Automation in Onsite Systems: Progress, Future, and Classification System

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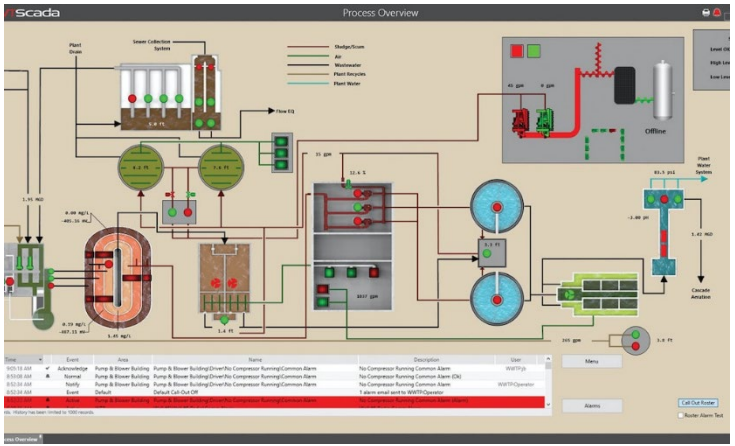
Definitions:

- **Automation:**
  - Use of technology to make process control decisions
    - Objective: reduction of human operation

- **Failure detection & remote monitoring:**
  - Identification of system malfunctions & process conditions
    - Objective: manual servicing

Automation in Wastewater Treatment

- 1970s discussing the prospect and promise of automating WWT
- Significant adoption since 2000s in centralized facilities
- Major advancements in processing power, WW specific sensors, improved control strategies



Benefits of Automation

- Benefits include:
  - Higher efficiency – smaller footprints
  - Ability to meet treatment standards
  - More reliable water recycling
  - Better protection of human and environmental health

Automation in OWTS

- Major changes in OWTS in the same timeframe
  - Improved materials & new systems
  - Focus has been on improving design
  - Limited focus on automation

- OWTS systems could benefit from improved process control
  - Improved treatment performance
  - Smaller systems (smaller safety factors)
  - Application in “unsuitable” areas

Classification System

Class		Category Name	
	1	Manual operation	
	2	Passive systems	
	3	Open-loop control + hydraulic Inputs	
	4	Water quality feedback + hydraulic inputs	

Class 1: Manually operated

- **Design Philosophy:**
  - **Frequent** maintenance
  - Logistics are critical

- **Examples:**

  Vaults (Holding tanks)

  Cartage services

Class 2: Passive systems

- **Design Philosophy:**
  - Completely passive design
  - System design is critical
  - Large safety factors
  - Poor system performance can go undetected for years

- **Examples:**

  Septic tanks

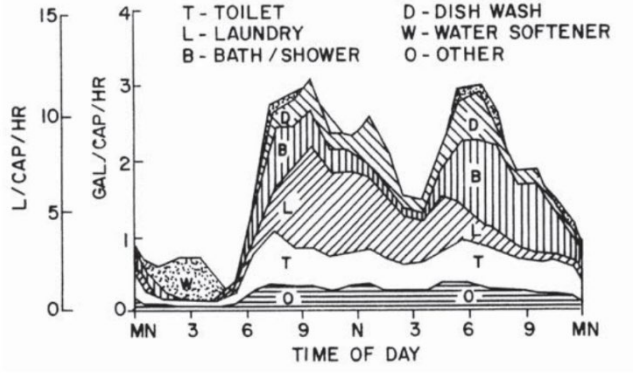
  Gravity fed SWIS

Class 3: Open-loop + hydraulic inputs

- **Design Philosophy:**
  - Active control systems
  - Timers (open-loop)
  - Float switch – hydraulic conditions

- **Examples:**
  - Timer based dosing to SWIS
  - Aeration to ATUs
  - Operation of SBR

Figure 3-3. Daily indoor water use pattern for single-family residence



Source: University of Wisconsin, 1978.

Class 4: Water quality + hydraulic inputs

- **Design Philosophy:**

  Active control

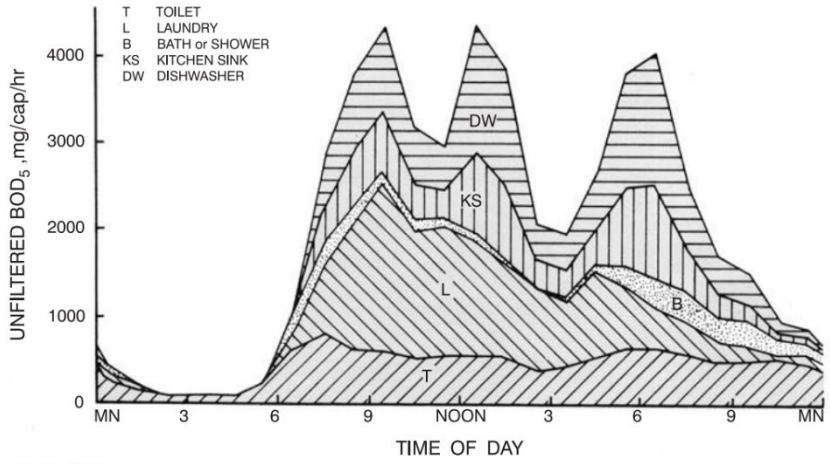
  Hydraulic Inputs

  Water quality & environmental inputs

- **Examples:**

  Centralized WWTPs

Figure 3-5. Average hourly distribution of total unfiltered BOD_5



Source: University of Wisconsin, 1978.

Class 4 Systems: What are the limitations?

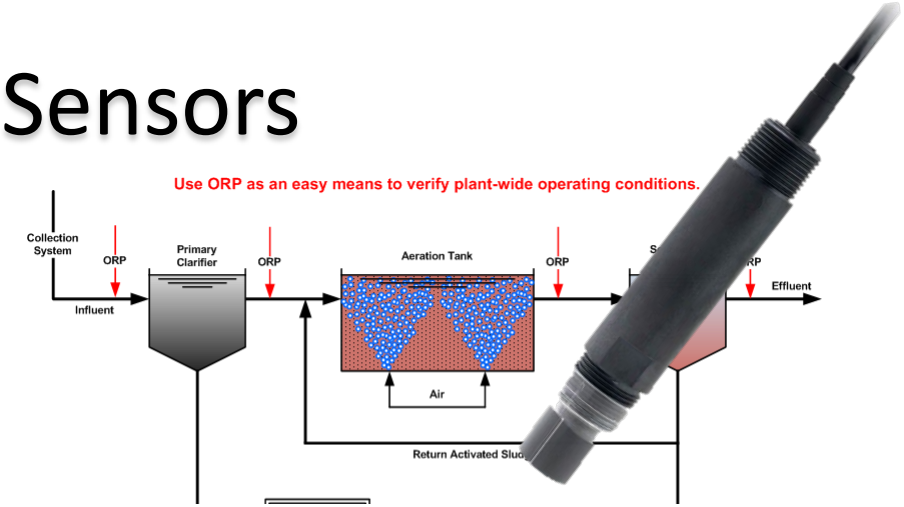
- **Computing power?**
  - Cheap, powerful, controllers
- **Sensors!**
  - Examples: Turbidity, DO, TSS, pH, ISP
  - Critical to OWTS
    - Initial costs
    - Replacement frequency
    - Maintenance frequency

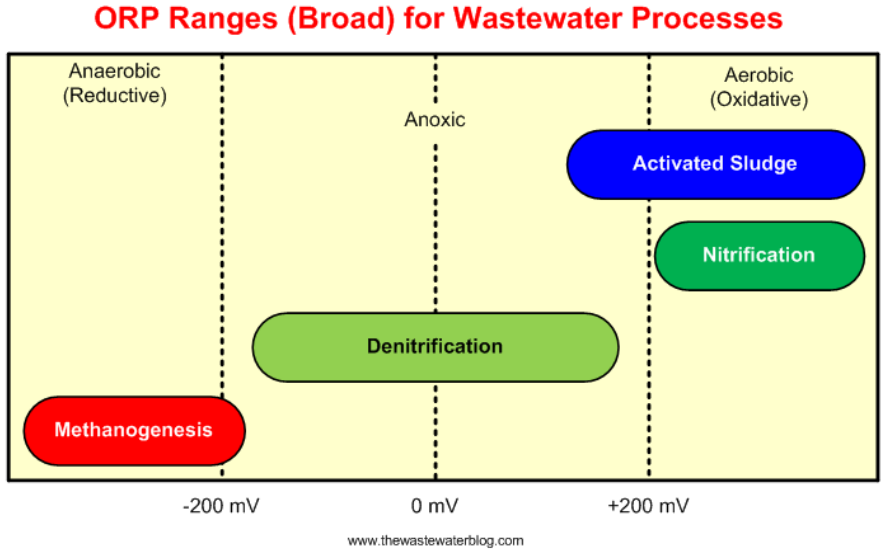
Direct Sensors

- **Direct Sensors –** directly measure the parameter of interest
- **Dissolved Oxygen**
  - Used for **aeration** processes
  - $500-3,000 per probe
  - Weekly- monthly recalibration & clea
- **Ion Selective Electrodes**
  - Ammonia, nitrate, & phosphate
- **Temperature & pressure**

Indirect Sensors

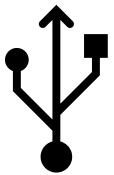
- **Indirect Sensors:**
  - Do not directly measure the parameter of interest
  - Correlation with parameter of interest
  - Examples:
    - ORP for dissolved oxygen
    - pH for nitrogen removal





Machine Learning & Artificial Intelligence

- **Develop complex predictive models**
  - Use less obvious relationships between indirect sensors and control targets



Conclusions

- Onsite systems can benefit from higher levels of Automation
- Water quality sensors can make OWTS more adaptable to changes in influent conditions
- R&D needed for direct sensors
- Indirect sensors can be used
- Use of ML and AI can help create more adaptive control strategies

Questions:

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