How to Respond to the Unexpected:

Industrial Slug Loading

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Outline

- Why should you listen to me?
- Overview of slug loading
- Real-world examples
- Lessons learned

First, a Few Questions

- How many of you are operators?
- Pretreatment?

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Experience

- 10+ years Field Experience
  - Facility had Mix of Municipal & Industrial
- Senior Process Engineer
  - Troubleshooting process issues
  - Ensuring processes operating efficiently
  - Evaluate & recommend alternative methods of operation

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Operational Experience Background

- Overall Facility
  - Combined Sewers
  - Design Flows: Avg = 26MGD, Max = 52 MGD
  - Recent Avg flows = 11.5 MGD
    - Municipal = 9 MGD
    - Industrial = 2.5 MGD
  - Dry Weather, Industrial could be as high as 40% of total flow

Slug Loading Events

- What is a slug loading event?
  - Large quantity/volume of loading
    - BOD
    - TKN
    - Other contaminant
  - Receiving an unexpected amount of something

Slug Loading Events

- When do you know something happened?
  - Typically, after it has hit the process
  - Damage is already being done
- Immediate Response
  - Try to limit damage to system
- Long-Term Response
  - How to identify future occurrence?
  - What data do you start to collect?
  - Ultimately: Do you treat the cause or the symptoms?

Example Events

- Low Influent pH on Municipal Side
- BOD Slug Loading
- TKN Slug Loading
- Surfactant Slugs

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Low Influent pH

- Immediate Response
  - Alarm Set in SCADA for Pump Station pH
  - Operator watches Influent pH closely for low pH to hit plant
  - Operator notifies pretreatment coordinator
    - Pretreatment in collection system with pH probe to try to trace back to source location

Low Influent pH

- Immediate Response
  - Once it arrives
    - Direct all flow to empty primary clarifier, or
    - Direct all flow to one in service clarifier
  - Once Low pH through influent
    - Close off low pH clarifier
    - Slowly drain back into system to minimize impact

Low Influent pH

- Long Term Response
  - Reviewed Trends: Flow Spikes
    - How long did they last?
    - How much flow?
    - Is there additional data to collect?
  - Initially – Seemed like a tanker dumping in the sewer
  - Ultimately, it was IDOT cleaning out storm tanks
    - Data isn't always what it seems

BOD Slugs

- Immediate Response
  - How to Identify
    - DO Consumption
    - Scum
  - Response depends on symptoms

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BOD Slugs: O2 Consumption

- Immediate Response
  - O2 Consumption
    - Increase Blower Output
    - Know your System
      - How much air flow can the system handle?
      - Can you operate multiple blowers at once?
      - Train new operators to understand this

BOD Slugs: Scum

- Immediate Response
  - Scum: Solids Shuffling
    - Can you divert to a single location?
      - Empty Basin?
      - Empty Clarifier?
      - Hold in Channel?
    - Still coming?
      - Shuffle clarifier or basins as possible
      - Allow scum removal systems time to work

BOD Slugs

- Long Term Response
  - Developed Long Term Operational Strategies
    - Took Anoxic Basins out of service – Denit happens in channel
    - Scum Control – Maintenance designed Scum Collection Pipe
  - Developed Data Monitoring
    - Scum Accumulation Spreadsheet
    - Microscopic Observations Spreadsheet
    - Discrete sampling & testing

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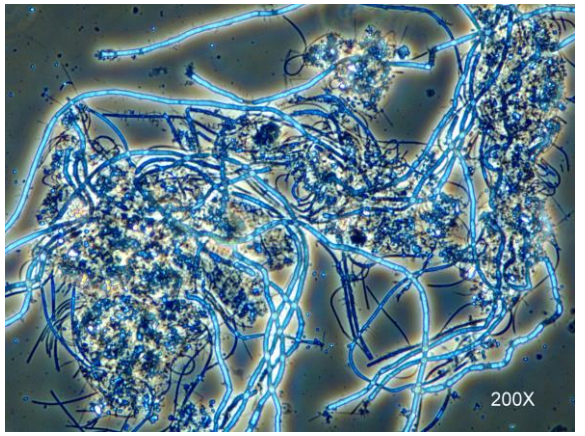
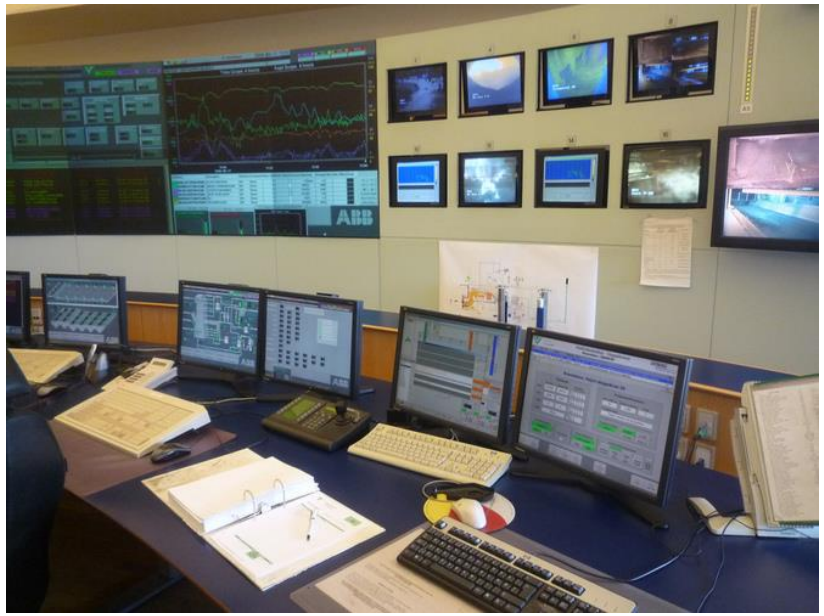
BOD Slugs



- Long Term Response
  - Data Evaluation Results (ongoing)
    - Low municipal flows & high industrial flows result in VFA slugs
    - This results in Filament Growth, typically N. Limicola II or N Limicola III (Microscope evaluations)
    - Long term strategy for filament control
      - Control MLSS concentration

TKN Slugs

- How to Identify
  - DO consumption
  - Low pH
- Handle Increased DO Consumption similarly to BOD Slug
  - Increase Blower Output
- pH drop
  - Might not be as easy to handle…

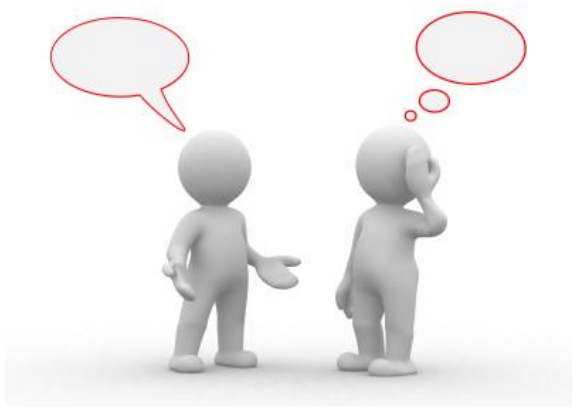


TKN Slugs: pH Drop

- Immediate Response
  - If equipped to do so, add alkalinity
  - If not…
    - Redirect some Influent to Biological Treatment Process
      - Storage Tank?
      - Open Clarifier?
    - Shut off Air intermittently
      - This stops nitrification process & alkalinity consumption
      - May be able to achieve some simultaneous nit/denit or just denit

TKN Slugs

- Long Term Response
  - In this case, minimal control over source
    - Communication with industry
      - Provide them with knowledge on process
      - The plant's success helps their success
  - Develop relationship with Chemical supplier
    - Understand process of ordering & shipping



TKN Slugs

- Long Term Response
  - Develop operational plans
    - Low Chemical Supply
      - increase target pH at industrial facility (chemical storage capacity higher)
      - Shut off air to treatment process (stops nitrification)
    - Oxygen Demand too high
      - Divert industrial flow (if possible)
    - Nitrite Lock
      - Operate pH optimally throughout process

Surfactant Slugs

- Immediate Response
  - How to identify?
    - Scum/Foam
    - Settling issues: impacts charge
    - Oxygen Transfer Efficiency

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Surfactant Slugs

- Immediate Response
  - Scum
    - Handle similarly to BOD Slug scum
      - Diversion
      - Solids Shuffling
  - Foam
    - Defoamer
    - Reduce aeration

Surfactant Slugs

- Immediate Response
  - Settling & solids Issues
    - Surfactants can be anionic, cationic, or nonionic
      - Can decrease settling & decrease polymer efficiency
    - Reduce Hydraulics
      - Add clarifiers to slow flow to each
      - Reduce RAS to reduce impacts
      - Make clarifiers as still as possible
    - Increase in solids (more details in long term)
      - Increase wasting

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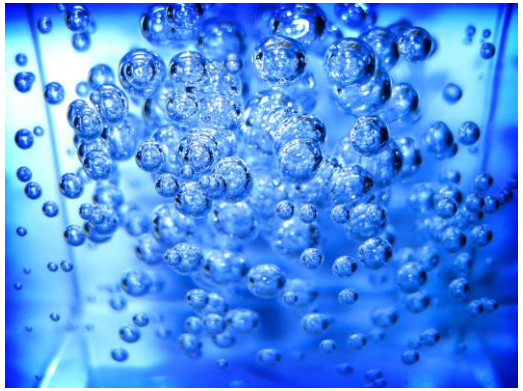
Surfactant Slugs

- Immediate Response
  - Oxygen Transfer Efficiency
    - Increase Blower output
    - Balance energy consumption with treatment needs
      - Watch pH Changes – if pH increasing, might indicate lack of oxygen to provide nitrification
      - If possible, watch DO towards end of process



Surfactant Slugs

- Long Term Response
  - Develop Data Collection Plan & Implement
    - Grab Samples, determine testing parameters
    - Settling: monitored SVI
    - Scum: Utilized Scum monitoring spreadsheet
    - O2 Transfer Efficiency: Trends for DO and Blower Output
  - Site visit to better understand customer's process

Surfactant Slugs

- Long Term Response
  - Ultimate conclusions
    - Data showed significant relationship between quantity of surfactant loads & increase in inert solids
      - Prior to changes in operation, MLSS was over 5000 mg/L at a 5-day MCRT
      - Increased to over 8000 mg/L at 20-day MCRT
    - Further evaluation showed more significant relationship with one particular type
    - Change of discharge location to post oil-removal had significant impact
    - Significantly reduced quantity of surfactant loads accepted

Operations Lessons Learned

- During a slug loading event, early operator action is vital
  - Train operators to know signs of a slug load
  - Ensure operators are trained to understand the limits of the plant
  - Ensure operators are empowered to take action
  - Develop operational plans & train on them

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Operations Lessons Learned

- Developing operation tools
  - Develop SOPs for known slug events
    - SOPs should be short & simple
    - Pictures are GREAT for SOPs
  - Have additional information readily available
  - Train operators on ultimate conclusion
  - Involve operators in data collection

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Operations: Lessons Learned

- Good Data is important
  - Collect during normal & abnormal times
  - Make sure collection is economical & feasible
  - Make sure data collection is meaningful
  - Find ways to capture operator observations
    - Observations are important
    - Finding a way to present meaningfully is just as important
    - Impartial, unbiased, assign a value for trending

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Lessons Learned

- Similar looking events can have different causes
  - Don’t have blinders on for evaluation
    - Look at all possibilities, not just historical causes
    - Be open to collecting new data
- Understand that you will not be able to isolate the event to study
  - Slugs move through quickly
  - Operations have to proceed
  - This may limit your ability to fully diagnose

Lessons Learned

- It might take years to determine the cause
  - Collecting data takes time
  - You cannot shut off revenue based on a hunch
- You will have to balance treating the cause with treating the symptoms
  - Cutting off a regular customer or sources of revenue may not be an option
  - Develop methods to treat the symptoms
    - Costs for additional treatment can be passed along as a surcharge

Lessons Learned

- Develop an understanding of what your plant is capable of
  - All facilities are different
  - Textbooks & Research can provide starting points
- Most of the time, the best you can determine is the “most likely cause” of an event



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Questions?

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