearly Cost
2004 (0.6 MGD SBR)	248,885 – Belt 943,200 – Truck 1,192,100 - Total	22.67 – Belt 99.39 – Truck 122.06 - Total	$16,850 – Belt $30,088 – Truck **$46,938 - Total**
2005 (1.2 MGD MBR) MBT operational for 2nd half of year only	572,400 – Belt 432,000 – MBT 1,004,400 - Total	55.62 – Belt 47.55 – MBT 103.17 - Total	$39,135 – Belt $14,623 – MBT **$53,758 – Total**
2006	**887,400 - MBT**	**130.48 – MBT***	**$32,739 - MBT**

Belt press was needed for years 2003 -05 due to lack of storage space.

Sludge Hauling costs for first full year of operation of MBT in 2006
was $32,739 which is lower than the last 5 years

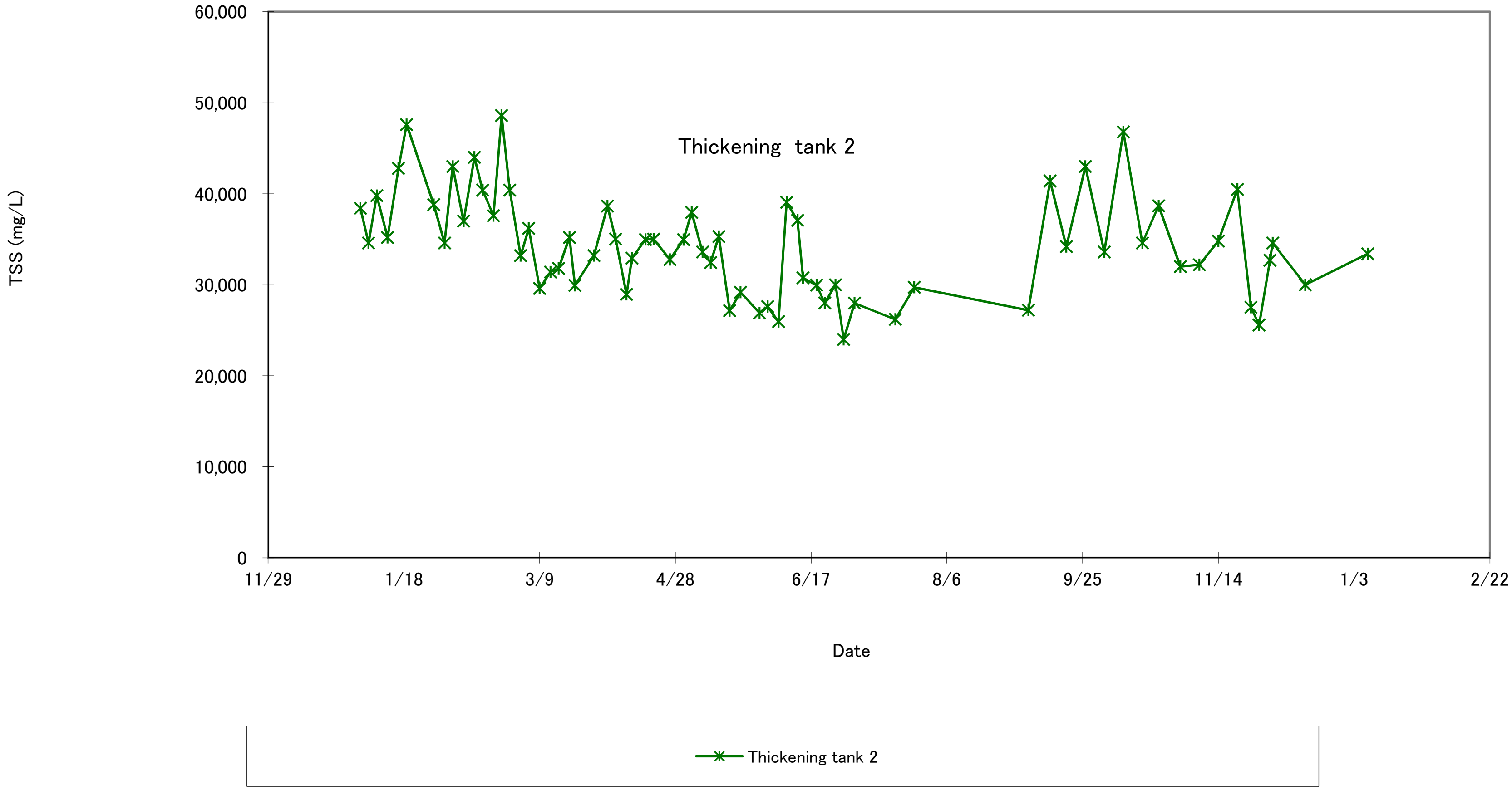
McFarland Creek, OH
MBR + Mem-TAD

SMUs Installed Directly in Digesters



100

McFarland Creek WWTP, Ohio

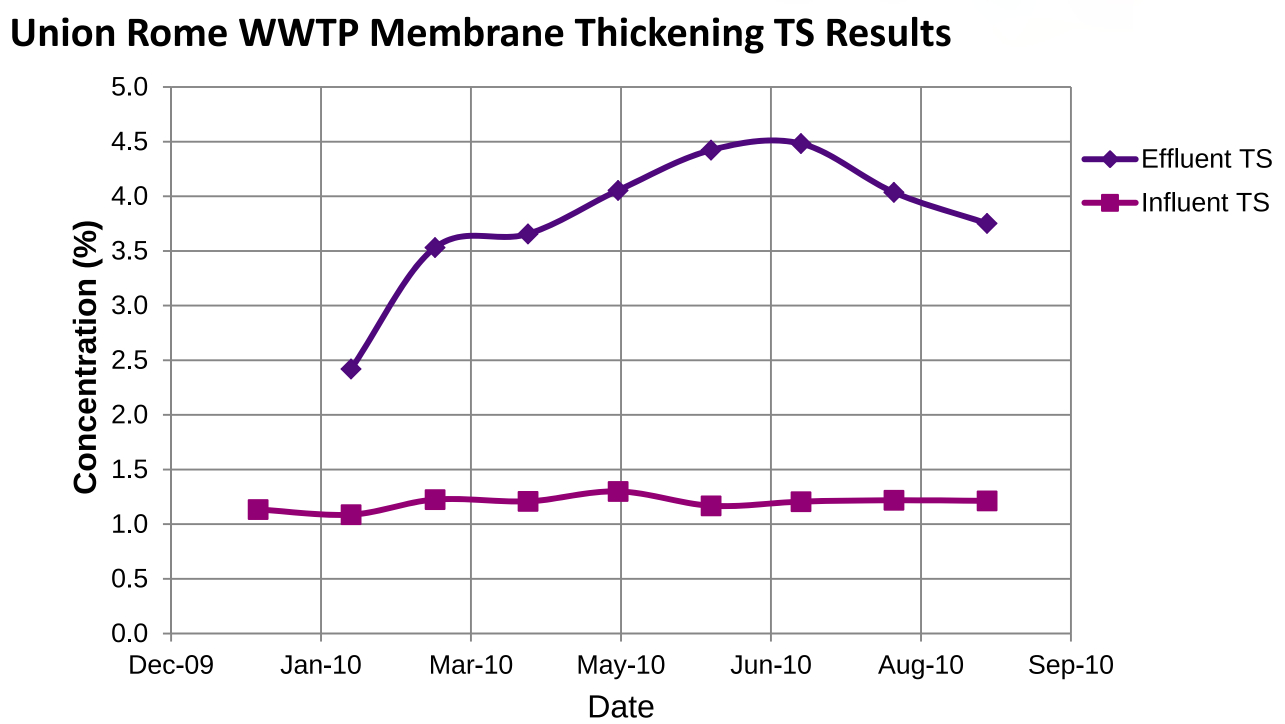


Membrane thickening at McFarland Creek WWTP was able to thicken up to 5% solids.

Union Rome WWTP, Ohio
Engineer: CT Consultants

MBR and Mem-TAD

Union Rome WWTP, Ohio



The TS concentration was MORE THAN TRIPLED by thickening with membranes at Union Rome WWTP.

Union Rome WWTP, Ohio

January 2010 to October 2010 Data

Sustainable Permeate Quality

after it's blended with MBR effluent

BOD:	**<1.0 mg/l**
TSS:	**<1.0 mg/l**
NH_3-N:	**<0.1 mg/l**
TP:	**<5.0 mg/l**

Membrane Thickening

Combines a Membrane Thickening Tank with a Solids Holding Tank.

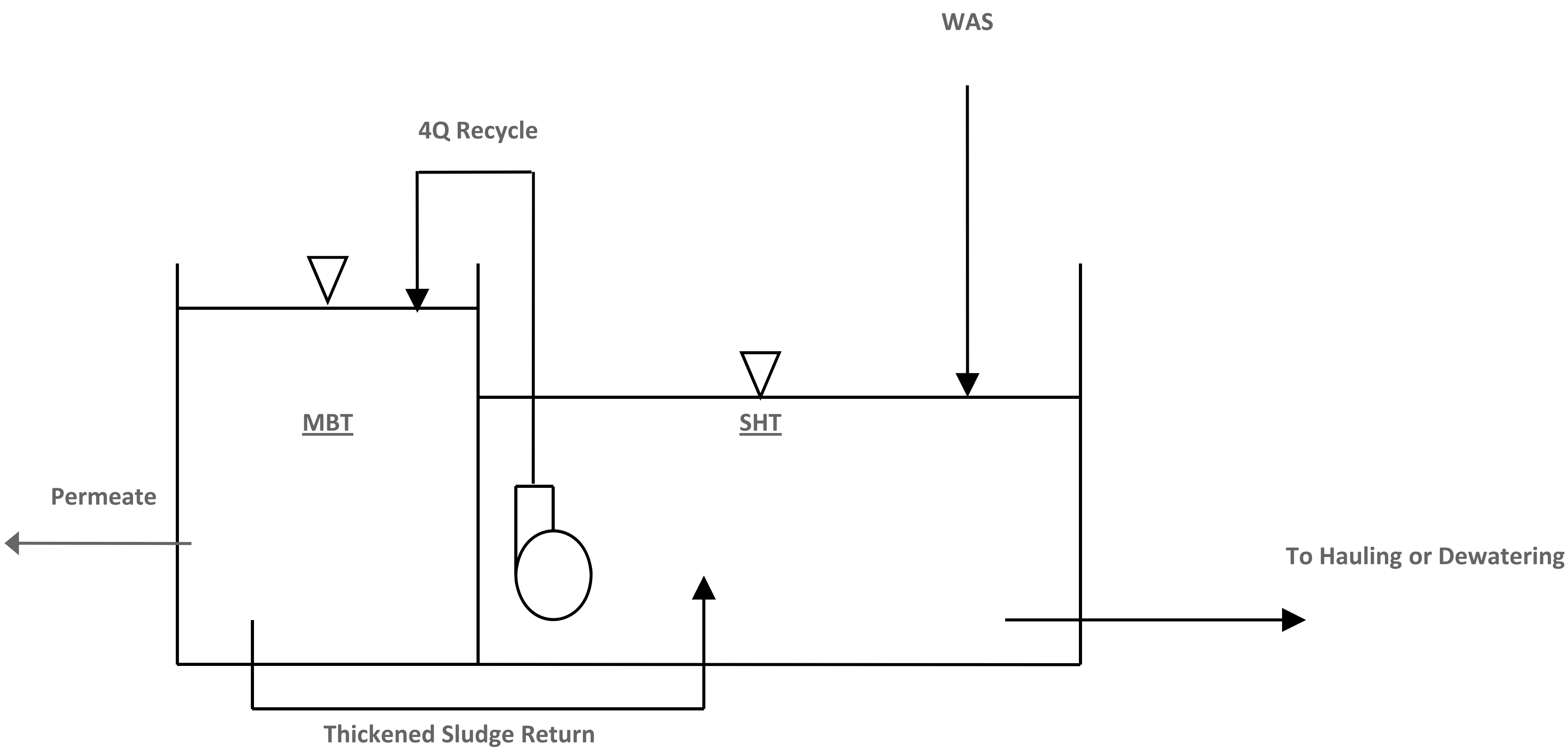
Thickening not Class B!

Capable of between 3% & 5% solids

No polymer required

Continuous thickening - independent of wasting schedule

Membrane Thickening Process Flow Diagram



Woodside NY – 0.30 MGD

Driver: Reduce Hauling costs

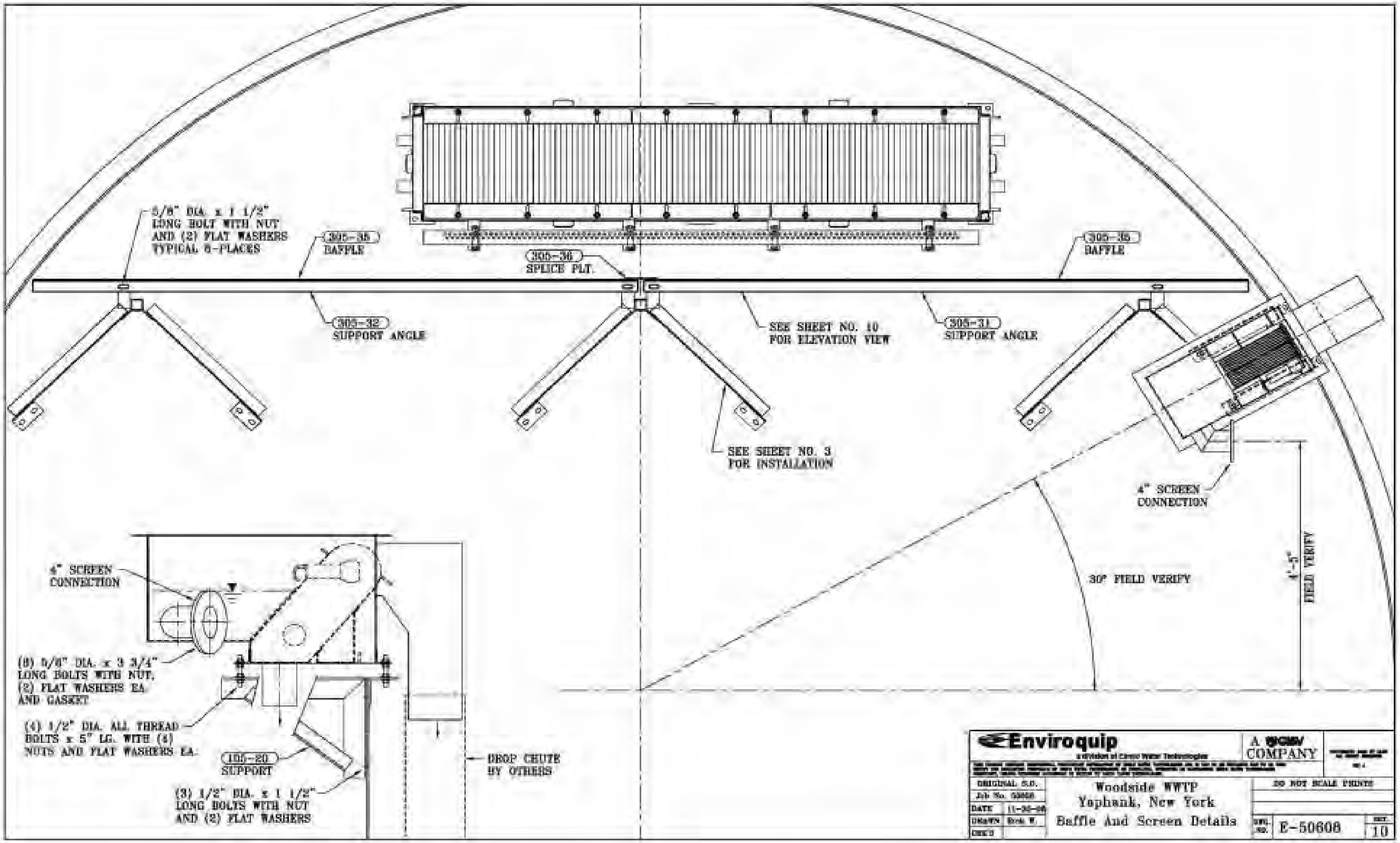
Retrofit system following Conventional Activated Sludge

Operational since Feb. 2008

Using Existing Tanks (2-25’ dia. x 15’ deep)

107

Woodside, NY



5/8" DIA. x 1 1/2" LONG BOLT WITH NUT AND (2) FLAT WASHERS TYPICAL 6-PLACES
305-35 BAFFLE
305-36 SPLICE PLT.
305-35 BAFFLE
305-32 SUPPORT ANGLE
SEE SHEET NO. 10 FOR ELEVATION VIEW
305-31 SUPPORT ANGLE
SEE SHEET NO. 3 FOR INSTALLATION
4" SCREEN CONNECTION
30° FIELD VERIFY
4'-5" FIELD VERIFY
4" SCREEN CONNECTION
(8) 5/8" DIA. x 3 3/4" LONG BOLTS WITH NUT, (2) FLAT WASHERS EA. AND GASKET
(4) 1/2" DIA. ALL THREAD BOLTS x 5" LG. WITH (4) NUTS AND FLAT WASHERS EA.
105-20 SUPPORT
(3) 1/2" DIA. x 1 1/2" LONG BOLTS WITH NUT AND (2) FLAT WASHERS
DROP CHUTE BY OTHERS
Enviroquip
A COMPANY
ORIGINAL S.O.
DATE
DRAWN
CHK'D
Woodside WWTP
Yaphank, New York
Baffle And Screen Details
DO NOT SCALE PRINTS
E-50608
10

Woodside MBT Compartment / SHT

Woodside, NY Results

Thickening of CAS solids to 3.0 to 3.5%

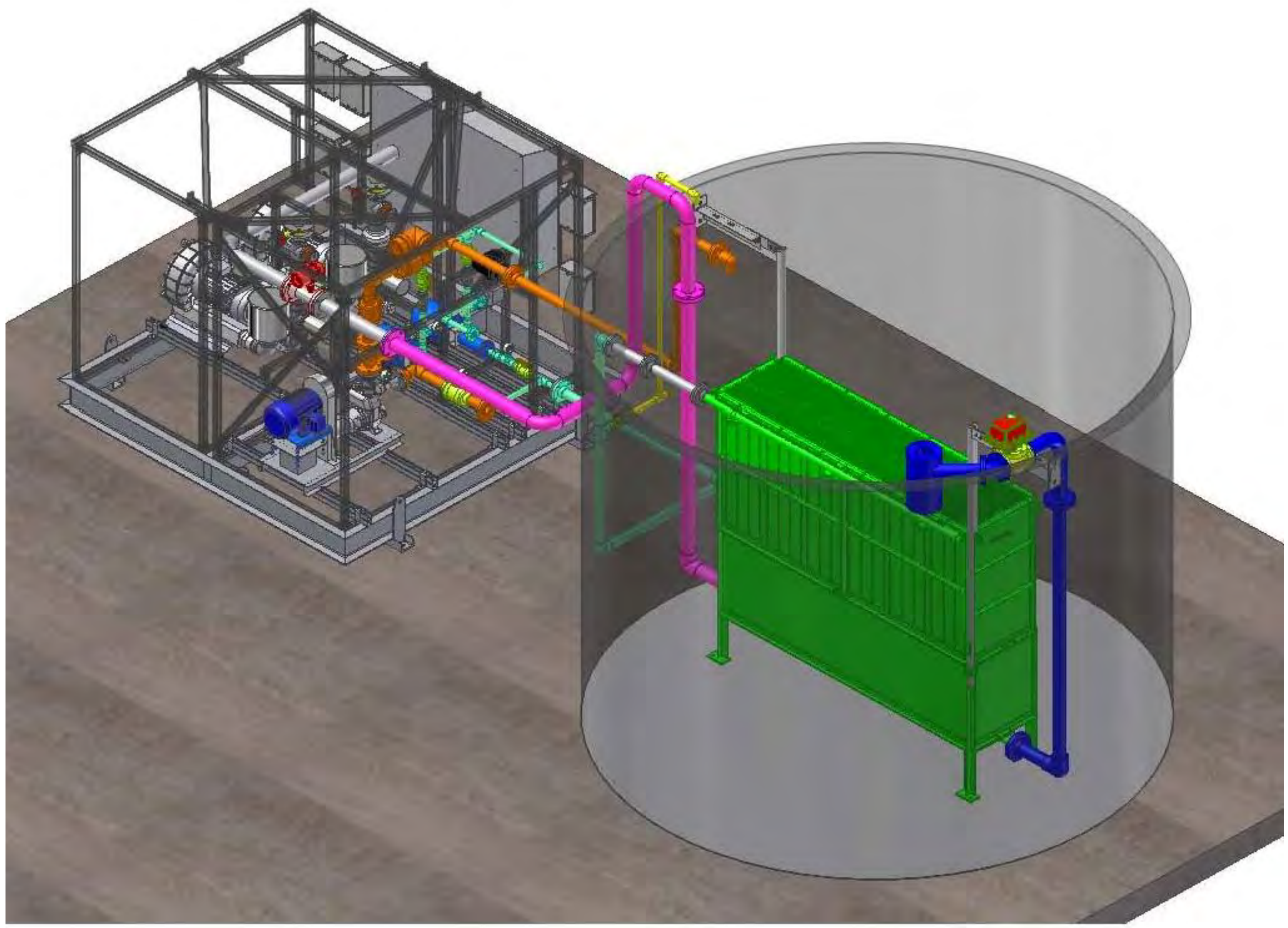
Reduced the number of trucks by Half in 2008

Reduced amount of Nitrogen in the sludge and permeate

Low operator attendance required

110

Eco-MAT



Operations: What don’t you do?

Start the unit up each day

Shut the unit down each day

Check the polymer system

Check the unit repeatedly throughout the day

Check the polymer system

Operations: What do you do?

Collect daily process data

Perform visual inspection of system

Chemical clean membranes 3 – 4 times per year

Perform regularly scheduled preventative maintenance

MBT – Aerobic Dig. Installations

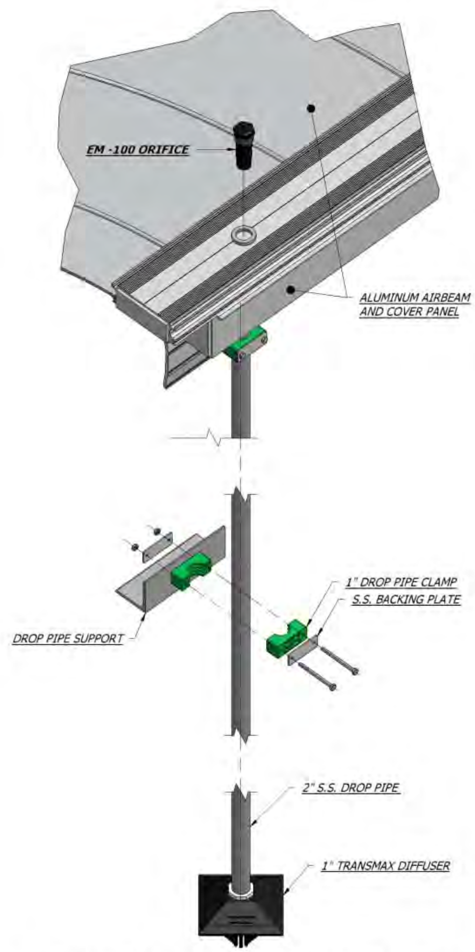
Date	Plant	City	State	Liquid Process	MBT/ PAD-K
Jun-04	Dundee WWTP	Dundee	MI	MBR	PAD-K
Jun-04	Arlington WWTP	Arlington	WA	SBR	MBT
Jul-04	Troy WWTP	Troy	MO	MBR	PAD-K
Aug-04	McFarland Creek WWTP	Chagrin Falls	OH	MBR	PAD-K
Nov-04	Gnadenhutten WWTP	Gnadenhutten	OH	MBR	PAD-K
Apr-05	Delphos WWTP	Delphos	OH	MBR	Stormmaster
Apr-05	Cottonwood WWTP	Manor	TX	MBR	PAD-K
Aug-05	Lewes WWTP	Lewes	DE	MBR	MBT
Nov-05	East Dundee WWTP	East Dundee	IL	CAS	PAD-K
Apr-06	Yakama IN Casino	Toppenish	WA	MBR	PAD-K
May-06	Woodside STP	Yaphank	NY	CAS	PAD-K
May-06	Stoutsville WWTP	Stoutsville	OH	MBR	MBT
Jun-06	North Lewisberg WWTP	North Lewisberg	OH	MBR	MBT
Jul-06	Harvest Monrovia	Hunstville	AL	MBR	MBT
Jul-06	Bob's Creek WWTP	Lincoln County	MO	MBR	PAD-K
Aug-06	Hamden WWTP	Hamden	OH	MBR	MBT
Aug-06	Shelton WWTP	Shelton	WA	MBR	MBT
Sep-06	Lake of the Pines WWTP	Auburn	CA	MBR	PAD-K
Nov-06	Concrete WWTP	Concrete	WA	MBR	PAD-K
Dec-06	Providence Estates	O'Fallon	MO	MBR	PAD-K
Feb-07	Westford-Acton WWTP	Acton	MA	MBR	MBT
Apr-07	Winlock WWTP	Winlock	WA	MBR	PAD-K
Jun-07	Burwell Road WWTP	Hunstville	AL	MBR	MBT
Jun-07	Highland Lake Estates WWTP	Monroe	NY	MBR	MBT
Apr-08	Alpine WWTP	Alpine	WY	MBR	PAD-K
Jul-08	Union Rome WWTP	Union Rome	OH	MBR	PAD-K
Oct-09	C'oeur d'Alene Casino	C'oeur d'Alene	ID	MBR	PAD-K
Dec-09	Cayce WWTP	Cayce	SC	OX	PAD-K

114

AirBeam Covers

AirBeam® covers help to aid in temperature control and integrates Ovivo's aeration equipment

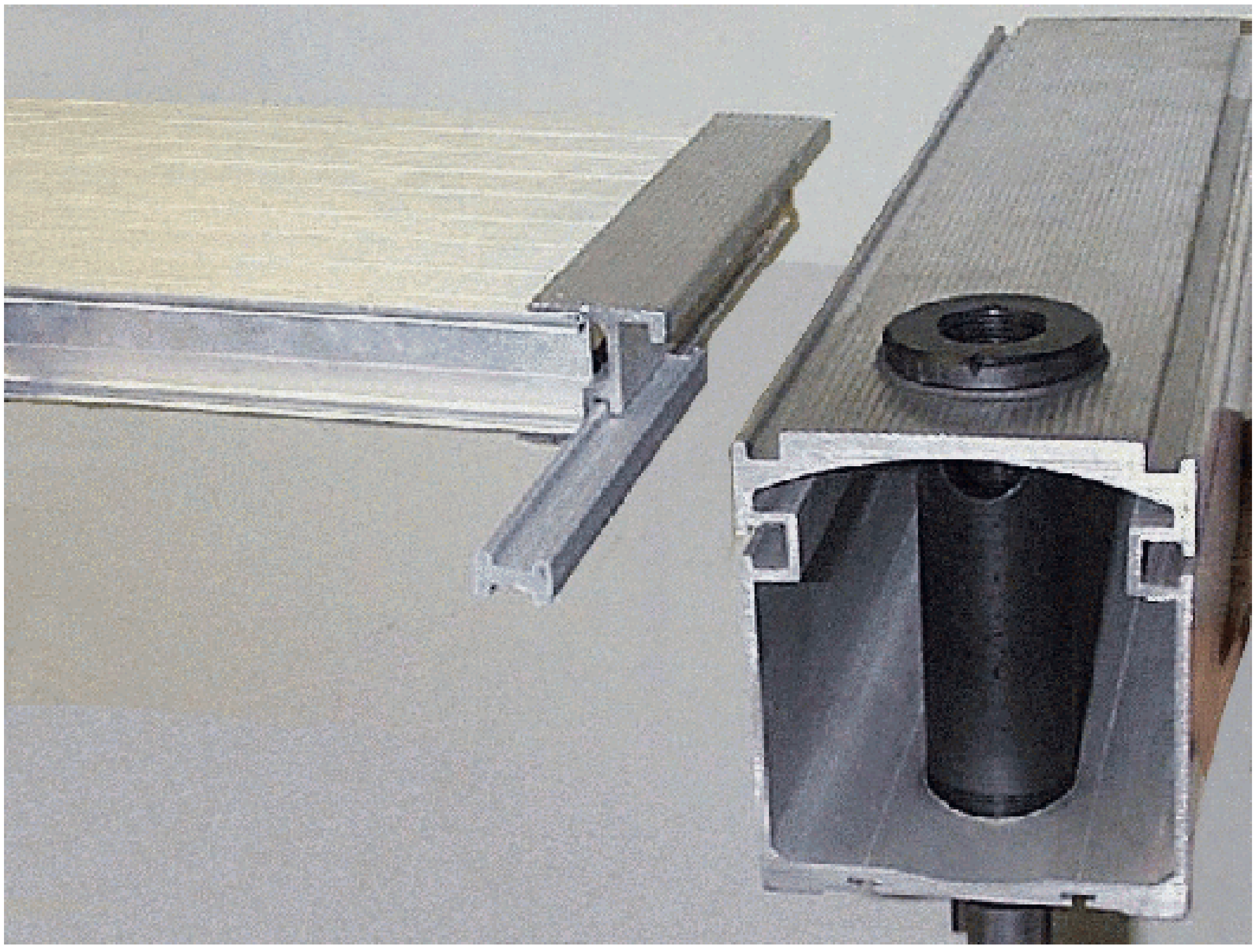
AirBeam with Diffusers



TRANSMAX DIFFUSER WITH AIRBEAM COVER ASSEMBLY - TYPICAL

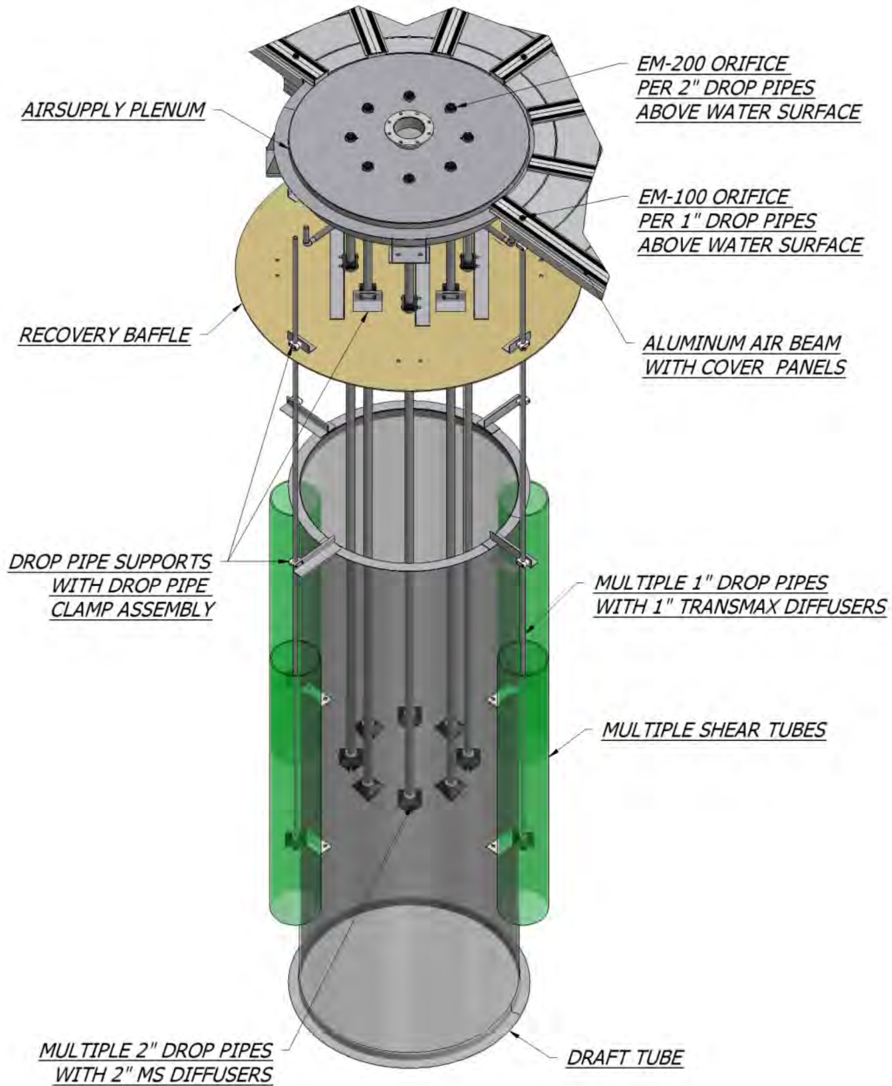
AirBeam Covers

AirBeam Components



AirBeam Covers

AirBeam with Draft Tube



MULTI-EDUCTOR DRAFT ASSEMBLY WITH AIRBEAM COVER

Is Aerobic Digestion Right for You

Right for You?

Aerobic Digestion is very good for anyone who has a nutrient limit on their effluent

We are able to remove nitrogen (and phosphorus with the mem-TAD) thus lowering the impact of recycle streams on the liquid process

Mem-TAD systems can be fed around the clock, this means less of a shock on the liquid stream biomass

Right for You?

Our products and systems (especially the membranes) are ideal for expanding existing capacity of treatment plants

This is a huge issue as towns and cities have to do more with less all the time

Right for You?

Membrane products produce reuse quality effluent

As water becomes more and more valuable this feature is going to become more and more important for wastewater plants

Right for You?

Coarse bubble diffusers work extremely well in deep tanks, always be on the lookout for a plant that has existing deep tanks and/or one looking to lower it's blower power requirements.

Thank You for your Time and Attention!