Relative Distribution of Plant Power -- 7.5 mgd WWTP

- Process
  - Raw Water P.S.O
  - Headworks
  - Primary P.S., Clarifier
  - Activated Sludge
  - Secondary Clarifiers RAS
  - Thickener, P.S.
  - Effluent Filters
  - Utility Water
  - Solids Dewatering
  - Heating
  - Lighting
  - Aeration/Cl₂ Mixer

- Percent of Total Plant Energy

- Air

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Aeration Energy Demand

- 1000 – 1500 kWh/MGD
- $100 - $150/MGD
- Largest Single Operation Cost
- Nitrification ~ 50% of oxygen demand

- Energy Saving Potential 20% - 50%
What Controls Aeration Requirements

- Load
- Permit Requirements & Process Design
  - PCL, N, NDN, SRT, SST
- Blower Type and Design
- Diffuser Type & SWD Depth
- **Aeration Control**
Controlling DO vs. Effluent Quality

- **DO ~ Surrogate Parameter**
- **DO > 0.1 mg/L = Aerobic**
- **Low DO**
  - High transfer efficiency into water
  - Low transfer rate into flock
  - Reduction in O2 Demand through SNDN
- **High DO**
  - Low transfer efficiency into water
  - High transfer rate into flock
Controlling DO vs. Effluent Quality

• Required DO varies
  – Change DO setpoint diurnally/seasonally
  – Adjust based on Effluent Ammonia/Nitrite
  – Most systems operate on constant DO setpoint
Aeration Control Limitations

- Overdesigned Aeration System
- Blower Turndown
- Minimum Air Flow per Diffuser
- Mixing Air
- Diffuser Grid Layout
- Lack of Automated Valves
Aeration Control Challenges

• Basin Geometry
Aeration Control Challenges
Aeration Control Challenges
Aeration Control Challenges

Grid 1 Grid 3

Grid 2 Grid 4

Grid 5

Flowmeter
Motor Actuator
DO-Probe
PLC
DO-Display

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Aeration Control Challenges

• Competing Control Loops
  – Blower start and stop
  – Blower Discharge Pressure
  – Air Flow
  – Valve Position
  – DO
    • Recycle zone
    • Clarifier influent
    • First aerobic zone
Aeration Control Challenges

- Control Valves
  - The valve position vs Aiflow

\[ Cv = \frac{Q}{61\sqrt{P_2\Delta P}} \]
Aeration Control Challenges

- Instrumentation
  - Reliability
  - Instrument Noise
  - Maintenance
Aeration Control
Aeration Control

Effluent Ammonia/Nitrite → DO Setpoint → Air Flow

DO Setpoint → Line Pressure

Line Pressure → Blower

Blower → DO Setpoint
Independent Control Loops:

- Header Pressure Control
- Basin Air Flow Control
- DO Setpoint Control
- (Effluent Ammonia Setpoint)
Control Loops

LPA Header Pressure Control Loop

A-Basin Air Flow Control Loops
Basin Air Flow Control Modes

- D.O. Mode
- Other Basin’s D.O. Probe Mode
- Fixed Air Flow Mode
- Time of Day Mode
Automated DO Control

- LPA Header Pressure Control
  - Loop Controller
  - Current Sensor
  - Flow Meter
  - Modulating Butterfly Valves
  - Multi-Stage Turbine Blowers
  - Motorized Open/Close Valves

- Basin Air Flow Control
  - Loop Controller
  - Operator Entered Setpoint
  - Flow Meter
  - Aeration Basins
  - DO Analyzers
Automated DO Control

[Graph showing Dissolved Oxygen (DO) and Air Flow Rate over a 24-hour period]

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Automated DO Control

Ammonia Control

Effluent

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Automated DO Control based on EFF NH4-N
Automated DO Control based on EFF NH4-N
Automated DO Control based on EFF NH4-N