

Treatment Facility Performance Optimization Using Automatic Control and Online Monitoring

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Process Engineer



WISCONSIN WASTEWATER
OPERATORS' ASSOCIATION

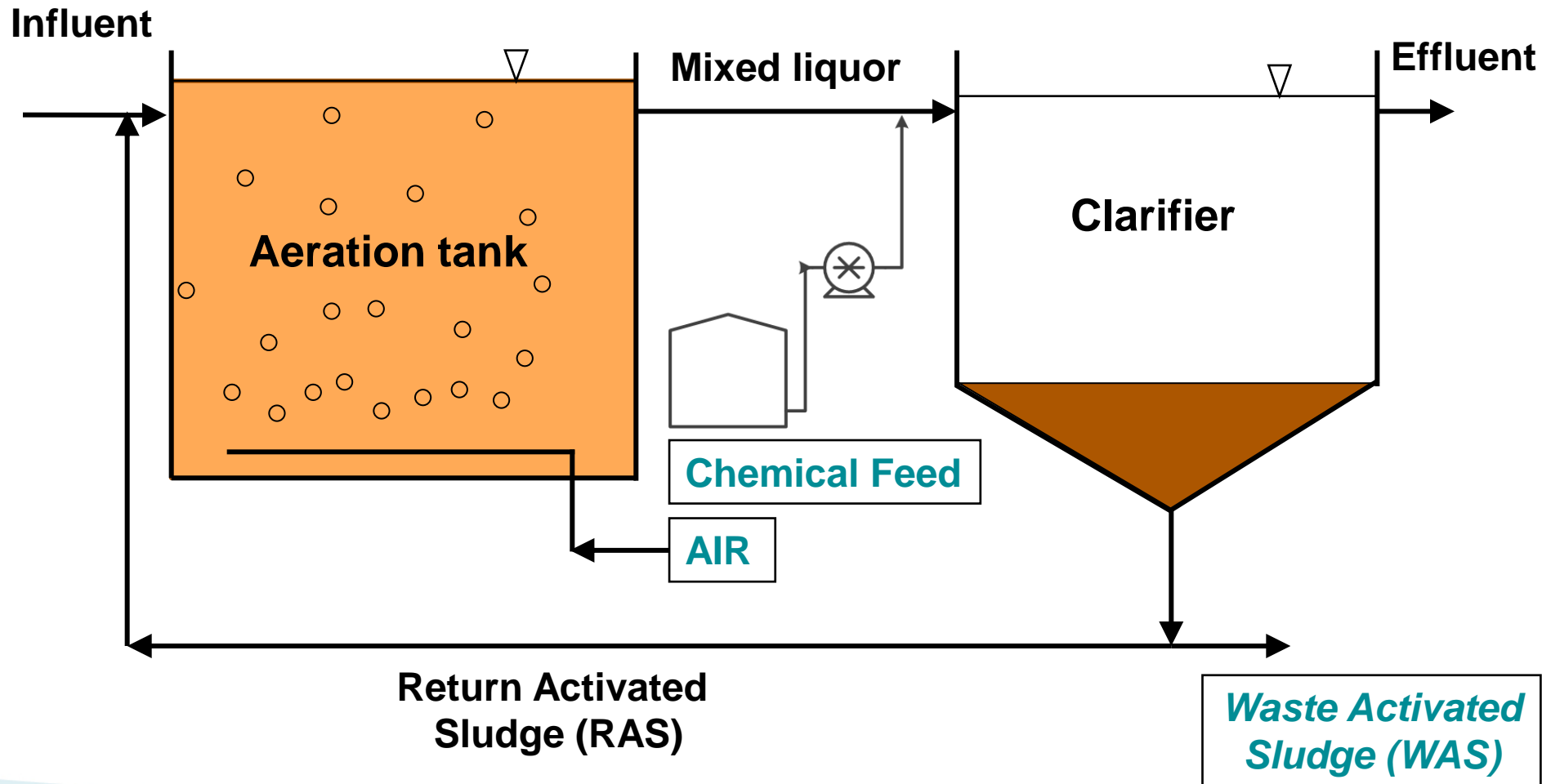
Levels of Control

- Manual based on manual samplings**
- Manual based on online measurements**
- Automatic with online measurements**
 - **Single-variable feedback control**
 - **Multi-variable intelligent control**

Why Instrumentation & Automation?

- Eliminates judgment call**
- Provides instantaneous decision based on real-time data**
- Provides operational cost and labor hour savings**
- Avoids poor treatment and effluent violations**
- Provides stable process**

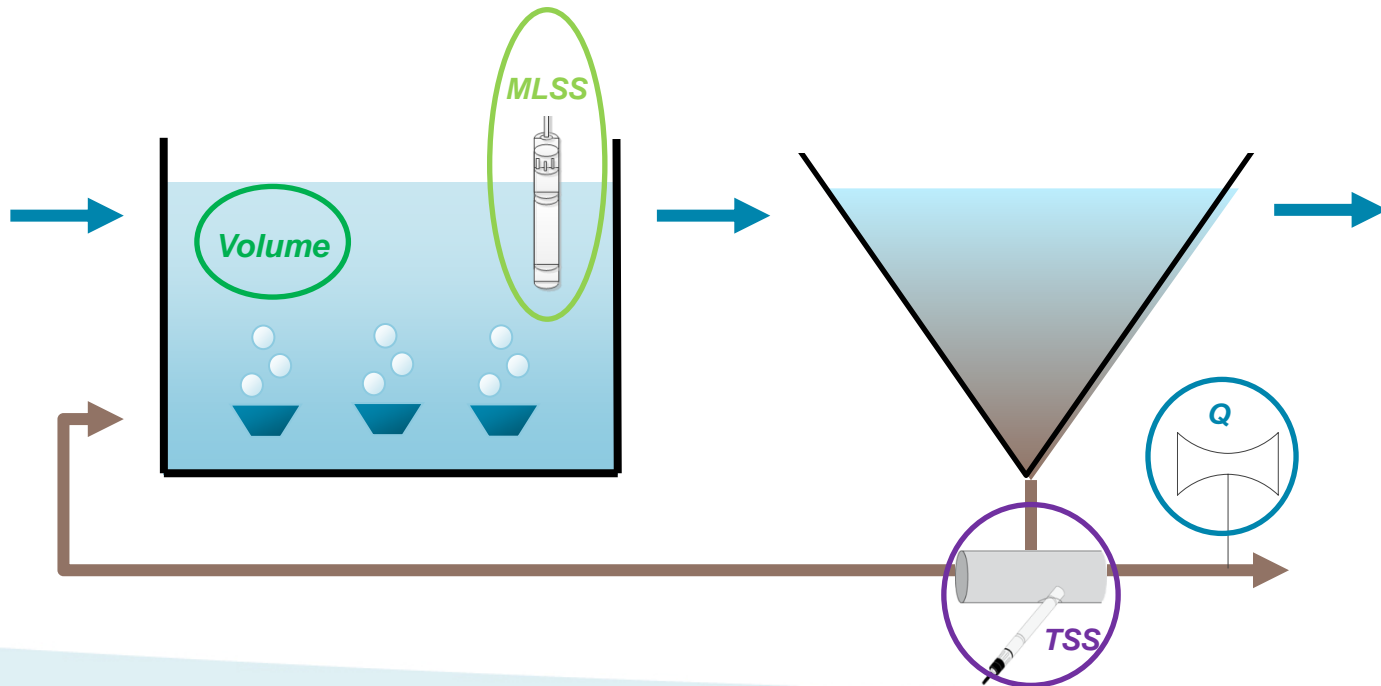
Activated Sludge Process Control



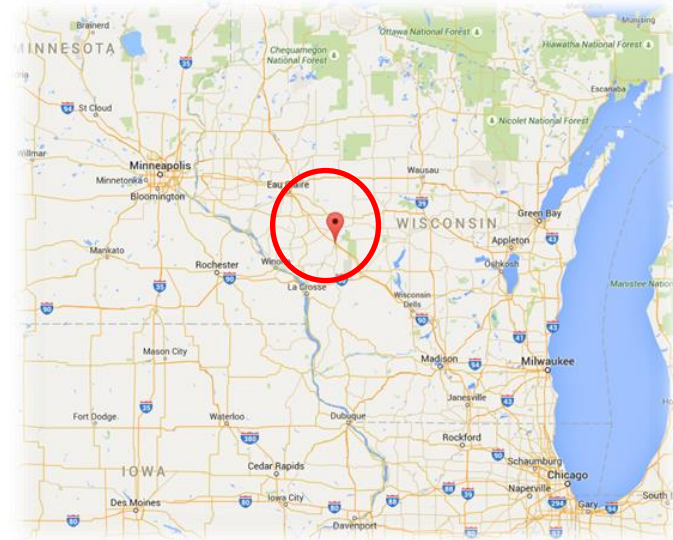
What is Solids Retention Time (SRT)?

Solids Retention Time = average duration of time an organism spends in the system

$$\text{SRT} = \frac{\text{Basin Mass}}{\text{Mass wasted per day}} = \frac{\text{Basin volume(m}^3\text{)} \cdot \text{MLSS (mg/l)}}{\text{WAS Q(m}^3\text{/day)} \cdot \text{WAS TSS(mg/l)}} = \frac{\text{kg}}{\text{kg/day}} = \text{days}$$



Black River Falls (BRF) WWTP



Effluent Discharge Permit

BOD₅ = 30 mg/l

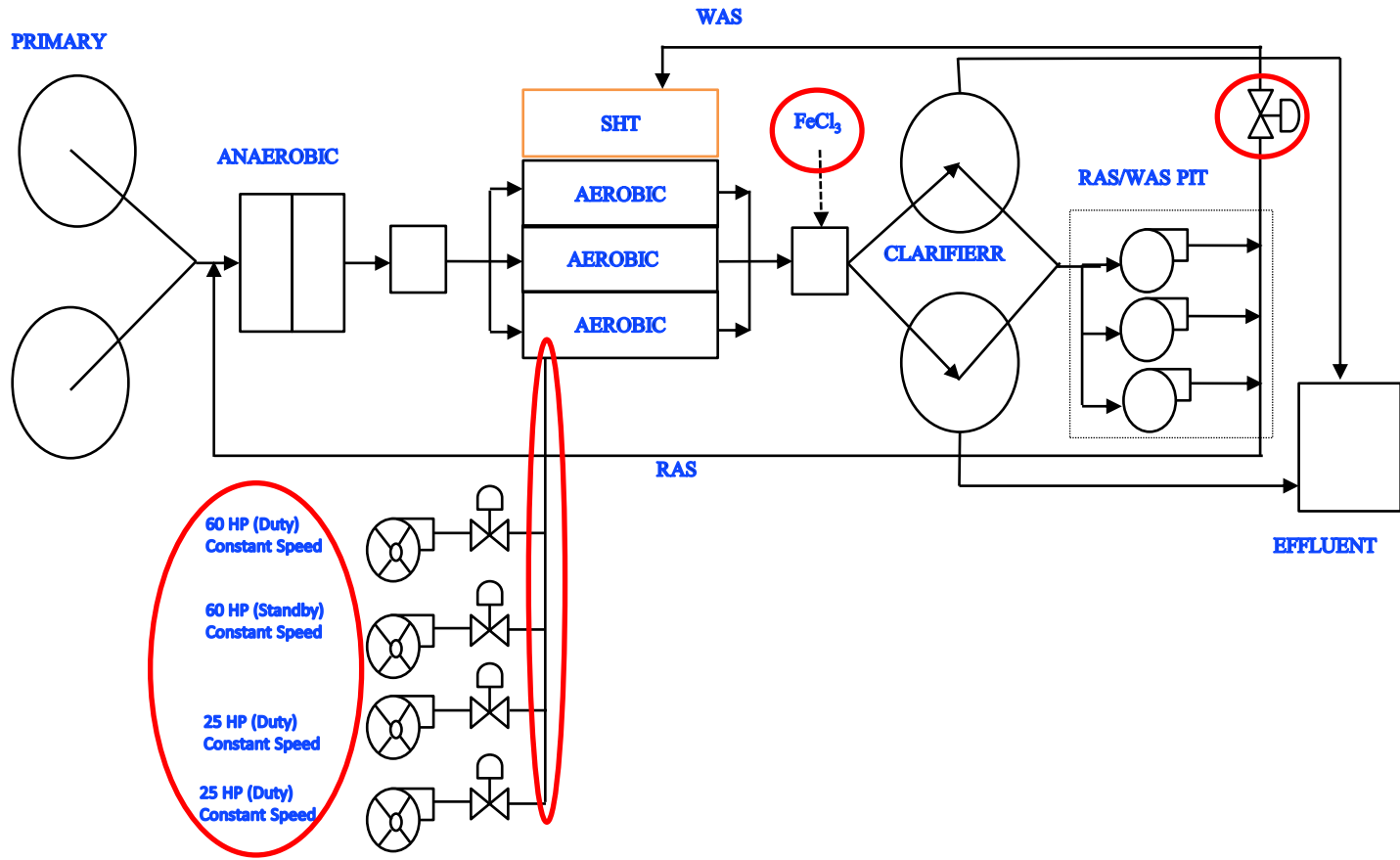
TSS = 30 mg/l

TP = 1.0 mg/l

Design/Average Flow

0.86/0.60 MGD

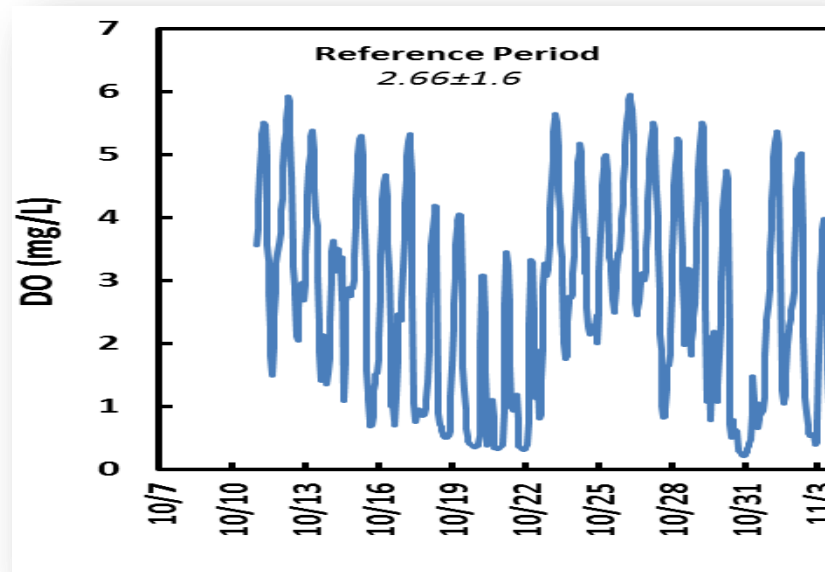
BRF WWTP Process



Problem Statement

Process Aeration

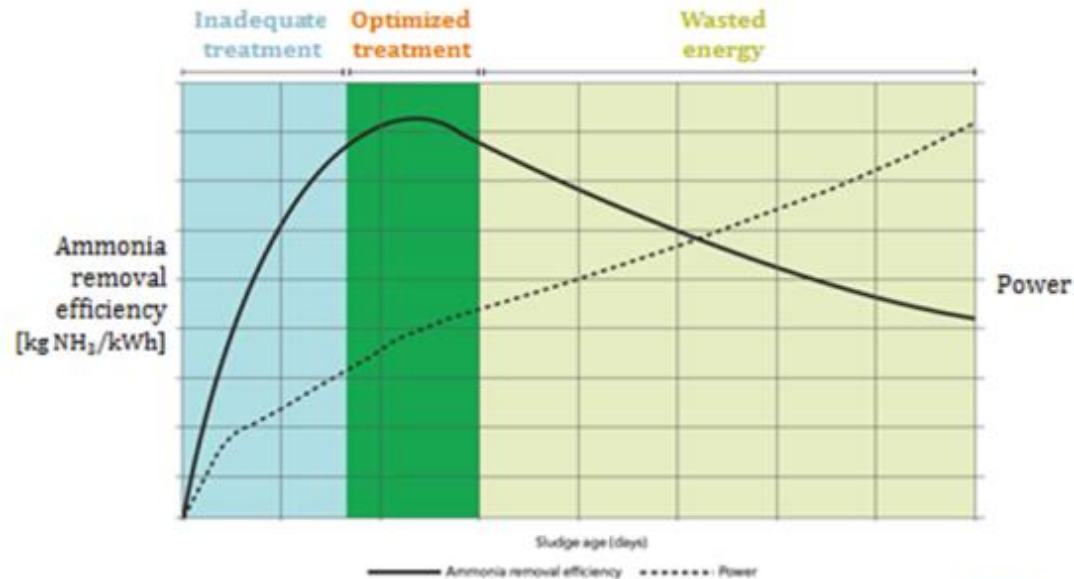
- Manual Aeration Control
 - Blower speed was adjusted based on observed DO concentration.
 - Limited control



DO: Dissolved Oxygen

Process MLSS/SRT

- Manual Sludge wasting based on time
 - Amount of sludge wasted was unknown
 - What happens if valve failed to close
 - What happens if valve is not closed on time by operators
 - Limited success in maintaining desired SRT/MLSS conc.



MLSS: Mixed Liquor Suspended Solids
SRT: Solids Retention Time (Sludge Age)

Chemical P Removal Process

- **Manual Chemical addition based on effluent TP concentration**
 - **Concentration of reactive ortho-phosphate is unknown**
 - **Potential waste of chemical(s)**
 - **Unstable basin pH**

Optimization Objectives

Test following **automatic control algorithms** against **manual control** to examine process stability and treatment efficiency optimization

- **Automated Aeration Control (DO control)**
- **Operator Desired Solid Retention Time (SRT) Control**
- **Process Optimized SRT (Smart SRT) Control**
- **Operator Desired MLSS Control**
- **Automated Chemical Dosing Control**

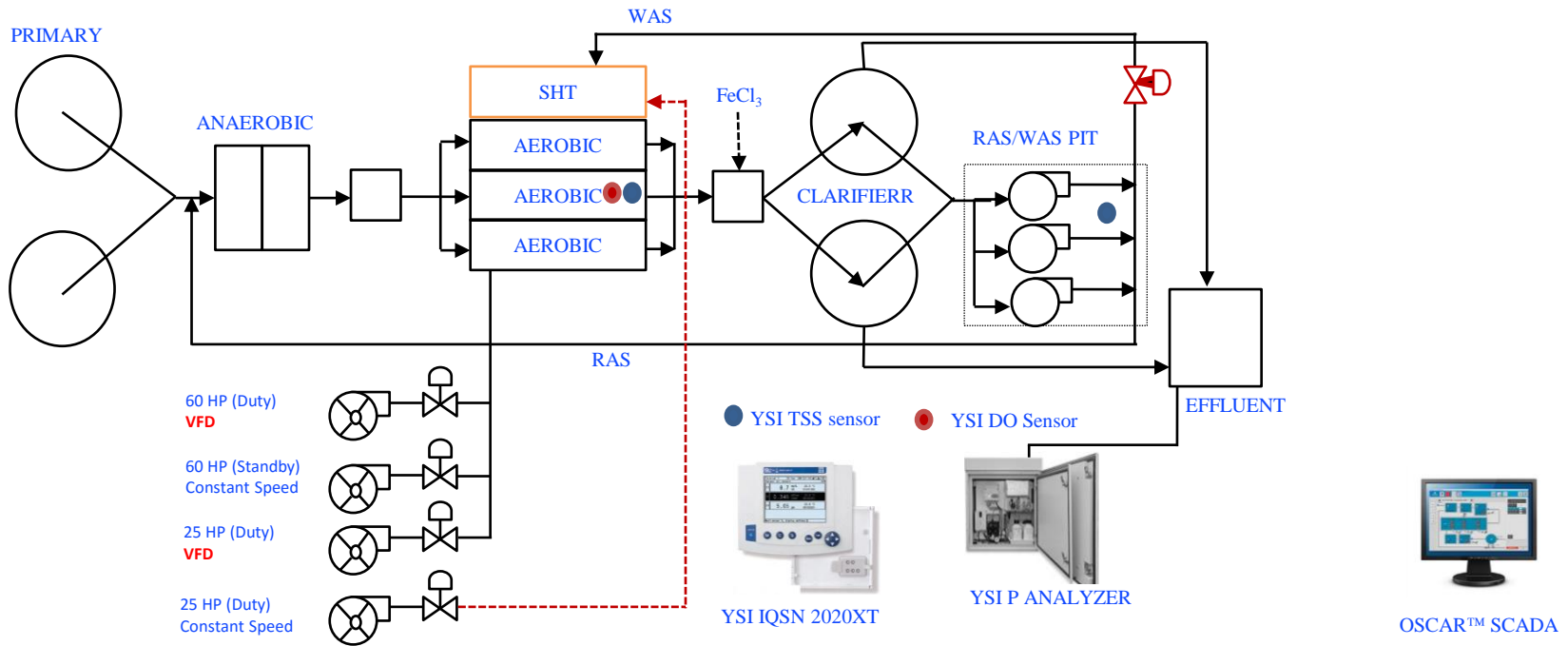
DO: Dissolved Oxygen
MLSS: Mixed Liquor Suspended Solids
SRT: Solids Retention Time (Sludge Age)

I was developed by Xylem's team of experts in product knowledge, system controls and biological processes. I take process optimization and energy efficiency to the next level

OSCAR™



Monitoring & Control Improvements

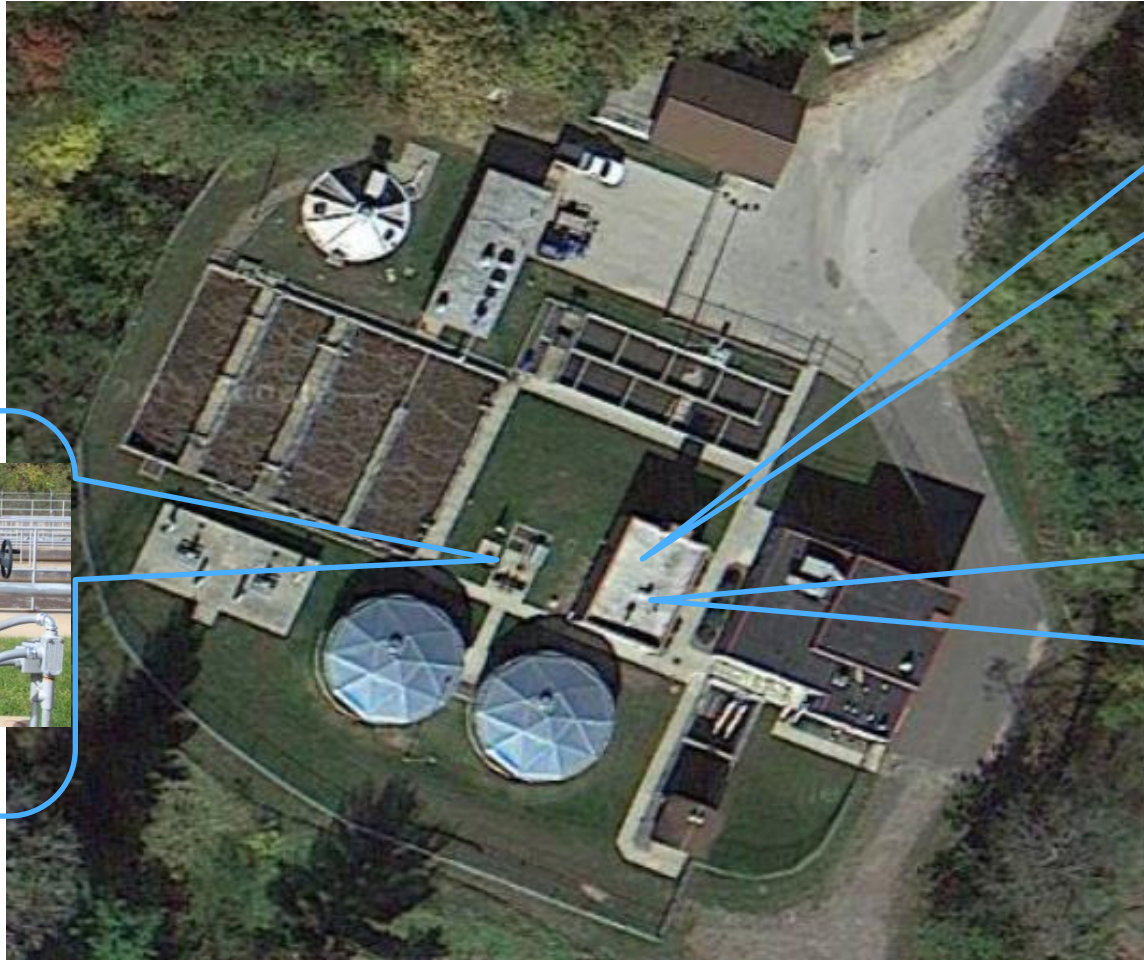


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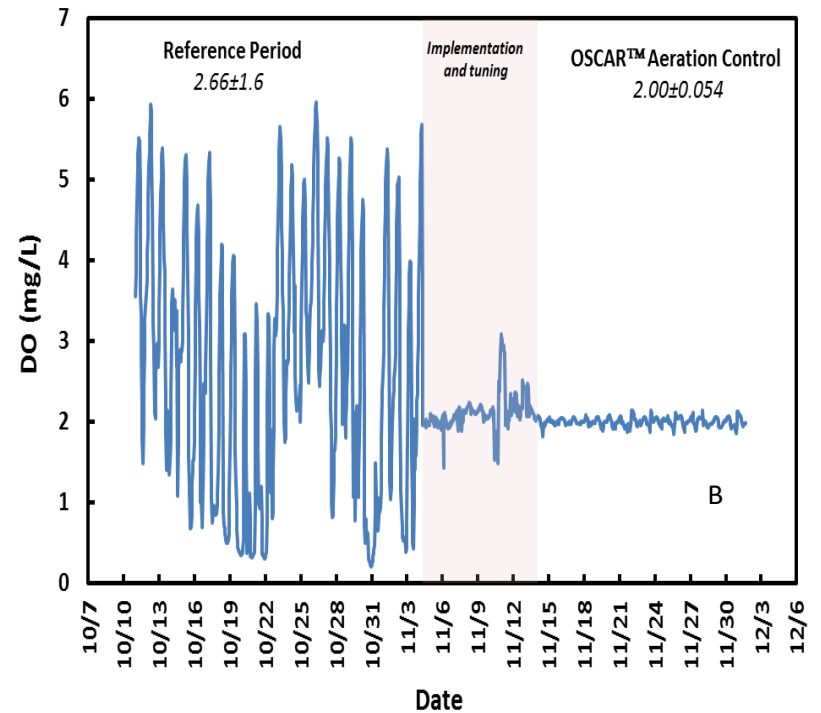
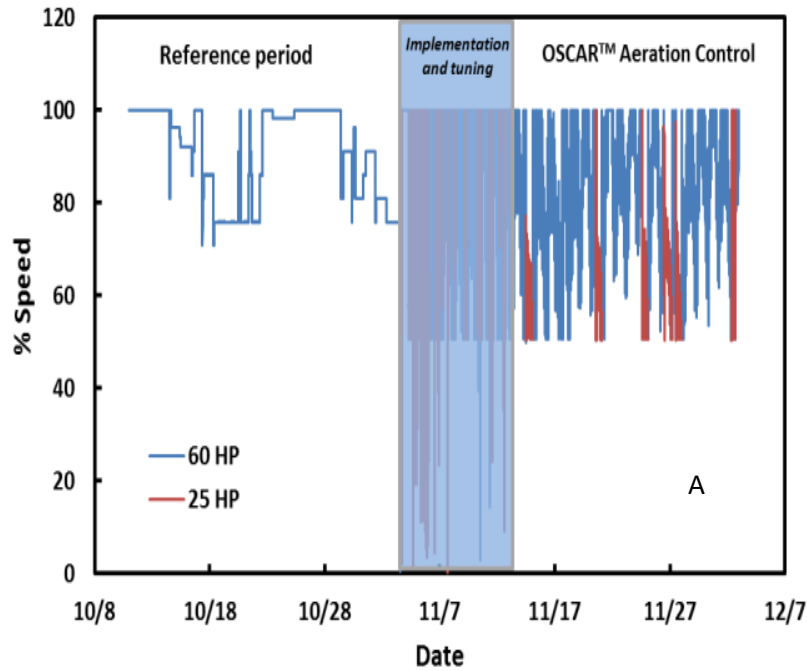
Monitoring System Improvements



Control System Improvements

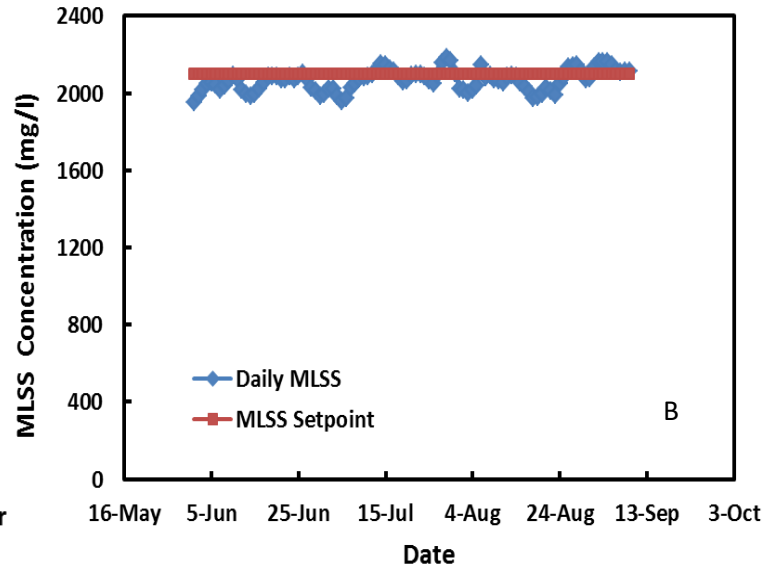
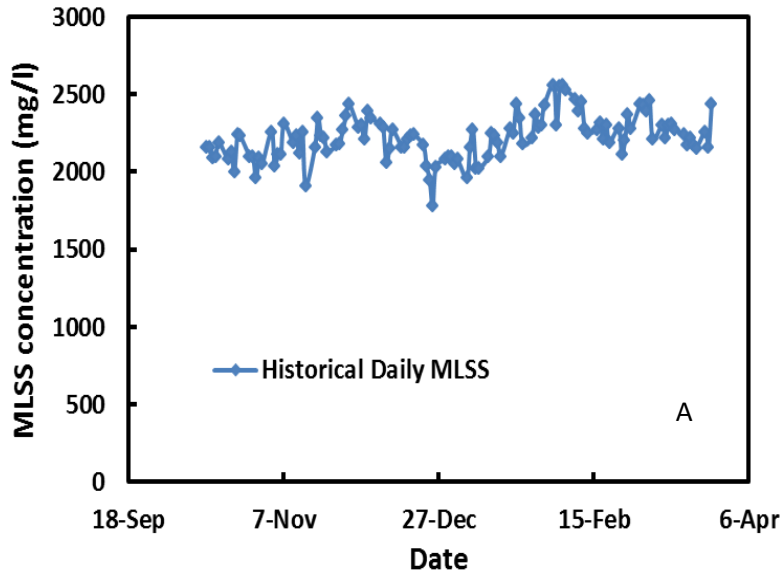


Process Aeration (DO) Control



DO control reduced energy consumption on average 10-15 %

Operator Desired MLSS Control



Without OSCAR™ Control

- MLSS concentration varies from 1900 to 2600 mg/l
- No control during weekend or holidays

With OSCAR™ Control

- MLSS was maintained close to the setpoint (2100 mg/l)
- Stable MLSS concentration over long operational period

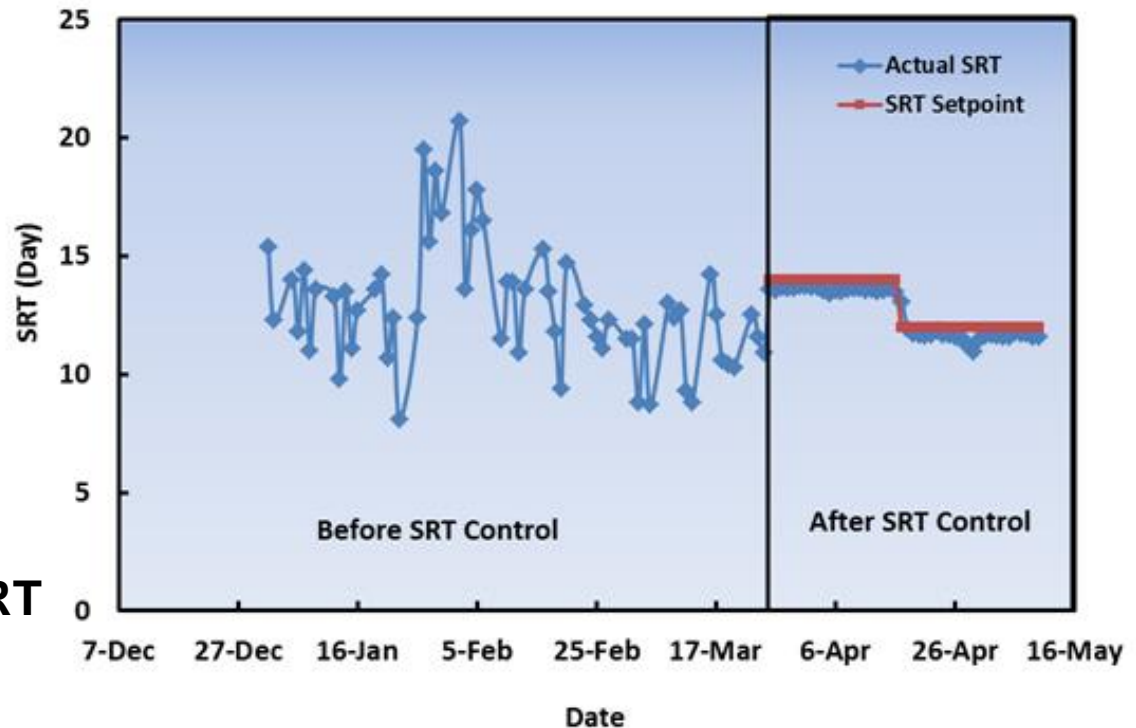
Operator Desired SRT Control

Without OSCAR™ Control

- SRT varies of 8 to 22 days
- Under/Over treatment
- Waste of energy
- Tedious manual wasting

With OSCAR™ Control

- Automatic Wasting
- Stable operator desired SRT
- Optimized treatment



Process Optimized SRT (Smart SRT) Control

Desired Treatment

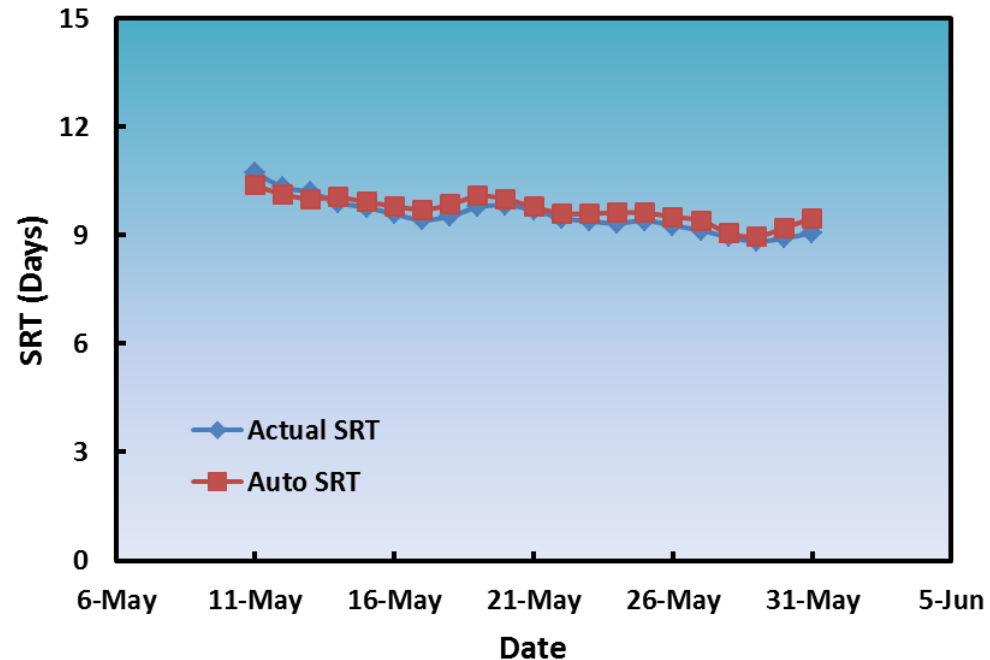
- Effluent ammonia concentration less than 1.0 mg/l

Without OSCAR™ Control

- Manual wasting

With OSCAR™ Control

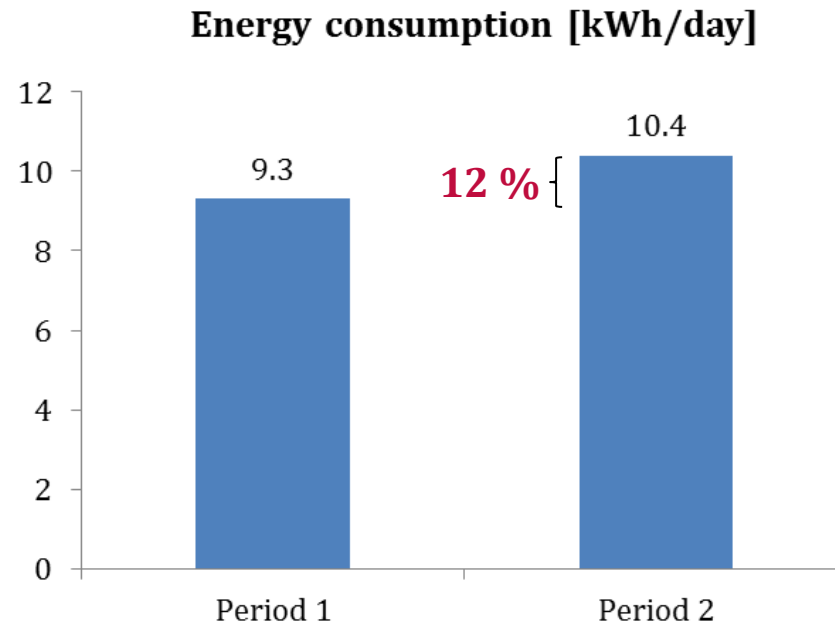
- Desired SRT was calculated based on process parameters
- Maintained SRT by automatic wasting adjustment
- Effluent ammonia conc. was always less than 1.0 mg/l
- Optimized process operation



Results – Energy consumption

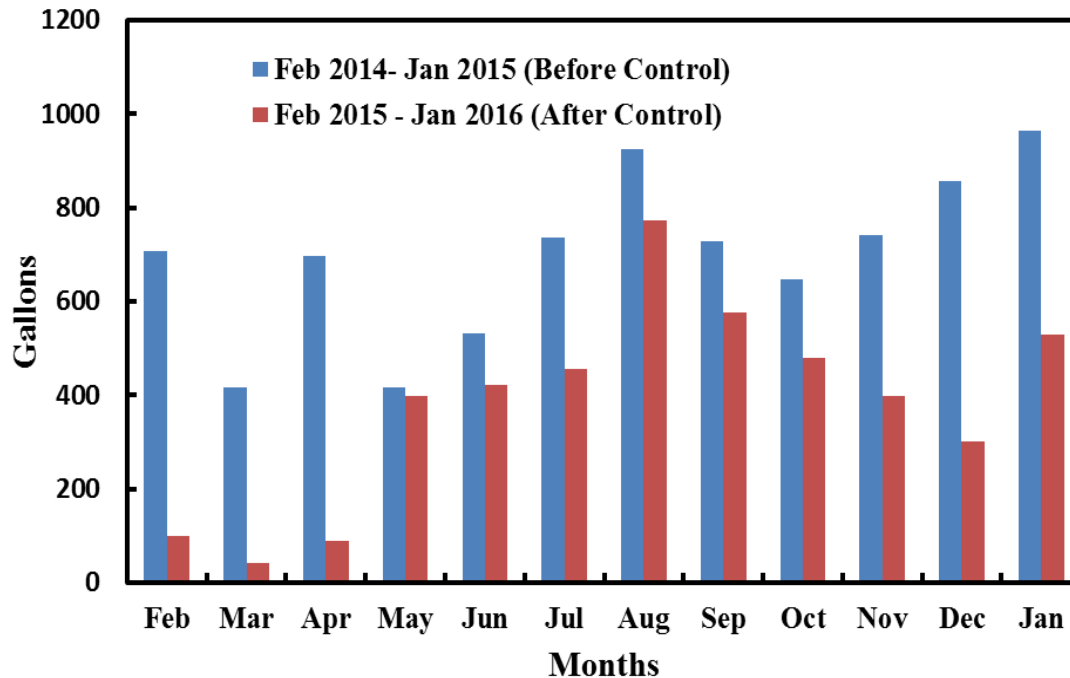
Significant difference in energy consumption from running at a higher SRT:

- **12 %** higher energy consumption
- **9 %** lower aeration efficiency



Åsa Henriksson and Alexis de Kerchove. 'Smart Biomass Control Saves Energy While Maintaining Treatment Objectives.' WEF Water and Energy 2015, Washington, D.C.

Chemical Dosing Control



Without OSCAR™ Control

- Manual dosing of FeCl_3 for P removal
- Caustic addition (50% of FeCl_3 volume) to recover alkalinity

With OSCAR™ Control

- Controlled FeCl_3 dosing for P removal
- Nearly elimination of caustic dosing
- 45% FeCl_3 and 100% caustic savings
- Consistent effluent TP (<1.0 mg/L)
- 24/7 control

Conclusions

Process Aeration

- **Process Stability and 10-15% energy savings**

Process MLSS/SRT

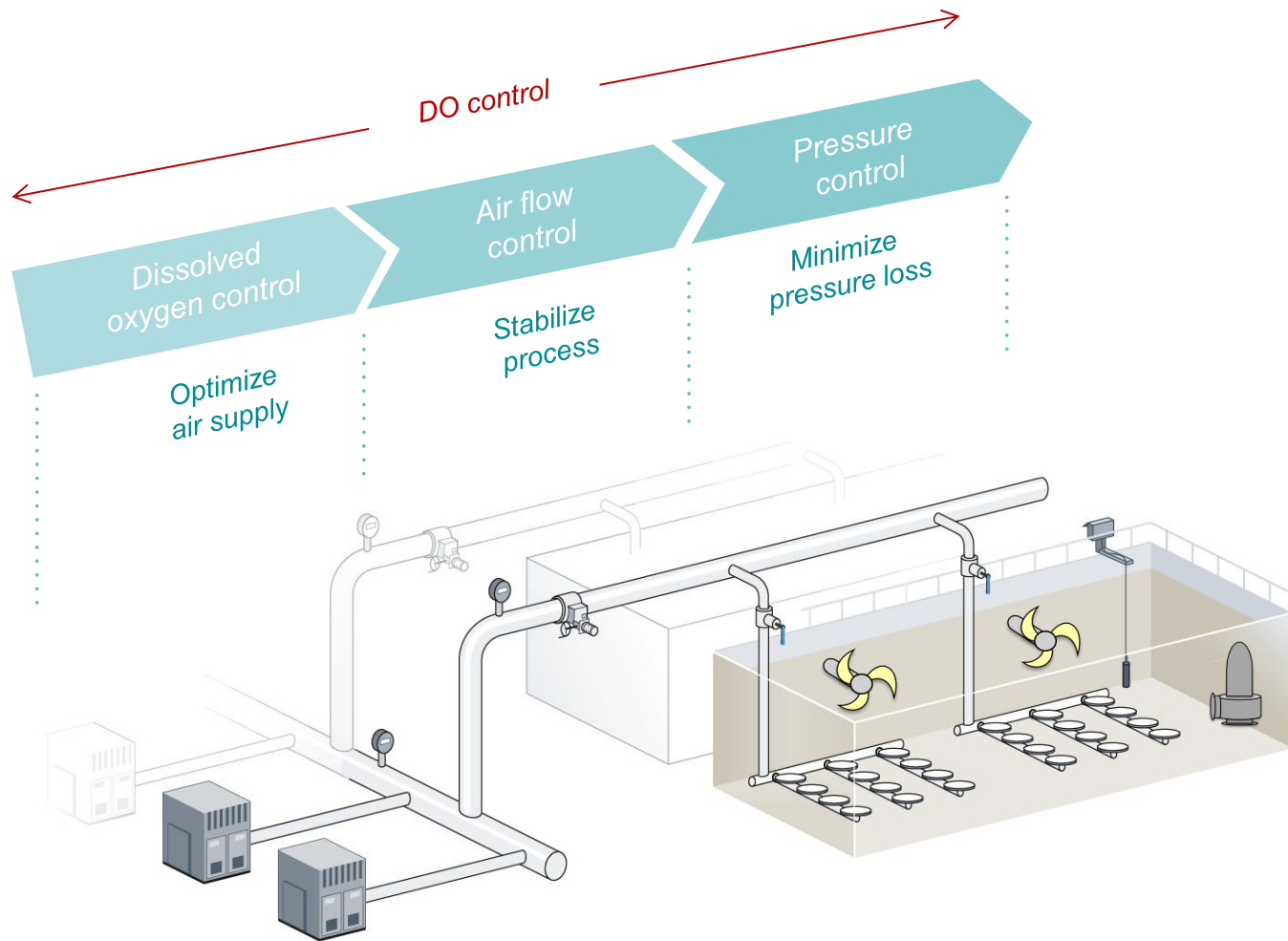
- **Flexible and Stable operation 24/7**
- **O&M hours savings**
- **Energy savings**
- **Visibility into dynamic process parameters such as MLSS, SRT, and mass wasted**

Chemical P Removal Process

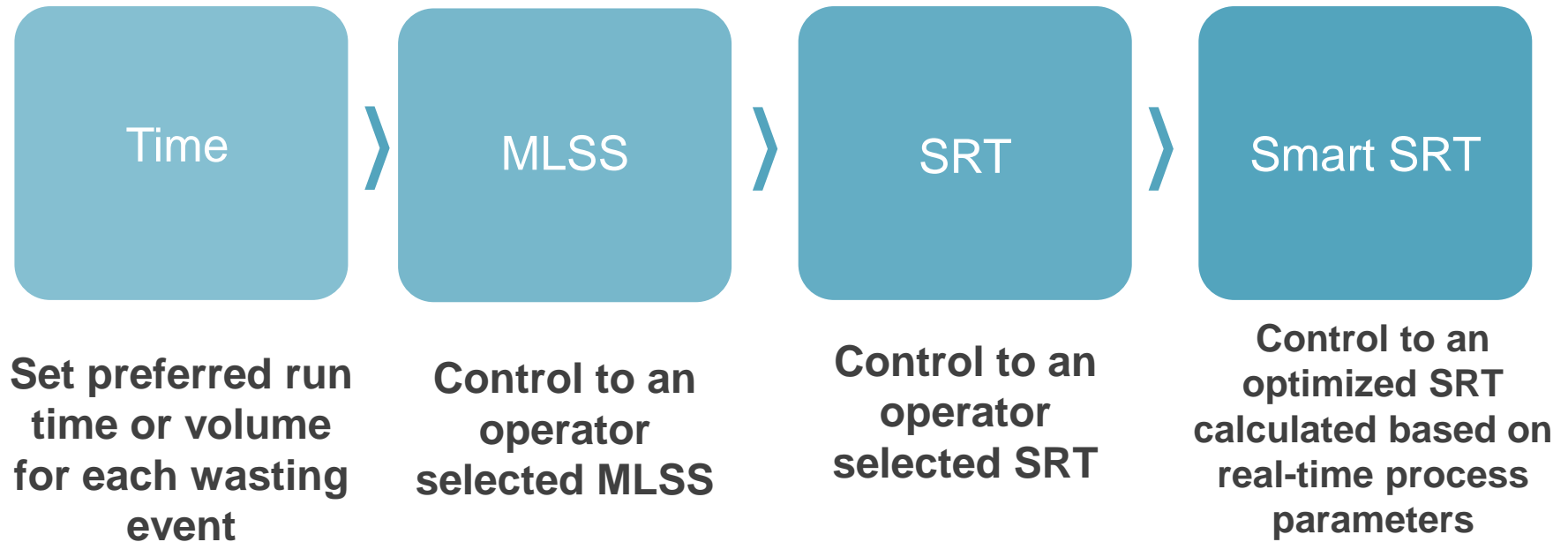
- **Consistent effluent TP concentration (<1.0 mg/L)**
- **Chemical cost savings**

Consistent effluent BOD, TSS and NH₄ concentration

Aeration Control Flexibility



SIMS Control Flexibility



Trouble-free Control

Careful and stable adjustments ensure a healthy biomass

- Avoids fast process changes
- Maintains a healthy SRT also in MLSS mode

Trouble-free control

- **We know our probes:**
 - Automatic detection of probe cleaning or calibration needs
 - During probe maintenance, SIMS switch to a separate control mode to avoid control using invalid data
- **We know the process:**
 - Automatic detection of process upsets or unhealthy biomass
- As issues are detected, SIMS switch to a safe mode and an alarm is sent to the operator

Implementation of Online Monitoring and OSCAR™ Control

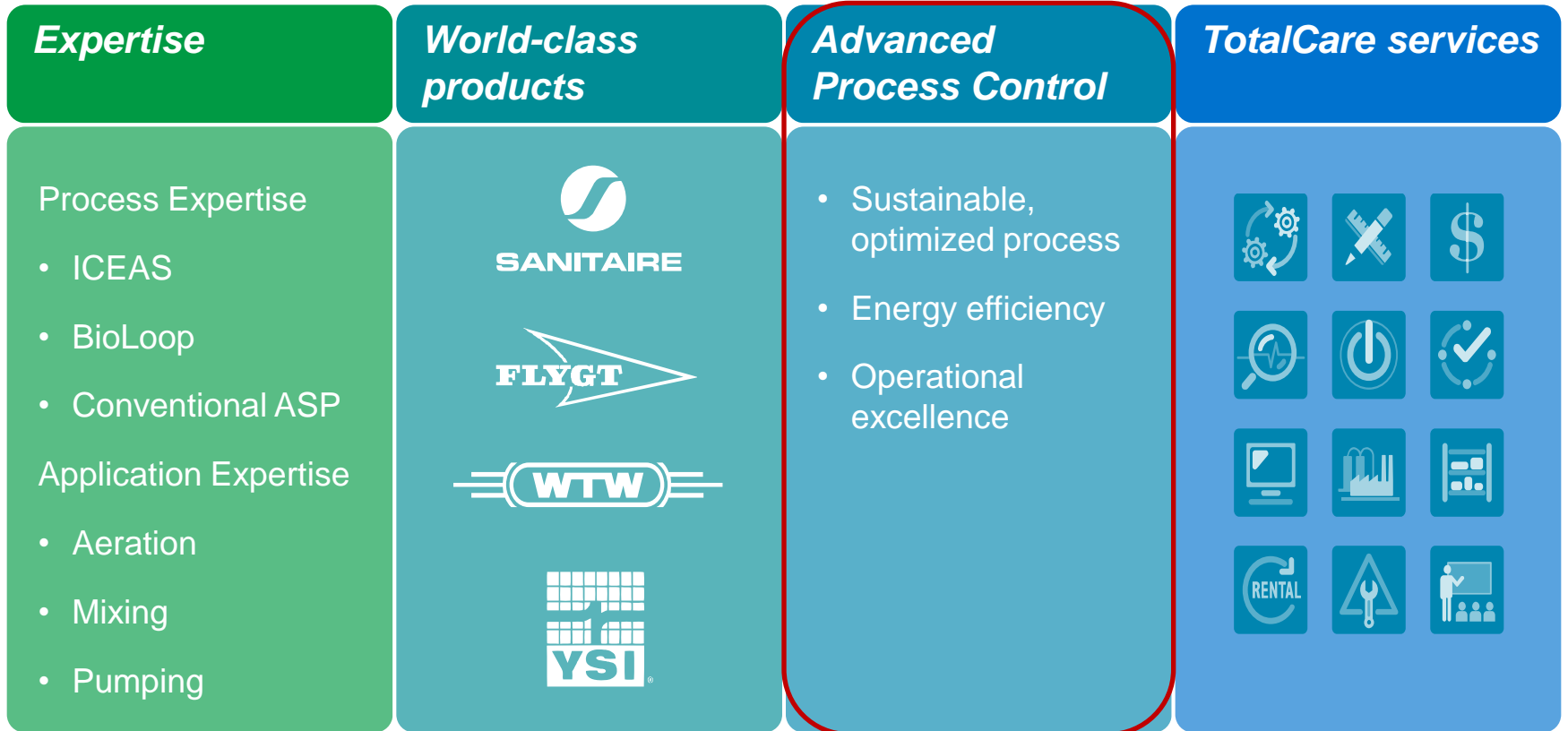
Automatic vs. Manual control

‘Historically, we ran our waste activated sludge pump manually for a certain period of time per day. We love the way the OSCAR™ SIMS control system is automatically controlling wasting based on our need, maintaining stable operation and providing superior effluent quality.’

‘We love the way the OSCAR™ aeration control system is automatically controlling blower speed and operation, and maintaining stable DO concentration that we never achieved during manual operation. Currently, we do not need to worry about blower operation during work days, weekends or long weekends.’

Rick and Bill
Black River Falls WWTP Operators
Black River Falls, WI

Why Xylem?



Questions?

- Web: www.xylem.com/treatment/us
- YouTube- www.youtube.com/user/SanitaireUS
- Phone: 1-414-365-2200
- Email: bulbul.ahmed@xyleminc.com