Thickening and Dewatering Optimization
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Agenda

• Equipment Specific Modifications
• Chemicals
• Feeding
• Cleaning and Maintenance
• Pretreatment
Optimization Approach

Dewatering and Thickening Optimization is a...

Balancing

Act

Cake Solids

Throughput

Polymer Dosage

Solids Capture
What is the Goal of Optimization?

- Key Performance Indicators
  - Solids content output
  - Solids capture
  - Polymer dose
  - Energy consumption

What Can We Do To Achieve These Goals?

- Vary different inputs
  - Equipment parameters
  - Hydraulic and solids loading rates
  - Polymer characteristics
  - Washwater
Equipment Specific Modifications

Belt Presses and Gravity Thickeners

• Belt speed
• Belt tension
• Chicane configuration
• Washwater pressure
Belt Press and Gravity Thickener – Belt Speed

• Faster speed
  • More throughput
  • Shorter retention time in gravity and pressure zones

Belt Press – Belt Tension

• Higher tension
  • More force applied in pressure zone
  • More force applied to belt
Belt Filter Press and Gravity Thickener – Chicane Configuration

- Balance turning of sludge with water drainage time

Centrifuges

- Differential speed
- Torque
- Pond levels
Centrifuge – Differential Speed

- Conveyor moving faster than bowl
- Increased differential speed
  - Solids move through quicker
  - Reduced cake solids
  - Increased capture

Centrifuge - Torque

- Use torque measurement to estimate cake dryness
Centrifuge – Pond Levels

- Increased pond level
  - More room for liquid clarification
  - Likely reduced cake solids
  - Possibility for increased solids capture

Gravity Thickener

- Elutriation water
- Solids removal rate
Gravity Thickener – Elutriation Water

- More water = lower hydraulic retention time
- Lower retention time = less chance for septicity

- Temperatures increase → fermentation increases → gas is produced → sludge floats

- Reduce residence time by increased hydraulic load to reduce gas production potential

Gravity Thickener – Solids Removal Rate

- Pumping rates faster than sludge “refill” rates
Solids Pumping

- Clarifier blanket level controls
- TSS meters

Chemicals
What Types of Chemicals

- Iron salts
  - Ferric chloride
  - Coagulates colloids
- Lime
  - Combine with iron salts for filter press applications
  - Increase resistance to filtration
- Polymers
  - Organic flocculants
  - Fix destabilized particles on the long monomer chains

Most Applications Use Polymers (Flocculants)
Typical Polymer Doses for Dewatering

Polymer Types

- Polymer is used for sludge conditioning and to enhance settling, thickening, and dewatering
  - Electronic charge
  - Charge density
  - Molecular weight
  - Molecular structure
Electronic Charge

- Anionic (negative) to attract mineral particles
- Cationic (positive) to attract organic particles
- Best determined via lab/bench testing

Charge Density

- More biological sludge requires more positive charge required

Source: SNF/Floerger
**Molecular Weight**

- Molecular weight = length of chain
- Longer chain is more able to handle high shear forces (i.e. centrifuge)
- Low to medium weight promotes good gravity drainage (i.e. GBT, RDT, BFP)

**Molecular Structure**

- Linear
  - Low shear resistance
- Branched
- Cross linked
  - High shear resistance
  - Blocked charges
Emulsion Polymer

- Milky/cloudy liquid totes
- Higher concentration of active polymer
- Shorter self life than dry polymer
- Usually 25% to 60% active polymer

Direct Feed Polymer System

From Chemical Unloading → Polymer Storage Tank → Dilution Water → Polymer Mixing Unit
Mix-Age Polymer Feed System

From Chemical Unloading

Polymer Storage Tank → Polymer Mixing Unit → Mix/Age Tank

Dilution Water

Dry Polymer

- Pellet or flake provided in large bulk bags
- Lower concentration of active polymer
- Longer shelf life than emulsion polymer
Polymer Conclusions

- Polymer aging is important for dewatering
- Polymer dosing location can be important for thickening
- SCADA can provide real time polymer performance tracking
  - Feed rates
  - Solids concentrations
  - Close mass balance
Feeding

Sludge is Inherently Variable

- But thickening and dewatering processes like consistent characteristics...
- Influent changes
- Biological process variations
- Digestion process variations
- Seasonal fluctuations
Control Feeding Equipment

- Manage pumping times and intervals
- Monitor solids content – ratholing
- Improve control over upstream processes (if possible)
- Sludge storage and blending

Consistent Feeding Has Multiple Benefits

- Predictability of thickening/dewatering performance
- Consistent polymer dosing
- Reduces equipment adjustments
Feed Distribution Can Impact Performance

Credit: BDP

Cleaning and Maintenance
Poor Cleaning Can Reduce Capture

Credit: BDP

Uneven Belt Stretching

Credit: BDP
Clogged Spray Nozzle

Pretreatment
An Emerging Approach

- Likely are many options similar to those used for digestion pretreatment
- One manufacturer recently working in the North American market

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Orege SLG Approach

- Compressed air injection into sludge
- Short retention time
- Allows release of free water from sludge
Initial Installation – Allentown, PA

• Goals
  • Improve cake solids – 15.3% baseline
  • Increase BFP throughput – 100 gpm baseline
  • Decrease polymer dose – 60 lbs/dry ton baseline

• Initial Results
  • Cake solids – 18.6%
  • BFP throughput – 150 gpm
  • Polymer dose – 45 lbs/dry ton
Case Study

RDT Optimization
F. Wayne Hill WRF, Gwinnett County, GA

PS and WAS Holding Tank
Rotary Drum Thickeners

Rotary Drum Thickener
Thicknessed Sludge Hopper & Pump

Optimization Approach

- Understand performance
  - Long term historical
  - Variability on different time scales
- Field sampling
- Full scale parameter adjustment
  - Tracking key performance indicators
- Develop “real life” guidance and approaches
RDT Analysis – Historical Data

- Average solids and hydraulic loading rates
- Sludge feed to digesters
- Field sampling
- Conclusions

WAS Load

![WAS Load Graph](image-url)
WAS + PS Load

Average RDT Solids Loading Rate
Average RDT Hydraulic Loading Rate

Calculated Thickened Sludge Loading to Digesters
Thickened Sludge Flow to Digesters

Digester SRT
Feb 1-14, 2014
Individual RDT Thickened Sludge Flow

Oct 14-21, 2014
Individual RDT Thickened Sludge Flow
Oct 14 – 21, 2014
Thickened Sludge flow to digesters

Oct 2014 – PS and WAS Loading
RDT Data Update Conclusions

• Periods of:
  • Good Thickening and High Digester SRTs
  • Sporadic Thickening and Lower Digester SRTs

• Variable Individual RDT Performance

RDT Field Sampling

• Measured TSL concentration of operating RDTs
  • Including new drum of RDT 4 (same day as install)
• Varied polymer dose on one RDT
• Measured WAS, PSL, and TSL concentrations
• Field Observations:
  • RDTs had different polymer doses & different TSL concentrations
  • TSL concentration can be optimized by varying polymer dose
Field Sampling Results

![Graph showing thickened sludge concentration vs polymer dose]

Field Sampling Results

![Graph showing thickened sludge flow vs polymer dose]

- RDT 3 on Nov 11, 2014
- WAS: 95 gpm @ 1% TS
- PSL: 75 gpm @ 2% TS
- HLR: 170 gpm
- SLR: 1,226 lbs/hr
Diurnal Sampling Results

RDT Thickened Sludge Concentration

RDT Field Sampling

- Still have variable RDT performance

- Use Thickened Sludge Flow as quick assessment of individual thickening performance
RDT Analysis – Key Conclusions

• Target thickened sludge concentration of 6.5% (Max 8%)
  • Necessary for maintaining digester capacity

• Variable performance across different RDTs
  • Likely due to varying polymer doses
  • Target uniform polymer dose
  • Average % capture >99.5%
  • Average filtrate TSS range = 100-200 mg/L TSS

Wrap Up
What Did We Learn?

- Equipment adjustments
- Polymer optimization
- Feeding controls
- Cleaning and maintenance
- Pretreatment potential

Questions and Discussion

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