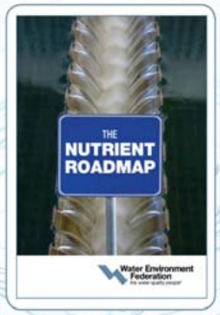
Webcast attendees receive
10% off *The Nutrient Roadmap*



Order No.	P150002 (print) P150002EBOOK (e-book)
List:	~~$105.00~~ $94.50
Member:	~~$84.00~~ $75.60

Use promo code WEB at checkout

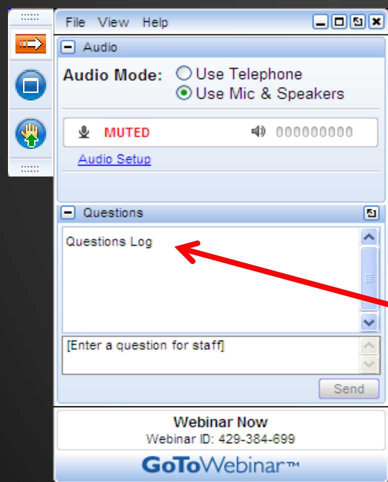
Offer valid through 7/31/2017

To order

Online: www.wef.org/ShopWEF | **Call:** 1.800.666.0206

Water Environment Federation
the water quality people

How to Participate Today



- **Audio Modes**
  - Listen using Mic & Speakers
  - Or, select “Use Telephone” and dial the conference (please remember long distance phone charges apply).
- **Submit your questions using the Questions pane.**
- **A recording will be available for replay shortly after this webcast.**

Water Environment Federation
the water quality people

Mixing Activated Sludge

Fundamentals and Recent Advances in Low Energy Mixing

June 28th, 2017
1:00 PM – 3:00 PM ET

Water Environment Federation
the water quality people

Today's Moderator

John B. Copp Ph.D.
Primodal Inc.
Hamilton, Ontario

Mixing – June 28, 2017

An MRRDC Short Course

Mixing Activated Sludge: Fundamentals and Recent Advances in Low-Energy Mixing

- Topics:
  - Mixing Activated Sludge Basics
  - Several Low Energy Mixing Case Studies
  - Implications for the Future of Mixing

Mixing – June 28, 2017

An MRRDC Short Course

Mixing Activated Sludge: Fundamentals and Recent Advances in Low-Energy Mixing

- Speakers:


Jim Fischer
Xylem


Sid Arora
Milwaukee Metro


Bill Norton
Fairfield Conn.


Mark Hemeyer
Kennedy Industries

Water Environment Federation
the water quality people

Jim Fischer, PE

FLYGT
a xylem brand

Water Environment Federation
the water quality people

Agenda

I. Mixing Activated Sludge Basics
   I. Goals of Activated Sludge Mixing
   II. Progression of Mixing Philosophy
   III. Mixing Technologies
   IV. Making the Best Design Decisions

II. Case Studies
   I. Milwaukee WI - MMSD South Shore WRF
   II. Fairfield CT WWTP
   III. DuPage County, IL – Knollwood WWTP
   IV. Ypsilanti County, MI Utility Authority,

III. Implications of Recent Advancements for Future Standards

Mixing Basics

Jim Fischer

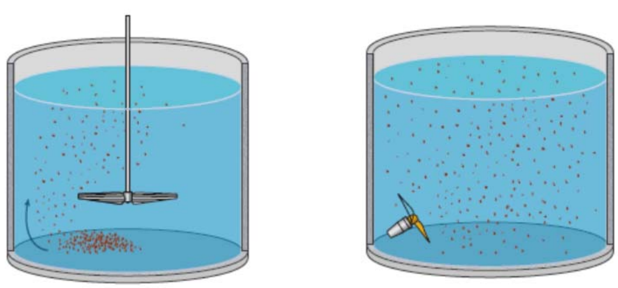
Goals of Activated Sludge Mixing

I. Prevent settling
II. Prevent short-circuiting of inflows
III. Promote robust contact between microbes and wastewater.
IV. Minimize energy consumption
V. Maximize process flexibility

Preventing Settling:

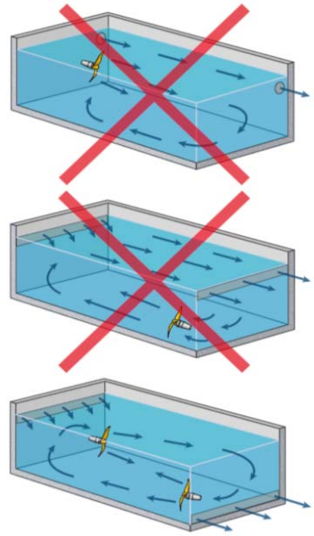
Maintaining Suspension

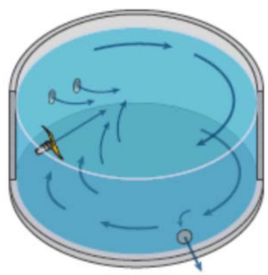
- ✓ Re-suspending solids off bottom or drawing down solids from surface crust
- ✓ Keeping solids in a homogeneous suspension
- ✓ Leveraging full tank volume



Preventing Short Circuiting:

✓Strong Bulk Flow
✓Place inlets and outlets strategically far apart along the streamline of the loop



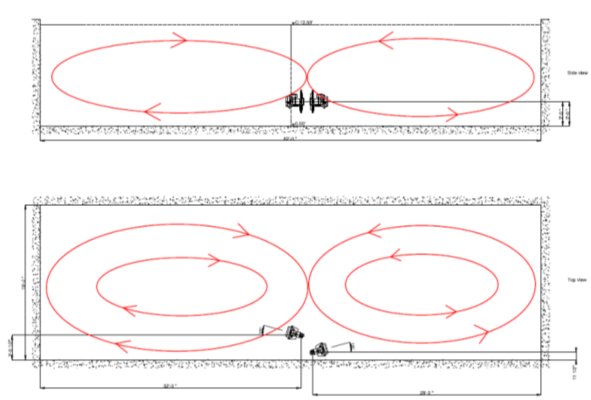


13

Water Environment Federation
the water quality people

Riverside, California WQCP Anoxic Zones

Two mixers back-to-back provide for two sub-zones, reducing short-circuiting.

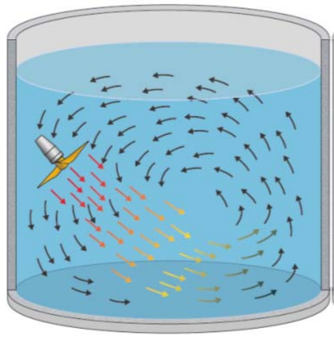


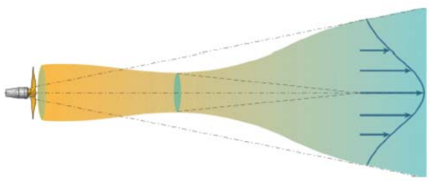
14

Water Environment Federation
the water quality people

Robust Contact:

Promoting Movement
- ✓ Establishing bulk flow
- ✓ Mixing at jet boundary
- ✓ Maximizing process efficiency





15

Water Environment Federation
the water quality people

Energy Consumption & Flexibility:

Operating 8760 Hours/Year
- ✓ How much of the time really needs full thrust
  - ❑ Cyclic Operation
  - ❑ Variable Speed

Needs Change Year to Year
- ✓ System modifications to accommodate new standards
- ✓ Evolving seasonal needs

16

Water Environment Federation
the water quality people

Progression of Mixing Philosophy

Good context for this webcast:

Paper presented at WEFTEC 2015

How Oversized Mixers
Became an Industry Standard

Carollo Engineers and authors form
City of Boulder, CO
and Seattle, WA

"Limited published data suggests that power levels much below the traditional design criteria… are able to maintain adequate mixing…"

Common Perception of Mixing

Energy per Unit of Volume

Like Watts / Cubic Meter, assumes that

a) no variations in the amount of energy required to properly mix *different shaped tanks*
b) no variations in the amount of energy required when there are *obstructions in the tank*
c) *inlet and discharge positioning have no influence*
d) all mixers can equally *transform a given amount of energy input into the same amount of mixing*.

As a result, mixing system s based on Energy per volume yield conservative designs in order to assure that they work for the worse-case scenario.

G-Value

G-value (s^{-1}) = Velocity Gradient

•The G-value is closely linked to power per unit volume (P/V, W/m^3).

$$G = \sqrt{\frac{P}{\eta V}}\ \left(s^{-1}\right)$$

- Engineers often recognize the concept is inadequate but can be reluctant to challenge it because, of its long tradition and ease of use.
- Some "make it work" by adding requirements like minimum impeller diameter & maximum tip speed

Submerged Jet Mixer Sizing and Selection

Important concepts:

- Thrust and Power
- Mixer Jet
- Bulk flow
- Mixer Positioning

Mixing basics

Mixers are like hammers

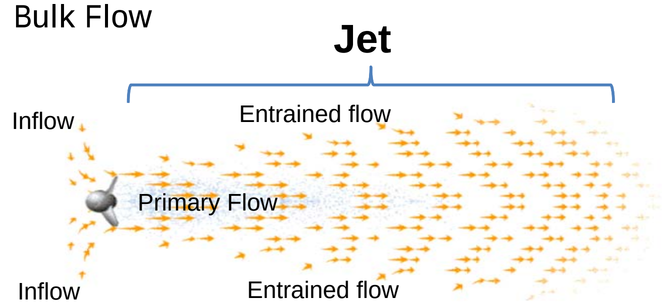
How does a submerged jet create mixing?

Submerged Jet Mixing Basics

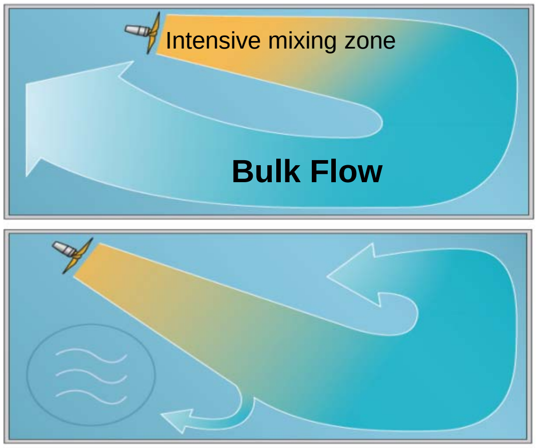
Creating Mixing and Bulk Flow

Many flows, one source

1. Inflow
2. Primary flow
3. Entrained flow
4. Bulk Flow

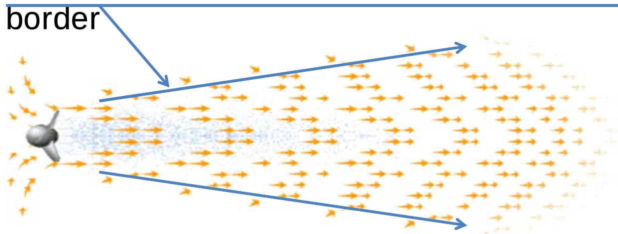


Mixer Positioning
Creating Mixing and Bulk Flow



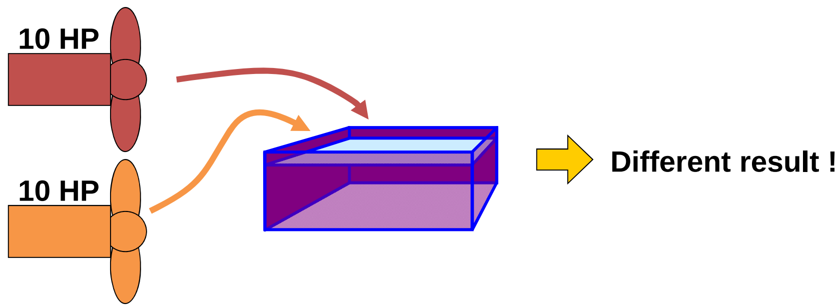
Mixer Positioning
Mixer Jet

- Jet drives both primary flow and bulk flow
- Jet brings the surrounding liquid into motion
  - The surrounding low-velocity liquid is entrained
  - Majority of the mixing is not in the prop-area
  - Intensive mixing happens along the jet border



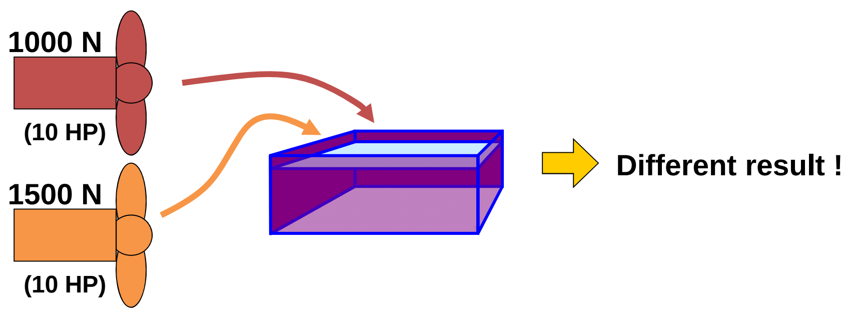
Mixer performance

- Traditionally Power [HP] has been used to compare mixers.
- But the Power consumption does not say anything about:
  - How efficient the motor is
  - How efficient the propeller is



Thrust is a better measure of performance

- Different mixers produce different thrust
- Some are more efficient than others



Verification

- ISO Standard, 21630:2007

INTERNATIONAL STANDARD

ISO 21630

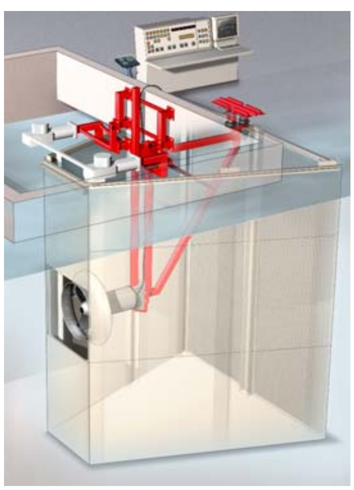
First edition
2007-08-15

Pumps — Testing — Submersible mixers for wastewater and similar applications

Reference number
ISO 21630:2007(E)

© ISO 2007

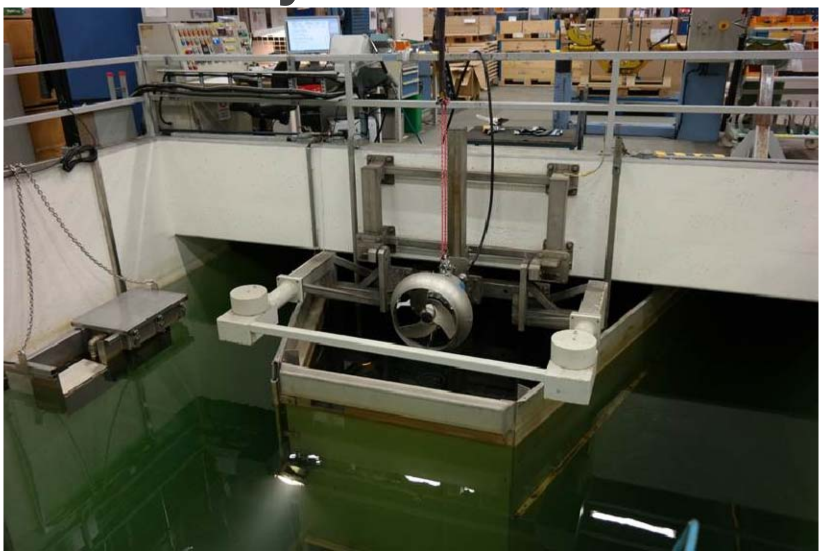
Measuring mixer performance



Thrust vs. Power consumption in clean water

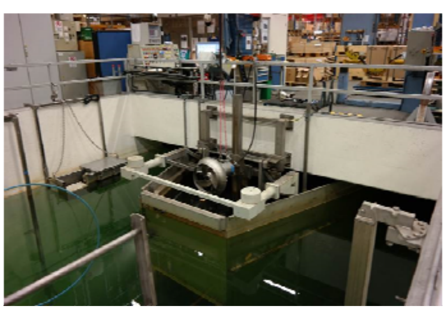
- The mixer is installed in a test rig and connected to a power meter
- The mixer is turned on
- The reaction force is measured
- The power consumption is measured
- ISO 21630:
  - Thrust to Power Ratio
  - Ratio of mixer thrust force to mixer power consumption

Test facility



Test certificates

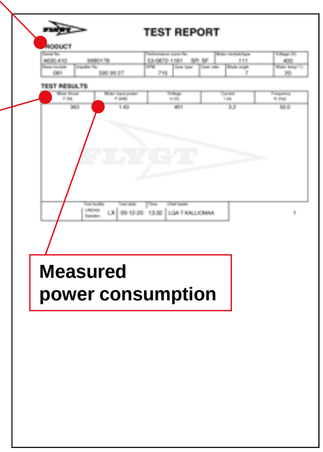
- To demonstrate what we promise:
  - Test report
  - Witness tests



Product serial number

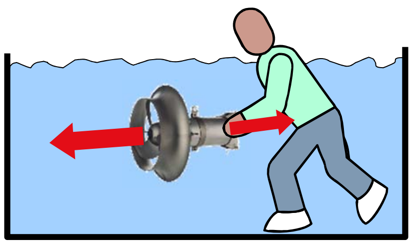
Measured thrust

Measured power consumption

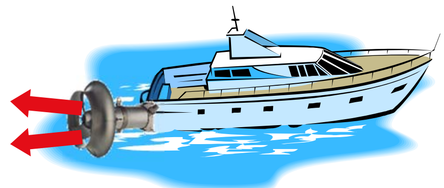


What is Thrust ?

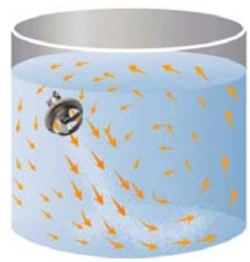
Thrust: equals the reaction force you feel if you are trying to hold on to a mixer in operation



The reaction force of the propeller Thrust drives the boat forward



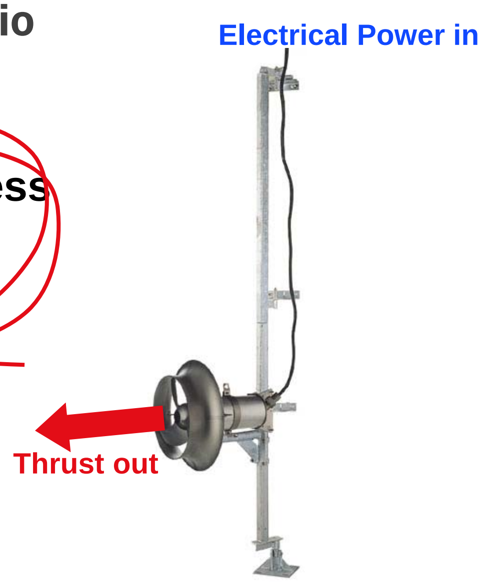
In a tank, the Thrust sets the liquid in motion



Thrust : Power Ratio $R_{F/P}$

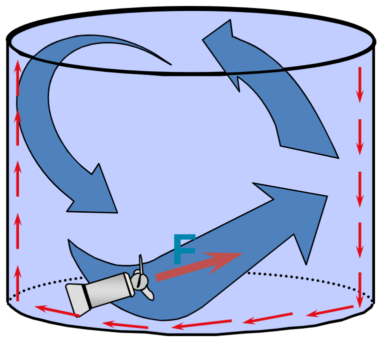
Mixer Effectiveness

$$= \frac{\text{Thrust [F]}}{\text{Power }[P_{in}]} \left[\frac{N}{kW}\right]$$



Mixer Sizing to achieve bulk flow

- The friction losses due to obstacles and tank geometry are calculated based on the required bulk flow velocity for desired mixing results.
- From this we select the most suitable mixer.



Steady state Bulk flow when

F_{mixer} = F_{losses}

Mixer thrust **Total flow losses**

Required Thrust is a function of Bulk Flow Velocity

- The equation for required thrust is:

$$F_{req} = \frac{\rho u^2}{2} A_b k$$

- ρ is the liquid density (1000 kg/m^3 for water)
- $k = k_f + k_b + k_{aer} + k_o$ are loss factors from
- friction, bends, aerators, other obstacles.
- U is the velocity
- A_b is the bulk flow area (projected area of cross section of main flow)

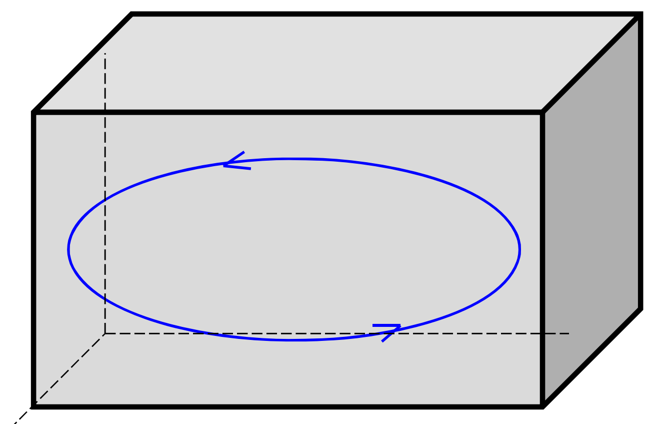
Mixer Positioning for a bulk flow loop

1. Determine an efficient bulk flow loop
2. Locate the mixer along the streamlines of the loop
3. Position for a long jet path
4. Smooth Jet deflection
5. Steer clear of obstacles

37

Water Environment Federation the water quality people

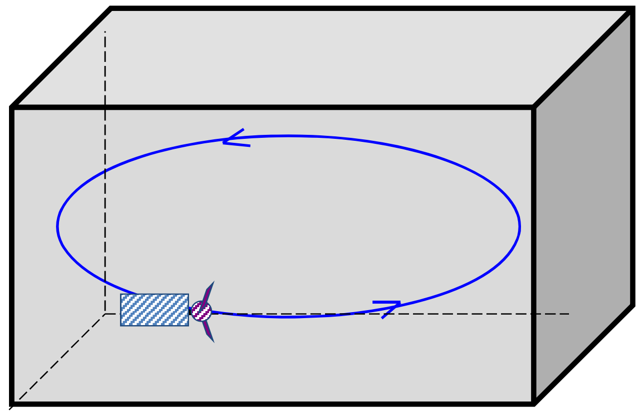
Submersible Mixer Positioning 1. Determine the most natural, efficient bulk flow loop



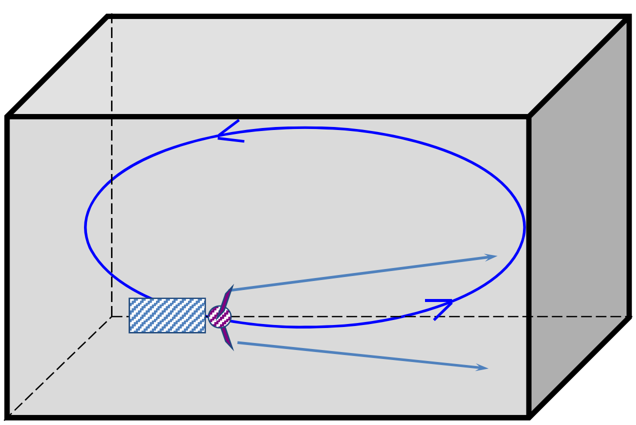
38

Water Environment Federation the water quality people

Submersible Mixer Positioning
2. Locate the mixer along the streamline of the loop



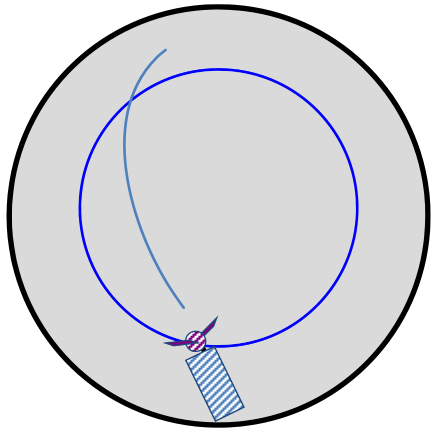
Submersible Mixer Positioning
3. Position for a long jet path



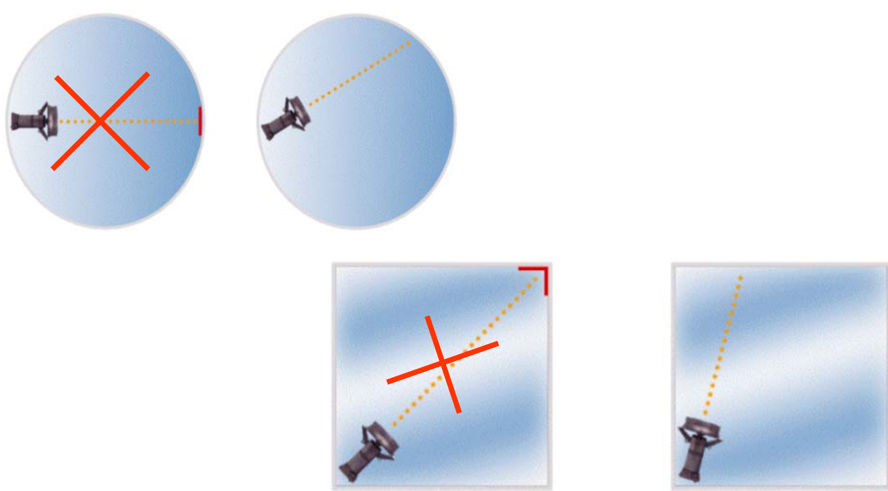
Long jet paths entrain more flow and develop stronger bulk flow

Submersible Mixer Positioning
4. Smooth jet deflection

Smooth jet deflection:
Yields low hydraulic
losses

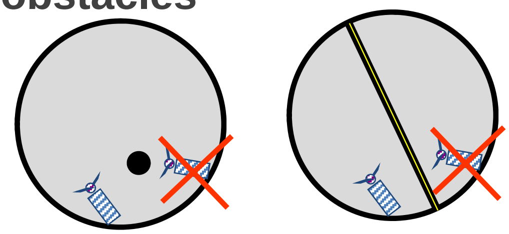


Submersible Mixer Positioning
Long jet path & smooth deflection

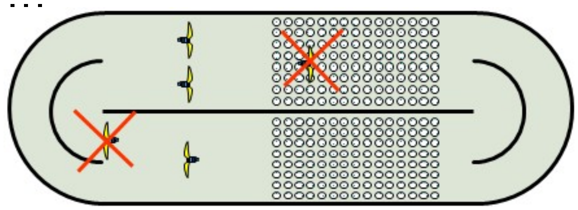


Submersible Mixer Positioning
5. Steer clear of obstacles

- Pipes, Pillars …



- Bends, Aerators …



Summary

- ✓ Identify the best bulk flow for the tank you are working with.
- ✓ Determine where the jet needs to be placed – and how much thrust it will need to deliverd
- Select your mixing technology...

Mixing Technologies

Jim Fischer

Mixer Types

1. Jet Mixing
2. Large-Bubble Compressed Air
3. Vertical Turbine
4. Hyperboloid
5. Submersible Horizontal Propeller
   A. High speed
   B. Low speed
   C. Variable speed, High Efficiency

Pump Driven Jet Mixers

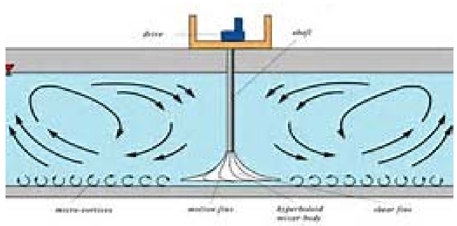
- Simple low cost intermittant duty mixing
- Highly directable
- Low efficency
- Can also be used as flushing device in basins when drained down

Vertical Turbine/Traditional Top Entry

- Easy to maintain
- Expensive installation infrastructure
- Optimal jet flow for deep cylindrical tanks
- Fixed jet positioning (downward flow)

Hyperboloid Top Entry

- Easy to maintain
- Expensive installation infrastructure
- Claims Improved flow and efficency over other top entry designs
- Fixed positioning – (radial flow)



http://www.peltonenv.com/invent_hyper_classic_mixer.php

Big Bubble

- No moving parts below water
- Requires compressed air system for power
- Good where bulk flow is hard to develop

http://www.enviro-mix.com/wastewater/biomix/

Submersible High Speed

- Compact
- Most popular BNR mixer type
- Inexpensive to install
- Highly versitale jet placement
- Simple direct drive designs
- Lower cost, but lower efficency

51

Water Environment Federation
the water quality people

Submersible Low Speed

- Highest efficency
- Slow speed / long life
- Flexible horizontal jet placement

52

Water Environment Federation
the water quality people

Why larger props have a higher thrust-to-power ratio

Variable Speed
High Efficiency

- High efficiency IE4 Equivalent permanent magnet motor
- Integrated variable speed drive
- Best in class ISO 21630 efficiency
  - Over 1,400 N/kW
- Soft Start / Stop
- Auto overload reduction
- Communicates directly with SCADA via Modbus
- No VFD to install – completely tested @ factory

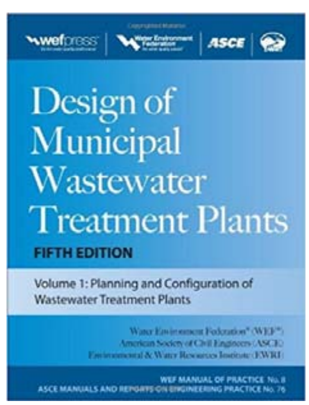
Making Design Decisions

Jim Fischer

Water Environment Federation
the water quality people

National / International Standards

- WEF – Manual of Practice - MOP



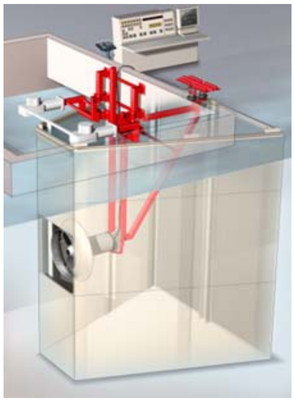
56

Water Environment Federation
the water quality people

National / International Standards

ISO 21630:2007

- Standardizes how to measure thrust
  - Testing rig
  - Water conditions
  - Simulating “Open Sea” conditions
- Accuracy & reporting standards



57

Water Environment Federation
the water quality people

Equipment Manufacturers

Sizing
- ✓ Tools for applying their particular technologies
- ✓ Potential to iterate with sizes and strategies

Performance
- ✓ Caution - comparing “apples to apples”
- ✓ ISO 21630 Where applicable

Cost
- ✓ Equipment
- ✓ Installation
- ✓ Maintenance
- ✓ Energy

58

Water Environment Federation
the water quality people

Case Studies

Variable speed mixing:

- Highly efficient thrust production
  - "How low can you go"
  - Easily reaching 1000 to 1,500N/kW
- Varying thrust with need
- Cycling thrust to:
  - Define process details
  - Enhance process performance

59

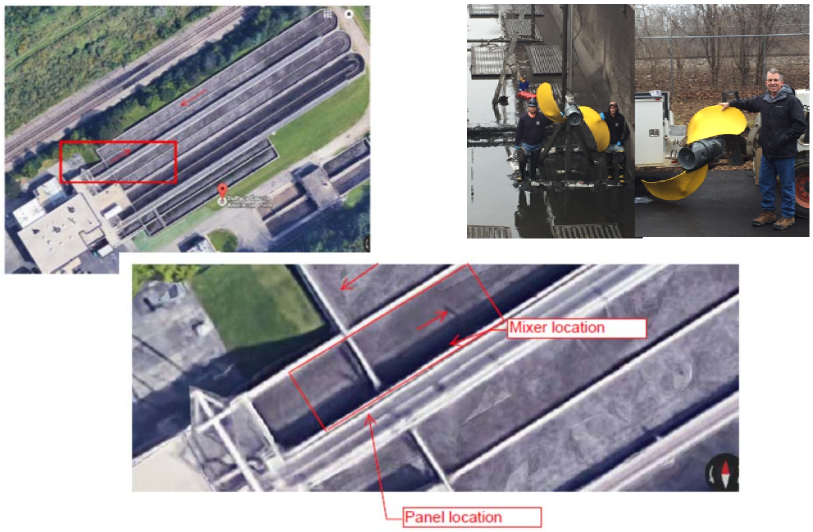
Water Environment Federation
the water quality people

DuPage County, IL Knollwood WWTP

Jim Fischer

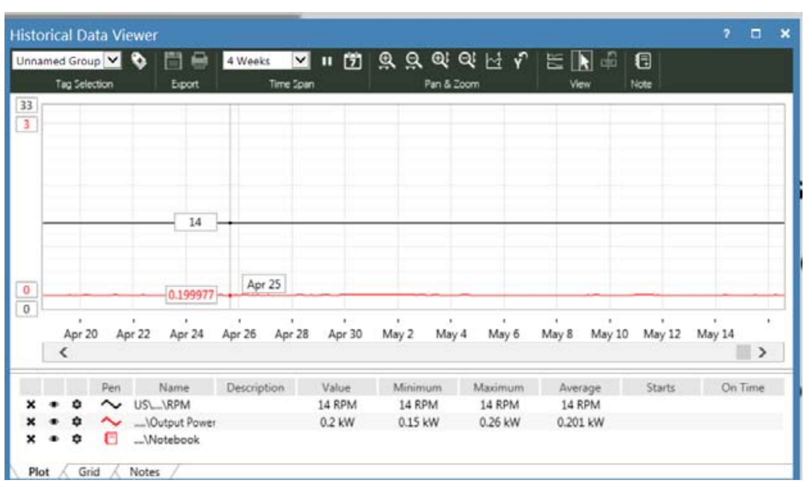
Water Environment Federation
the water quality people

DuPage County, IL Knollwood WWTP



Water Environment Federation the water quality people

DuPage, County, IL Knollwood WWTP



Water Environment Federation the water quality people

South Shore Water Reclamation Facility Mixing Pilot

Sid Arora, PE
Milwaukee Metropolitan Sewerage District

Water Environment Federation the water quality people

South Shore Water Reclamation Facility

NACWA Platinum Award 20

Plan to Convert from Chemical P to Bio P by 2020

300 MGD Full Treatment Capacity
90 MGD Annual Average

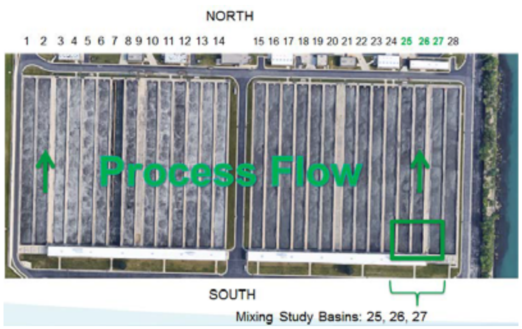
Liquid Treatment Processes
-Preliminary/Primary/Secondary/Disinfection
-Chemical P removal

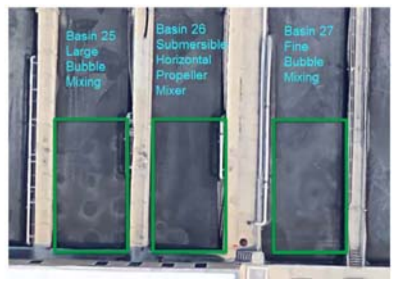
Solids Handling & Disposal
-Interplant pumping of solids
-GBTs and Plate and Frame
-Digesters Methane 1.3 MMCF

Water Environment Federation the water quality people

Study Comparing 3 Mixing Methods

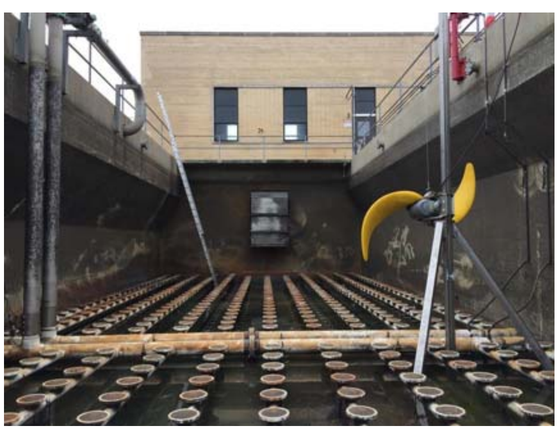
- 3 identical sized anoxic/anaerobic zones, 48 ft long x 30 ft wide x 15 ft deep
  - Basin 25: Large Bubble Mixing System
  - Basin 26: Submersible Horizontal Propeller Mixer with Adjustable Thrust
  - Basin 27: Fine Bubble Diffused Air, turned down to mix and not aerate

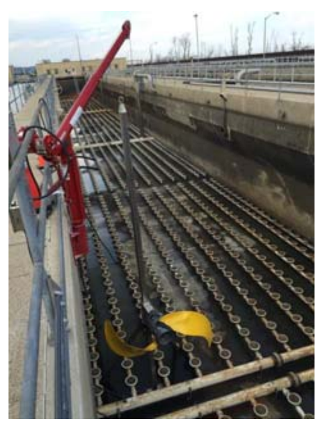




Water Environment Federation the water quality people

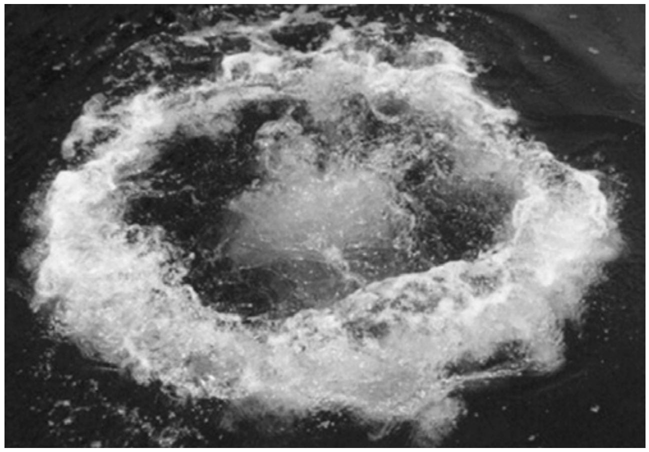
Submersible Horizontal Propeller Adjustable Speed (SHPAS) Mixer





Water Environment Federation the water quality people

Large Bubble Mixing



Reduced Air Flow Fine Bubble Mixing

Parameters Compared

- Quality of Mixing
- Conditions Favorable for BioP
- Energy Consumption

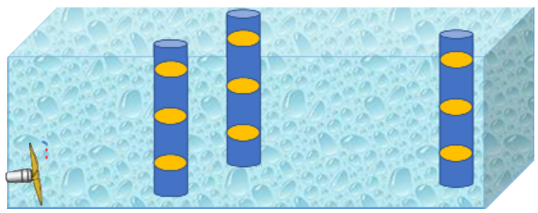
Quality Of Mixing

- Mixing Quality Index, MQI
- MQI = $\frac{1}{\text{STDEV of TSS Conc. along vertical and horizontal profile}}$
- The higher the MQI, the better the Mixing
- You can use this method for the following:
  - Evaluate the performance of the same mixer at varying speed
  - Evaluate minimum mixing energy required by a mixer to maintain a homogeneous solution
  - Compare the performance of different type of mixers

We call this method as Arora Mixing Evaluation Method

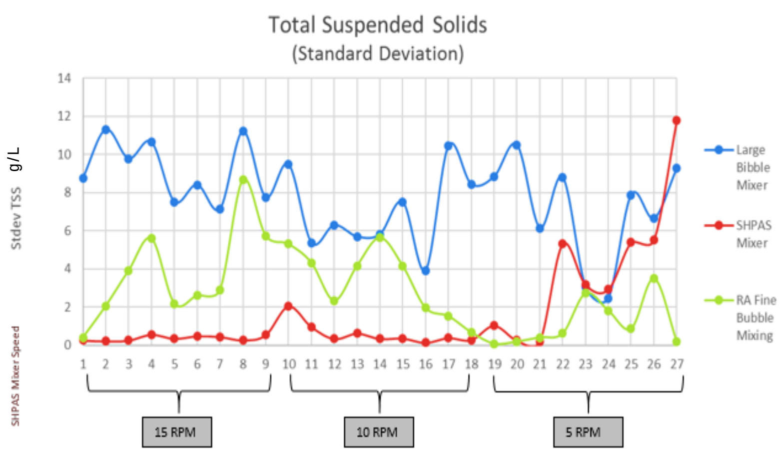
MQI Determination

- Sampling Location Selection: (0.3Y, 0.6Y and 0.9Y Depths)
- Sample Collection:
  - Sludge judge pour off MLSS from predetermined depths
  - Hand held TSS Analyzer
- Concentration Measurement:
  - Handheld TSS Meter
    (like a Royce Meter Model 711)
  - Laboratory Tests
- Data Evaluation:
  - Stdev of 9 or more TSS conc
  - MQI = 1/Stdev
  - Calculate the MQI for 5 times
  - Determine Average MQI



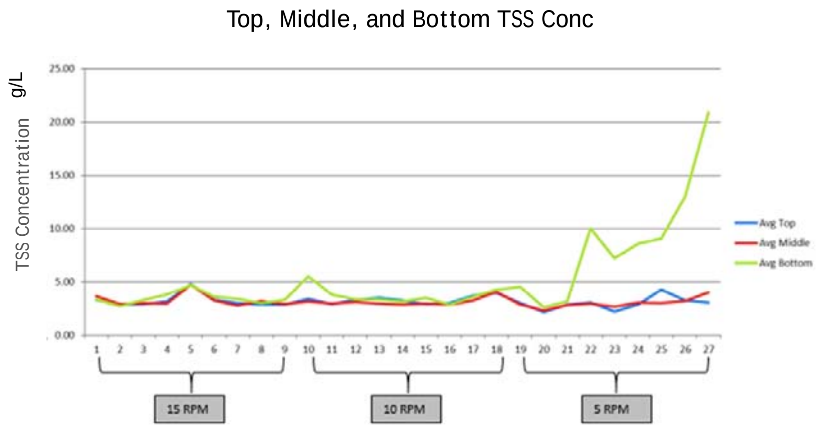
71 Water Environment Federation the water quality people

Standard Deviation of TSS



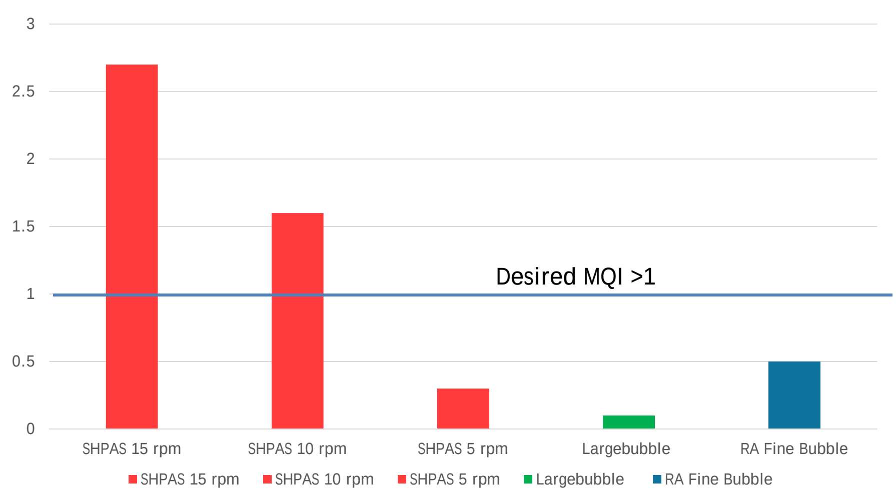
72 Water Environment Federation the water quality people

MLSS Mixing Zone Profile(SHPAS)



Water Environment Federation
the water quality people

Mixing Quality Index – 3 mixers



Water Environment Federation
the water quality people

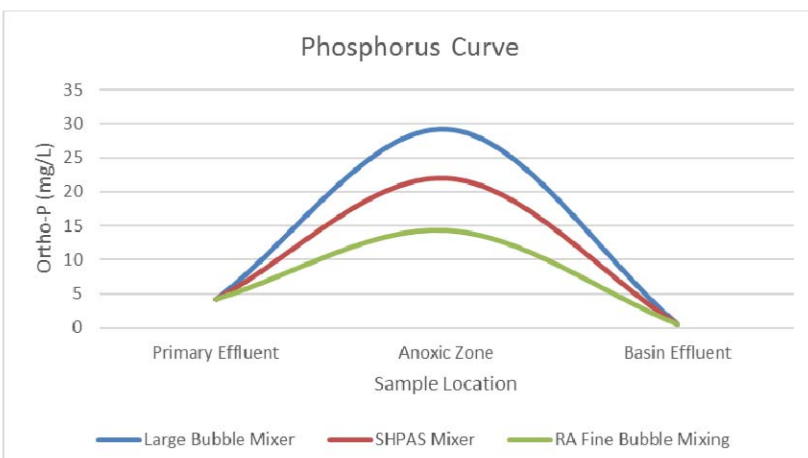
Conditions Favorable for BioP

- Phosphorus Profile

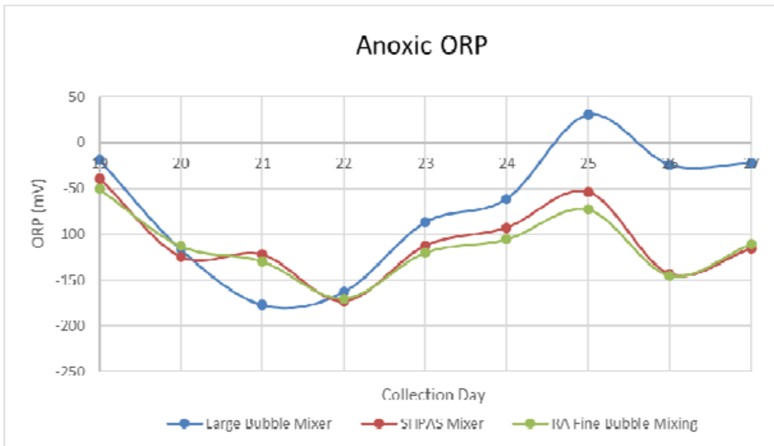
  -P in Anoxic zone Vs Primary Eff

- Anoxic ORP
- Anoxic DO

Conditions Favorable for BioP



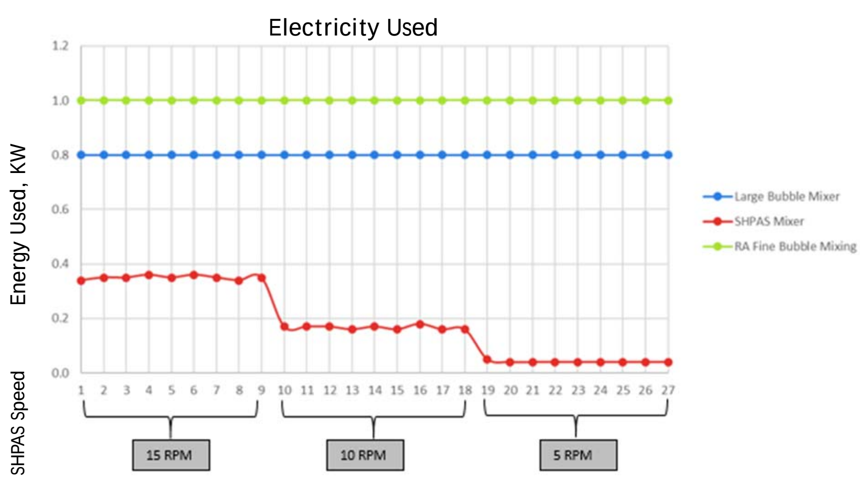
Conditions Favorable for BioP



77

Water Environment Federation
the water quality people

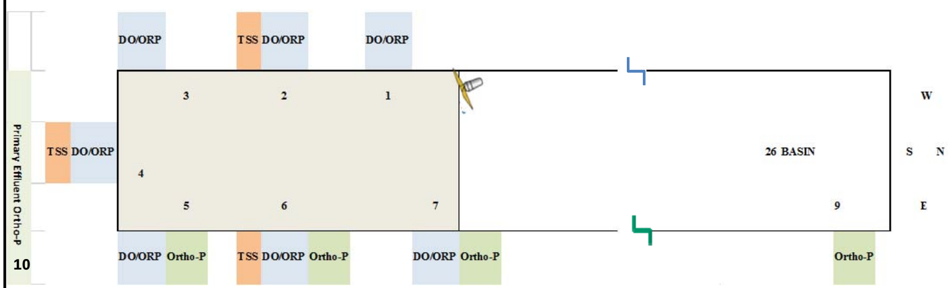
Power Consumption



78

Water Environment Federation
the water quality people

Sampling Locations



79 Water Environment Federation the water quality people

Samples and Results Evaluation

Test	Location (s)	Vertical Profile	Total Samples	Results Evaluation
1) Total Suspended Solids, TSS	2, 4, 6	Every 5 feet	9	MQI >1
2) Oxidation Reduction Potential, ORP	2, 3, 4, 5, 6, 7	1 foot from surface	6	Average < -100
3) Dissolved Oxygen, DO	2, 3, 4, 5, 6, 7	1 foot from surface	6	Average < 0.1 mg/L
4) Phosphorus	5, 6, 7, 9, 10	Scoop from top	5	$\frac{\text{Ave.Ortho P Location 5, 6, 7}}{\text{Ortho P Location 10}} > 2$

80 Water Environment Federation the water quality people

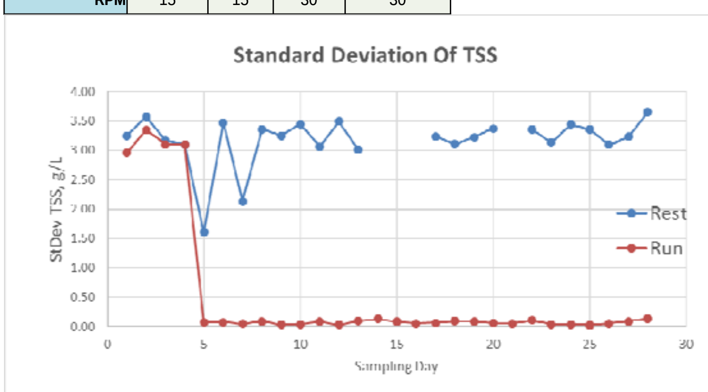
2017 Pilot Test Goals

- Evaluating the potential of Mixer to resuspend the settled solids
- Potential to generate VFA
- Testing various Rest Run cycles of the mixer

Rest Run Cycles of the Mixer

Mixer Settings

Days	1 to 3	4	5 to 19	20 to 30
Rest Hours	11.75	11	11	11.5
Run Hour/s	0.25	1	1	0.5
RPM	15	15	30	30



Conclusion

- SHPAS Mixer has the Best MQI hence the best mixer quality
- SHPAS also had the lowest Energy Use(0.17 KW) (by far) out of all three mixers
- Large Bubble Mixer had Best P Bump due to settled solids
- SHPAS Mixer was able to resuspend the settled solids after 11 hours of Rest and 1 hour of Run (@30rpm)

83

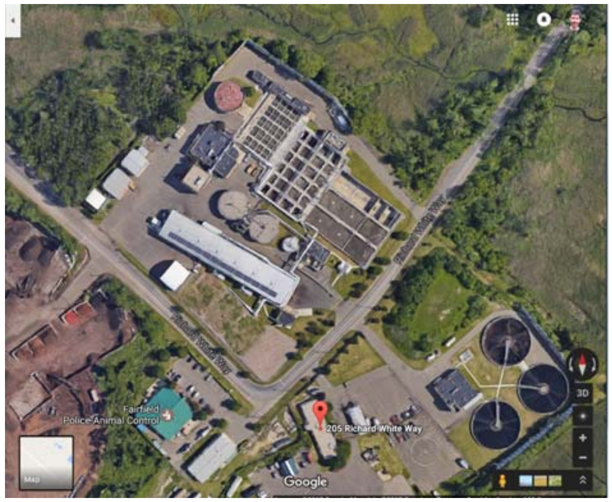
Water Environment Federation the water quality people

Fairfield, CT WWTP

Bill Norton

Water Environment Federation the water quality people

Fairfield, CT WWTP



85

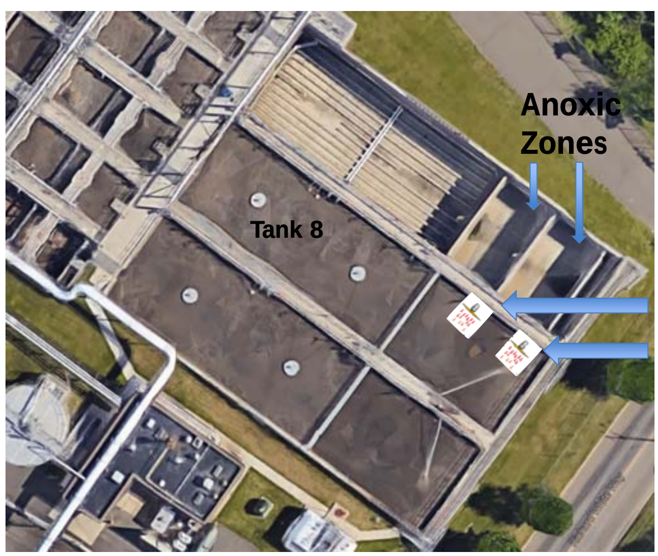
Water Environment Federation
the water quality people

Water Environment Federation
the water quality people

Fairfield, CT WWTP

Water Environment Federation the water quality people

Aeration Tanks



Low-speed mixers

Water Environment Federation the water quality people

Town of Fairfield BNR Removal

Aeration Tank 8

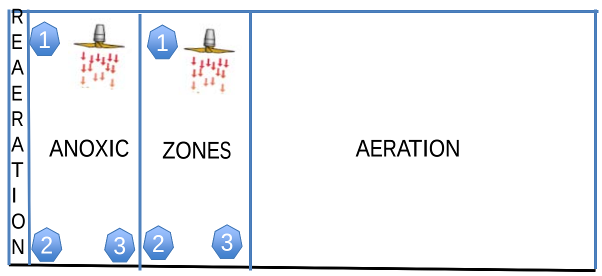
Mixer Design:
- 4.6 ft Dia
- Adjustable speed
- 0 – 45 RPM
- High Efficiency
- Self-cleaning
- Debris-free

Anoxic Zone of Aeration Tank 8 Shown Above

Zone Size:
- 24.6 feet long
- 45 feet wide
- 14 feet deep
- 15,498 ft^3

2 Zones Per Tank

TSS Sampling Locations



FAIRFIELD ZONE B AERATION TANK

Water Environment Federation
the water quality people

Fairfield CT

Basin 8

*TSS units = grams/liter

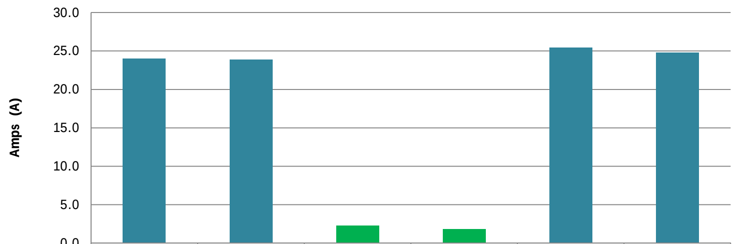
TSS Cross Section		6/6/2017	6/7/2017	6/8/2017	6/13/2017	6/14/2017	6/15/2017	6/20/2071	6/21/2017	6/22/2017
8-1A	Top	1.65	1.91	2.10	2.01	2.20	2.82	1.97	2.00	1.96
	Middle	1.72	2.14	2.03	1.89	2.21	2.75	2.07	1.96	1.94
	Bottom	1.66	2.12	1.71	1.94	1.98	2.78	2.06	2.02	1.82
8-2A	Top	1.62	2.00	1.02	1.99	2.25	2.40	2.14	2.10	2.00
	Middle	1.60	2.12	2.02	2.03	2.36	2.45	2.09	2.03	1.98
	Bottom	1.61	2.10	2.08	2.01	2.29	2.50	2.09	2.00	1.92
8-3A	Top	1.72	2.07	2.07	1.96	2.36	2.43	2.14	1.87	1.92
	Middle	1.76	2.02	2.08	2.07	2.31	2.50	2.19	2.01	1.89
	Bottom	1.66	2.02	2.07	2.08	2.30	2.54	2.17	1.95	2.02
8-1B	Top	1.65	2.09	1.93	1.93	2.26	2.17	2.06	2.04	1.79
	Middle	1.65	2.09	2.08	1.97	2.30	2.13	2.01	2.00	1.93
	Bottom	1.60	1.87	1.82	1.86	2.29	2.20	2.18	1.86	1.98
8-2B	Top	1.64	2.16	2.01	2.07	2.26	2.49	2.04	2.02	2.05
	Middle	1.78	2.18	2.08	1.97	2.30	2.28	2.14	1.99	1.98
	Bottom	1.62	2.05	2.08	1.97	2.29	2.45	2.16	2.01	1.82
8-3B	Top	1.67	2.06	2.09	1.96	2.28	2.44	2.06	2.00	1.98
	Middle	1.66	2.17	2.09	2.05	2.28	2.55	2.09	2.02	1.97
	Bottom	1.68	2.14	2.09	2.03	2.30	2.52	2.12	2.02	1.98
	stdev	0.05	0.10	0.10	0.06	0.02	0.16	0.06	0.05	0.08

92

Water Environment Federation
the water quality people

Fairfield CT

Relative Mixer Power Consumption
Amperage readings
Small diameter, high speed
vs
Large diameter, low-speed
Flygt 4320



	MB1-1	MB1-2	MB2-1	MB2-2	MB3-1	MB3-2
Amp Draw	24.0	23.9	2.3	1.8	25.5	24.8


FLYGT
Pump 1
Alternate Mixer $ 1890
Flygt 4320 Mixer $ 172
Annual Savings $ 5915
Input Power 0.42 kW
80.0
FLYGT


FLYGT
14 Jun 2017
13:43:45
Pump 2
Annual Operating Cost
70.00 %
21
Manual Speed Setting
70.0
Save
Run
Off
Alternate Mixer $ 1888
Flygt 4320 Mixer $ 122
Annual Savings $ 6081
Input Power 0.32 kW
FLYGT

Ypsilanti Community Utilities Authority

Mark Hemeyer

Water Environment Federation
the water quality people

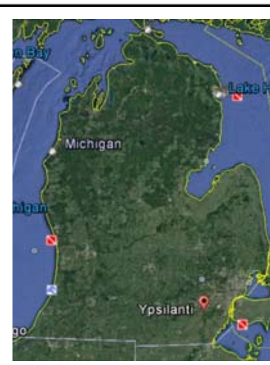
Background

YCUA
Ypsilanti Community Utilities Authority

Environmental Leaders

Dedicated to Providing Top Quality, Cost Effective, and Environmentally Safe Water and Wastewater Services to Our Customers

- YCUA formed in 1974
- Wastewater treatment plant opened in 1982
- Treatment plant capacity is 51.2 million gallons a day
- 17.2 tons of sludge produced each day
- YCUA water demands:
  - 11 million gallons daily average
  - 21 million gallons daily maximum (as of 2012)
- Service Population:
  - 22,000 homes and businesses receive direct service
  - 110,000 people receive water and sewer services
  - 227,000 people receive sewage treatment services
- 112 employees
- Annual Revenues = $33.8 million



98

Water Environment Federation
the water quality people

Background

YCUA Ypsilanti Community Utilities Authority

Environmental Leaders

Dedicated to Providing Top Quality, Cost Effective, and Environmentally Safe Water and Wastewater Services to Our Customers

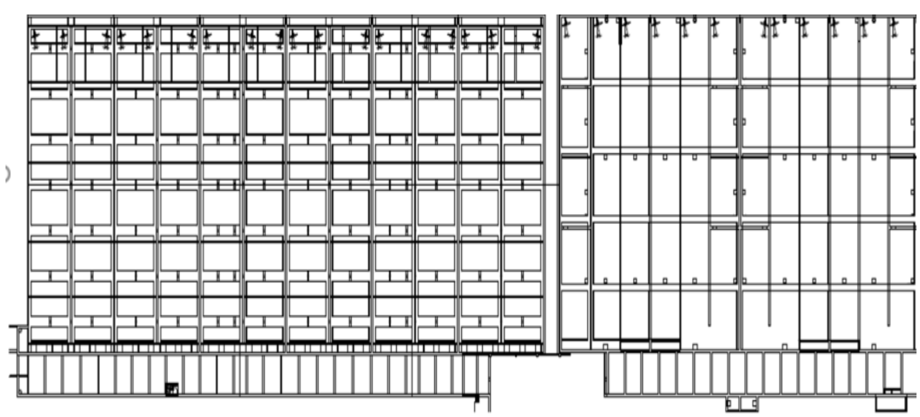
- Service Area Communities:
  - City of Ypsilanti
  - Ypsilanti Township
  - Pittsfield Township
  - Superior Township
  - Augusta Township
  - Northville Township
  - Canton Township
  - Plymouth Township
  - Parts of Van Buren Township and York Township

YCUA WWTP Aerial

YCUA WWTP Aerial

Water Environment Federation
the water quality people

Mixer Passes, Zones 1-10 Each with 3 Mixers 1 -6 on Left 7-10 on Right



Water Environment Federation
the water quality people

Plant Pain Points

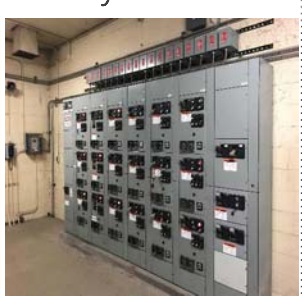
- Existing mixers were old and beginning to fail.
- Efficiency was unknown for each mixing unit.
- No potential to vary the speed of the mixer depending on the process demands.
- No room in the electrical control room to install VFD’s to vary the speed.
- Multiple mixer manufactures had various HP’s and did not list thrust of the machines. This made it difficult to compare mixers.
- Were the mixers even sized properly?
- Were there options in the market that could provide slower speed for longevity and decreased maintenance?
- Are energy efficiency rebates available from the utility?

103

Water Environment Federation
the water quality people

Analyze Energy Consumption

- Web-based kW meter
  - Measured the power to each mixer type.
  - Data logged for 1 week each
- 180 RPM, 310 rpm & 580 rpm mixers
- Easy to connect
- On wheels for easy movement




104

Water Environment Federation
the water quality people

Measured Power to Each Mixer

CUSTOMER =	YCUA
MIXER =	**580 RPM**
LOCATION =	PASS #4, ZONE 3
TEST START =	2:00PM, APRIL 29TH, 2016
TEST END =	8:00AM, MAY 3RD, 2016
AVERAGE KW =	6.920

CUSTOMER =	YCUA
MIXER =	**310 RPM**
LOCATION =	PASS #3, ZONE #1
TEST START =	9:00AM, APRIL 25TH, 2016
TEST END =	2:00AM, APRIL 26TH, 2016
AVERAGE KW =	4.776

CUSTOMER =	YCUA
MIXER =	**180 RPM**
LOCATION =	PASS #4, ZONE #1
TEST START =	11:00AM, APRIL 27TH, 2016
TEST END =	8:00AM, APRIL 28TH, 2016
AVERAGE KW =	6.246

CUSTOMER =	YCUA
MIXER =	**148 RPM**
LOCATION =	PASS #1, ZONE #1
TEST START =	4:10PM, APRIL 20TH, 2016
TEST END =	8:00AM, APRIL 25TH, 2016
AVERAGE KW =	2.049

105

Existing Mixers Installed

- Existing mixer provided with small propeller at higher speed
- No ability to adjust the speed to meet specific thrust requirements
- Mast assemblies were light duty and needed to be updated

106

YCUA History of Rebates

From: Sonya Pouncy
To: Scott Westover
Cc: jerry@ifcav.com
Subject: DTE Energy's Energy Efficiency Program for Business Project ID No. 23694 Incentive Adjustment
Date: Wednesday, May 08, 2013 9:28:22 AM

Scott,

Thank you for your application to participate in DTE Energy's Energy Efficiency Program for Business! We are very excited about your efforts to reduce energy use and look forward to working with you. As a reminder, all your measures are required to meet the specifications as defined in the Incentive Application and the Policies and Procedures Manual. For reference, these documents are available for download at www.dteenergy.com/saveenergy.

At this time, please be advised that your application amount has been adjusted from the requested amount of $57,846.72 for the following reason(s):

- Adjustments made to custom calculations:
  - utility data indicates estimated annual savings exceeds the reservation amount

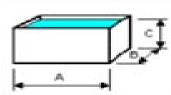
Your application will be processed for the adjusted amount of: $65,378.80 Your incentive check should be received within the next 4-6 weeks.

Resized Mixers Based on Thrust Per ISO 21630 NOT Horsepower as in the Past

Quote Number: 3556-160519-002
Project: YCUA
Position:

INPUT DATA	
Wastewater Treatment > Biological Treatment Mixing	
Biological Treatment:	Anox or Anaerobe or Deox - No Aeration
Type of pre-treatment:	Screen <= ½ inch, primary sedimentation
Outlet location in tank:	Top
Recommended average velocity:	0.82 ft/s
Accept recommended avg. velocity:	Yes
PRODUCT DATA	
Mixer Type:	**4320 without jetring**
Number of mixers:	1
Propeller Code:	V2501220
Propeller Design:	Open
Propeller Material:	Polyurethane
Nominal Thrust:	819 N (acc. ISO 21630)
Rated Shaft Power:	2.7 Hp
Max Input Power:	2.3 kW
Power uptake / mixer:	0.77 kW (67 % margin to input power)
Propeller Diameter:	78.7402 inch
Propeller Speed:	22 rpm
Thrust produced/mixer:	819 N
Total thrust required:	483 N
Total thrust produced:	819 N
Recommended Min. submergence:	1.3 ft
Approval:	STD
Rated Temperature:	40 °C / 104 °F

TANK DIMENSIONS	
Rectangular Tank	
[A] Length:	37 ft
[B] Width:	26 ft
[C] Depth:	18 ft



ELECTRICAL DATA	
Rated voltage:	380 V - 480 V
Mains frequency:	50/60 Hz
Phases:	3

Note .77 Input KW, 22 rpm

Based on the Field & Sizing Data 3 High Efficiency Mixers Were Ordered

- The YCUA team reviewed the data with the board and they all approved the purchase.
- The high efficiency mixers were more cost upfront but the life cycle costs were much less.
- Other details needed to be looked at prior to the arrival of the high efficiency mixers such as positioning & masts.

Water Environment Federation
the water quality people

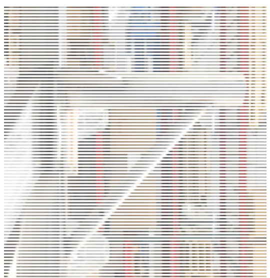
Working Together on Rail Design

- Installed new tri-pod mixer masts
- Used chain with grip eye to install mixers per their request.
- Extended rail up to railing for ease of installation.
- Welded channel on top for cable and chain and attached to railing.
- Manufactured the top rail with through hole to allow for easy installation in basin.
- Drilled drain holes to allow for water to drain if the tank was taken out of service and drained for cleaning.

110

Water Environment Federation
the water quality people

Tripod Rail Assemblies After Changes

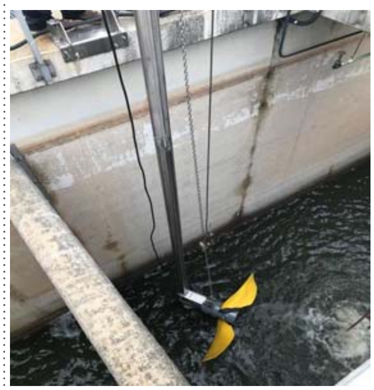


Chain with Grip Device for Easy Installation

Time for Start Up

3 New High Efficiency Mixer units installed and operational since April 11, 2017.

Did actual field conditions match what we anticipated on paper?



113

Water Environment Federation
the water quality people

Final Comparison less than 1/10 the energy! Potentially better.

The results of the tests are summarized below for your review:

- **14 - Existing 180 RPM** mixer averaged **6.246 Input KW**.
- Energy usage 24x365x6.246 = 54,714.96 KW per year x .08 = **$4,377.00** per year
- **3 - Existing 310 RPM** mixer averaged **4.776 Input KW.**
- Energy usage 24x365x4.776 = 41,837.76 KW per year x .08 = **$3,347.00** per year
- **7 - Existing 580 RPM** direct drive mixer averaged **6.920 Input KW**.
- Energy usage 24x365x6.920 = 60,619.20 KW per year x .08 = **$4,849.00** per year
- **3 - Existing 148 RPM** mixer averaged **2.049 Input KW**.
- Energy usage 24x365x2.049 = 17,949.24 KW per year x 0.8 = **$1,435.00** per year
- **3 - Newly installed with built in VFD** mixer averaged **.61* Input KW**.
- Energy usage 24x365x.61 = 5,343.6 KW per year x 0.8 = **$427.00** per year*
- ****Mixer set at 22 rpm, reduction of speed to 16 rpm would reduce the***
- ***KW to .24 Input KW.*** ***$168.00*** *per year at 16 rpm*

114

Water Environment Federation
the water quality people

YCUA WWTP Achieved Their Goals

- 5-year pro-rated warranty.
- Complete speed adjustability from 1 newton of thrust to 3,190 newtons of thrust allowing the mixer to be dialed in for precise mixing.
- Low speed (22 rpm or lower) providing long lasting service due to reduced vibration leading to longer bearing life, longer mechanical seal life and longer gear drive life.
- Adjustable speed to 44 rpm would provide 3,190 newtons of force. (4 times the thrust required)
- Tri-pod rail assembly is compatible with all existing mixers and allows for pin-pointing the exact angle for proper mixer positioning and efficiency.
- Maintenance inspection recommended every 2 years versus every year saving YCUA many man hours in maintenance.
- Mixers have Modbus protocol capable of transmitting: input kw, amps, volts, power factor and provides full control via YCUA's SCADA screen/s currently under development.
- Energy efficiency Detroit Edison (DTE Energy) credits. Replacing the existing mixers to the 4320 would certainly provide a compelling case.

115

Water Environment Federation
the water quality people

Plant Acknowledgements!

- Mr. Scott Westover, PE – Plant Engineer
- Mr. Stacey Reynolds - Maintenance Director
- Mr. Luther Blackburn – Operations Director
- Mr. Jeff Castro – Plant Superintendent
- Mr. Ryan Stetler – Maintenance Foreman
- Mr. Pete Grahm – Operations Foreman

YPSILANTI COMMUNITY UTILITIES AUTHORITY
Environmental Leaders
YCUA
www.ycua.org

116

Water Environment Federation
the water quality people

Thank you!

Implications for Future Standards

Jim Fischer

Power per Unit Volume Summary

Facility	P/V	Propeller Diameter	Prop Speed
	W/m3	m	RPM
Milwaukee MSD 2.5m 8'-2" dia	0.28	2.5	10
DuPage County Knollwood WWTP 2m 6.6 ft dia	0.34	2	14
YCUA	0.53	2	16
Fairfield, CT 1.4m = 4.6 ft dia **Mixer 2**	0.73	1.4	21
Fairfield, CT 1.4m = 4.6 ft dia **Mixer 1**	0.96	1.4	24

How was good mixing achieved with low energy?

- **1) Smart Mixer Position**
  - Engineered to takes full advantage of the mixer jet within the basin geometry
  - Minimizes hydro-mechanical losses

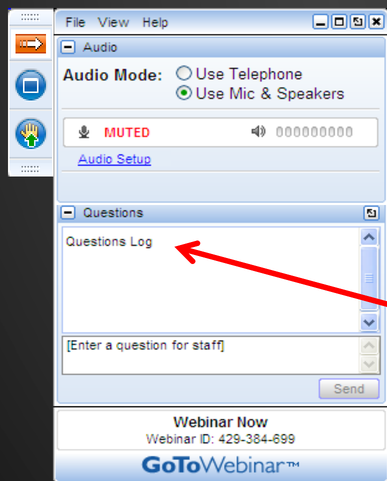
How was good mixing achieved with low energy?

- **2) Efficient, Adjustable Mixer**
  - **High thrust-to-power ratio**
    - Large Diameter, Low-speed Mixers have *the highest published ISO 21630 thrust-to-power ratio* of any mixer
    - 5 times more effective than high-speed mixers
  - **Adjustable thrust via integrated VFD**
    - Enables operator to turn the mixing energy up or down to suit needs and fine-tune mixing and energy
  - **Self-cleaning propeller does not collect debris**

Implications for Future Standards

- **Expect revisions to published guidelines to reflect new findings**
- **Updated MOPs** relating to mixing:
  - MOP 8, MOP 34, and MOP-37
- **Meanwhile, check with trusted suppliers for selections and system designs**
- **Look forward to lower energy mixing in activated sludge!**

Questions?



- **Audio Modes**
  - Listen using Mic & Speakers
  - Or, select "Use Telephone" and dial the conference (please remember long distance phone charges apply).
- **Submit your questions using the Questions pane.**
- **A recording will be available for replay shortly after this webcast.**

Water Environment Federation
the water quality people

Mixing – June 28, 2017

An MRRDC Short Course

Mixing Activated Sludge: Fundamentals and Recent Advances in Low-Energy Mixing

- Final Q & A:

Moderator	→	John Copp	Primodal
Mixing	→	Jim Fischer	Xylem
Milwaukee Case	→	Sid Arora	Milwaukee
Fairfield Case	→	Bill Norton	Fairfield
Ypsilanti Case	→	Mark Hemeyer	Kennedy Ind.

Water Environment Federation
the water quality people