Dissolved Air Flotation (DAF) Optimization

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Discussion Outline

- What is Dissolved Air Floatation (DAF)
- How does DAF work
- Where is DAF typically used/most effective
- DAF Design Considerations
- Advancements in DAF
- DAF Optimization – FOG Removal Case Study
What is Dissolved Air Floatation?

- A process using air bubbles to assist with the removal of suspended matter.
  - Compressed air is introduced to the waste stream and mixed with suspended particles causing them to become buoyant.
  - Flow is slowed in a settling/floatation tank allowing buoyant particles to float to the top of the tank where they are skimmed off.
  - Dense solids are collected at the bottom of the tank.
What is Dissolved Air Floatation?
Pre-DAF Chemical Conditioning

- Waste stream can be introduced to DAF untreated
  - Some manufactures claim as high as 85% solids removal
  or
- To aid in the efficiency of floatable particle formation, it is very common to chemically condition the wastewater prior to the DAF
  - Coagulant (typically metal salts)
  - Flocculant (polymer)
    - Solids removal as high as 98%

- Removal efficiencies depend on many factors!
Pre-DAF Chemical Conditioning

Untreated Wastewater

- Waste streams carry a consistent charge; usually slightly negative, but can also be positive
Pre-DAF Chemical Conditioning

Coagulant Applied

Charge neutralization of colloidal particles in the waste stream to promote clumping together to form light floc
Pre-DAF Chemical Conditioning

Flocculant Applied

- Promotes clumping of floc particles
Pre-DAF Air Introduction

Dissolved Air Applied

- Air is introduced to the waste stream under pressure to adhere to particles
Pre-DAF Air Introduction

Dissolved Air Applied

- Air bubbles expand in floatation basin at (close to) atmospheric pressure causing particles to rise
Where is Dissolved Air Floatation Used?

- DAF systems are most commonly used in industrial applications to treat waste streams to locality standards prior to discharge
  - Common Industries:
    - Food processing
    - Paper mills
    - Oil refineries
    - Chemical plants
    - Textile industry
    - Meat processing
    - Bakeries
    - Other high-solids waste streams

- Large-scale DAF systems can also be used for municipal wastewater treatment
  - Sludge thickening
  - Solids clarification
  - Algae removal
Typical Industrial DAF
Municipal DAF
Municipal DAF
Municipal DAF
DAF Design Considerations

- Design Factors/Considerations
  - Flow rate
    - Flow Equalization?
  - Water Temperature
  - Chemical pre-treatment?
  - Solids loading (lbs/ft²/hr)
  - Hydraulic loading (gpm/ft²)
  - Air to solids ratio (lbs of air/lbs of solids)
DAF Design Considerations

- Saturator Pressure: Usually 60 – 90 PSI
  - As water temperature increases, saturator pressure needs to increase to achieve similar saturation levels

- Bubbles: 0.01 to 0.10 millimeters
  - Too large, the bubbles won't interact with enough solids and won't “grab” the particles
  - Too small, not enough buoyant force

- Hydraulic loading: 0.3 to 3.0, 4.0 gpm/ft² MAX
  - \(\frac{Q + R}{DAF \text{ surface area}}\)
    - \(Q = DAF \text{ influent flow rate (gpm)}\)
    - \(R = \text{internal recycle rate (gpm)}\)
      - Typically between 15 and 25% of \(Q\)
DAF Design Considerations

- **Solids loading**: 1.0 – 6.0 lbs/ft²/hr
  - \((\text{TSS} \times \text{Q} \times 8.34 \div 1,000,000)/\text{DAF surface area}\)

- **Air/Solids ratio (lbs air/lbs solids)**: 0.015-0.05
  - \(\frac{A}{S} = \frac{1.3 \times \text{Sa} \times (P-1) \times R}{\text{(FOG+TSS)} \times \text{Q}}\)

- **Particle Rise Rate \(\geq D/T_R\)**
  - \(D = \text{basin depth}\)
  - \(T_R = \text{basin hydraulic retention time}\)
DAF Advantages and Disadvantages

Advantages:
- High removal efficiency
- Small footprint
- Relatively low chemical consumption

Disadvantages:
- Operational complexity
- Power consumption
- Shelter typically required
DAF Advancements

- Air entrainment methods
  - Removal of saturation tank by using air-handling pumps

- Influent mixing techniques
  - Floc tubes

- Inclined (lamella-style) plates
DAF Advancements
DAF Advancements
Every industry has different treatment needs and every DAF manufacturer has a different design!
Bond Water Case Study

Wastewater Treatment Case Study: Project Nemo

FOG (Fats, Oils & Greases), TSS, BOD Removal
FOG, TSS, and BOD can be one of the most challenging aspects for a plant to maintain compliance with their discharge permit.

A major seafood processing plant was facing pressure from both the city and sanitation district for violating their permit on FOG, TSS, and BOD in addition to causing major pump station issues for the municipality. The customer had a DAF system in place that was designed years ago for lower flows and FOG/TSS.
Due to recent plant expansions the flow had almost doubled and increased the FOG/TSS loading on the DAF. This resulted in hydraulic overloading and carryover of TSS and FOG in the effluent. DAF system very LIMITED on adjustments.

The previous chemical vendor was using caustic, alum, and anionic polymer to condition the water and resulting in excess sludge generation.

The plant was being subjected to numerous wastewater surcharge fines and needed immediate help to prevent damaging the city’s pump station. The customer chose Bond to help after contacting our references.
Treatment Before Bond Evaluation
Case Study Solution

- The current DAF system was designed for 45 gpm flows and the plant was sending 70 gpm to this system.
- TSS and FOG had increased significantly in the influent stream.
  - This increased loading resulted in an air to solids ratio of .006 - .01, whereas the DAF unit was designed for .02 - .06 (4 fold reduction in air)!!!!
- We designed a chemical treatment to produce a larger/lighter floc to enhance air collisions and increase the rise rates.
- Air saturation system was not performing according to specifications due to air compressor. Rise rate less than 8” per minute in white water.
- Lowered the pH set point resulting in less caustic addition and better protein/oil breaking.
Some minor piping changes were made to allow for longer air to solids contact time, thus increasing their chances of collision and floatation.

“In-house” modifications had been made to the DAF unit resulting in short cycling of the system. Always review the original equipment layout/specifications!!!!

Percent solids in sludge was running at <1% and resulting in extremely high disposal cost. Adjustments to varying the rake speed via level detection and modifications to the sludge tank to include decanting valves and dewatering boxes have increased this number to 10%.
Case Study Results

The new treatment system and modifications have allowed the customer to stay under permit for FOG and TSS. In addition the city has not had any further issues with their pump station. We are estimating a savings of $25K per year in chemical and surcharge reductions. Sludge disposal costs have been decreased by $65K per year. Bond’s continued value plan for servicing the customer includes:

- Routine service visits to monitoring chemical usage and system KPI’s
- Routine service reports covering system performance and chemical usage/cost
- Routine Jar Testing
- Routine Operator Training
- Continual Improvement Projects

https://www.youtube.com/watch?v=kuwCIARJZUY
Treatment With Bond Water
Questions?