Southerly WWTC Valve Selection and Flexible Aeration Control for Energy Efficiency

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One Water Conference
Agenda

• NEORSD Overview
• Project Background and Objectives
• Equipment Selection
  • Blowers
  • Air Flow Control Valves
• Process Control
  • Constant Pressure
  • Most Open Valve
  • Flow based Most Open Valve
NEORSD Southerly WWTC

- Two-stage advanced treatment facility
- Serves 500,000 residents of Cleveland, OH and Suburbs
- First Stage Aeration System (FSAS)
  - Reduce carbonaceous biological oxygen demand prior to Second State Aeration System (SSAS)
- Two stages operate in series during wet weather
  - After FSAS capacity reached a portion of primary effluent directed to SSAS (capacity of 400 mgd)
- Although not as large as SSAS, FSAS accounts for over $500K per year in electrical consumption

Goal: Improve the mechanical reliability and efficiency of the unit process with improved automation and energy efficiency of the process air blowers.
Southerly WWTC Plant Upgrades

2012
ADF ~ 132 mgd
Peak ~ 175 mgd

2010 - 2015
Upgrade Primary Settling Unit Process

2016-2019 Upgrade
Second Stage Lift Station

2017 - 2021
Upgrade Second Stage Activated Sludge System

2012 - 2018
Upgrade and increase
First Stage Activated Sludge System
Peak ~ 215 mgd process
First Stage Aeration Tanks Equipment Overview

- Channel Blowers
- Process Air Compressors
- Unit Substation
- Control Room
- Air Header Pressure and Flow
- RAS Control Valve (Typ)
- Sluice Gates (Typ)
- Air Flow Meter and Control Valves (Typ)
- DO Probe (Typ)
Southerly WWTC Energy Demand

Over $500,000/year

Plant Total
SSAS Blowers
FSAS Blowers

32-67%
10-22%
Project Objectives

- Provide greater operational flexibility and tighter control
- Consider regulatory changes
- Improve energy efficiency

Equipment selection and refined DO control has estimated savings of $150,000/year
Path to Success

**Equipment Selection**

- Right size the blowers
- Minimize pressure loss in control and delivery
- Ceramic dome diffusers replaced with fine bubble membrane discs

**Process Control**

- Provide flexible process control to efficiently deliver the right amount of oxygen where and when it is needed
Existing First Stage Process Air Compressor Operating Envelope

Flow Rate (scfm)

- Plug Flow Operation
- Step Feed Operation
- Single Roots in Service
- Two Roots in Service

- 1 PAC in service
- 2 PACs in service
- Limited Turndown
- Excessive Capacity

- Current Annual Average
- Future Annual Average
- Current Maximum Month
- Current Peak Hour
- Future Maximum Month
- Future Peak Hour
- Blower Operating Range
Step 1 // Blower Selection

- Maximize efficiency at normal operating conditions with greater turndown
- Decreased from 1250HP to 900HP blowers
Blower Features

- Constant speed - RVSS
- Capacity Control
- System Master Controller not provided by the Blower Manufacturer
- No automatic start/stop
- Note on Surge

Discharge Diffuser
Inlet Guide Vanes

WEFTEC Presentation Stand at Siemens Factory
Step 2 // Air Flow Control Valves

- Modulating control valve and thermal mass flow meter per pass (4 passes per tank)
- Balancing valve per zone (2 zones per pass)
- Actuator Technology
  - Hydraulic
  - Pneumatic
  - Electric Motor
- Control Valve Selection
Butterfly Valve

Common selection for this application

Lower capital investment compared to other valves

Quick opening (non-linear) performance particularly when at lower pressure drops

Typical range of control 30-70%

Not propriety
Control-Disk

Modified butterfly valve

Disk profile improves linear control range vs. standard butterfly valve

Typical range of control 15 - 70%

Proprietary

Photos: Fisher Control-Disk
Square Diaphragm Control Valve

Proportionally opening aperture improves linear control range vs. standard butterfly valves

Typical range of control 15 - 85%

Proprietary

Photo: Binder Group
Jet Control Valves

Expands linearity of response; nearly the full range of travel (10% open gives 10% flow)

Venturi shape provides some pressure regain

Lower pressure drop compared to other valves

“Bulb” shape straightens flow

Compact installation with flow meter installed at ½ pipe diameter upstream

Flow meter calibrated at factory

Proprietary

Photos: Binder Group
Control Valve Technologies

Chart from the Binder Group, manufacturer of the Jet Control Valve
Selection// The Jet Control Valve Investment

Extended consideration
- Site visit in Germany
- Longer warrantee
- Written spare and repair plan

Pressure regain – very low installed pressure drop

Estimated energy savings
- Assume 7-10 cents/kW*hr
- Assume 80% efficient blower
- Estimates a 0.45 – 0.57 psi decrease in pressure

$12K - $18.5K per year at current loadings

1st installations in the USA
Flow Based Dissolved Oxygen Control

- Cascade Control
- Minimum Flow Set Point

**Self Correcting**
- Ambient Temperature
- Oxygen Transfer Rates
- Nutrient Loadings
- Forward Flow

**Not Self Correcting**
- Dirty DO probes
Pressure Control – 3 Automatic Control Modes
Functionality builds upon one another

Control Mode 1: Constant Pressure

Current state of commissioning
Historical trending
Stall the airplane!!! *(scary idea in an aircraft...)*

Optimized in aeration

Control Mode 2:
Most Open Valve (MOV)
advancing * optimization

Control Mode 3:
Flow Based Most Open Valve

Tom Jenkins
Aeration Control System Design
A practical guide to energy and process optimization
Valve Control Network Topology

Network connectivity via Ethernet/IP drove a Rotork Valve Master Station solution with 3rd party protocol converter

2nd Stage Settling will have rack mounted communications to the Valve Master Station via Modbus/TCP
Thank You

it’s about connecting

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