Dewatering 101

Better Cake Through Conditioning

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Overview

- Define Polymer – types, forms and properties
- Dosage Calculations
- Getting the Most Performance Out of Your Polymer
- Sludge Parameters Influencing Conditioning
- Polymer Parameters Influencing Conditioning
- Questions and Answers
What is Polymer?

- Webster Dictionary defines polymer as “a naturally occurring or synthetic compound consisting of large molecules made up of a linked series of repeated simple monomers”
Industry definition – long-chained, high molecular weight, synthetic, water soluble, organic flocculant carrying a cationic, anionic, or non-ionic charge.
### Coagulant
- Product that adds charge causing particle neutralization
- van der Waals forces
- Destabilization

### Flocculant
- Product that links or enmeshes suspended solids into larger particles
- Bridging

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**Water Treatment**

**Waste Water Treatment**
Stable colloid

Unstable colloid

Microfloc formation
FLOCCULATION

Unstable colloid

Polymer bridges

Floc formation
Why We Use Polymer

- To help remove and concentrate solids
- Belt Presses and Centrifuges could not perform well without them
Types of Polymer for WW Treatment

- Cationic – positively charged, majority of WW applications
- Non-ionic – no charge, potable clarification and settling
- Anionic – negatively charged, potable clarification and dewatering of metal sludges
## 4 Forms of Polymer

<table>
<thead>
<tr>
<th>Emulsion</th>
<th>Dry or Powder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid Form</td>
<td>~ 100% Active</td>
</tr>
<tr>
<td>40% to 50% Active</td>
<td>Cationic, Non–Ionic, Anionic</td>
</tr>
<tr>
<td>Cationic, Non–Ionic, Anionic</td>
<td>Shelf life – unlimited</td>
</tr>
<tr>
<td>Shelf life &gt; 6 months</td>
<td>Granular, Flake, Microbead</td>
</tr>
<tr>
<td>Clear to Milky White</td>
<td></td>
</tr>
<tr>
<td>Oil Based</td>
<td></td>
</tr>
</tbody>
</table>
# Forms of Polymer

<table>
<thead>
<tr>
<th>Mannich</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liquid Form</td>
<td>Liquid Form</td>
</tr>
<tr>
<td>3% to 7% Active</td>
<td>3% to 7% Active</td>
</tr>
<tr>
<td>Cationic</td>
<td>Cationic, Anionic</td>
</tr>
<tr>
<td>Shelf Life ~ 3 Months</td>
<td>Shelf Life &gt; 3 Months</td>
</tr>
<tr>
<td>pH ~ 10 – 11</td>
<td>pH ~ 2.5 – 4.5</td>
</tr>
<tr>
<td></td>
<td>“Environmentally Friendly”</td>
</tr>
</tbody>
</table>
Polymer Properties

- Charge (cationic or anionic)
- Charge Density
- Molecular weight (chain length)
- Molecule type
- Chain shape
How is Polymer Effectiveness Monitored?

Pounds of polymer per dry ton of solids processed, or #/DT, is the industry standard for monitoring polymer effectiveness.
How is Polymer Effectiveness Monitored?

To find sludge loading rate (lbs/hour dry solids):

- \[ \text{gpm sludge} \times (\% \text{ sludge}/100) \times 8.34 \times 60 = \text{lbs/hour dry solids} \]

To find polymer usage (lbs poly/ton dry solids):

- \[ 2000 \times \text{gpm poly} \times 8.34 \times 60 \times (\text{poly conc. \%}/100) = \text{lbs /ton} \text{ lbs/hour dry solids} \]
How is Polymer Effectiveness Monitored?

Pounds per Ton =

\[ 2000 \times \text{gpm poly} \times \left(\frac{\text{poly conc.} \times 100}{100}\right) \]

\[ \times \left(\frac{\text{gpm sludge} \times \left(\% \text{ sludge} / 100\right)}{100}\right) \]
SAWS sheet
Keys to Getting the Most Performance Out of Polymers

- Proper Dispersion or Activation
- Proper Dilution Concentration
- Optimal Mixing Energy
- Optimal Mixing Location
Keys to Getting the Most Performance Out of Polymers

- Dispersion and Activation – proper use of make-up equipment
- Proper dilution
  - Mannich / Solution ~ 5 to 10%
  - Emulsion ~ 0.25 to 1.0%
  - Dry or Powder ~ 0.2 to 0.4%
Polymer Dilution

Flash mix

- Gallons per minute of polymer added divided by gallons per minute of water added
  - Draw down cylinder
  - Pump curve
- Equal polymer dilution
Emulsion Flash Mix – Draw Down Cylinder and Water Flow Meter
LMI – diaphragm pump
maximum pump capacity X stroke X speed
4.5gph X 0.5 speed X 0.5 stroke = 1.125 gph
1.125 gph / 60 min = 0.01875 gpm polymer

0.01875gpm polymer / 7.5 gpm water
= 0.0025 or 0.25% solution
Flash Mix System w/ Primary and Secondary Dilution Water
Flash Mix pressure differential
Dynablend Water Flow/Pressure Valve
Constant Water Pressure is Required
Poor Emulsion Make-up System
Optimal Emulsion Make-up System
Polymer Dilution

- Batch tank
  - Pounds of polymer added to tank divided by the pounds of water within the tank
  - Equal polymer dilution
Batch Tank Calculation

\[
\frac{12 \text{ pounds polymer}}{600 \text{ gallons water} \times 8.34 \text{ lbs/gal}} = 0.0024
\]

\[0.0024 \times 100\% = 0.24\% \text{ solution strength}\]
Dry Polymer Batch Tank
Keys to Getting the Most Performance Out of Polymers

- Mixing Energy ~ sludge/polymer addition point
- Injection Location ~ retention prior to application
Adjustable Sludge/Polymer Injector
Adjustable Polymer/Sludge Mixer
Polymer / Sludge Injector Problem
Polymer Injection Port
Polymer Injection Port
Keys to Getting the Most Performance Out of Polymers

- Optimize Polymer Dosage
  - Too little can cost more!
    - Too little polymer can produce:
      - Poorer captures, recycling solids (high TSS)
      - Wetter cakes (hauling/drying costs)
      - Man hours (clean ups/hauling)
Optimize Polymer Dosage
  - More Polymer is not necessarily better
    - Too much polymer can produce:
      - Poorer captures (foaming centrate)
      - Wetter cakes
      - Wastes money
BFP Gravity Drainage
Sludge Parameters Influencing Conditioning

- **Organic Matter Content (%)**
  - The organic matter content is comparable to the Volatile Solids content (VS)
  - The higher the VS, the more difficult the dewatering
    - Low cake dryness,
    - Low mechanical properties
    - High polymer usage
  - **Solution** – recommended to add a thickening step in order to achieve better dewatering
Colloidal Nature of the Sludge

- The higher the colloidal nature, the more difficult it is to dewater
- Factors affecting the colloidal nature of sludge
  - Origin of the sludge
    Primary–Digested–Fresh Mixed–Digested Mixed–Biological
    Low colloidal nature >>>>>>>>>>>>>>>High colloidal nature
Colloidal Nature of the Sludge

- The higher the colloidal nature, the more difficult it is to dewater

Factors affecting the colloidal nature of sludge

- Origin of the sludge
- Freshness of the sludge, colloidal nature increases with fermentation (septic)
- Origin of the wastewater: dairy or brewery increase colloidal nature
- Sludge return: poorly controlled return of sludge increases colloidal nature
Sludge Parameters Influencing Conditioning

- Concentration (Total Solids)
  - “Incorporation of the polymer” – the higher the concentration of sludge, the harder it is to mix in a viscous solution of polymer
  - Solution – post dilution, injecting the polymer upstream, multiple injection points, use of in-line mixer
Sludge Parameters Influencing Conditioning

- **Concentration (Total Solids)**
  - “Incorporation of the polymer” – the higher the concentration of sludge, the harder it is to mix in a viscous solution of polymer
  - Consumption of the polymer – the higher the concentration of the sludge, the lower the consumption of the polymer
    - True, only if incorporation is correctly done
Polymer Parameters Influencing Conditioning

- The Type of Charge
  - Anionic polymer to catch mineral particles
  - Cationic polymer to catch organic particles
Polymer Parameters Influencing Conditioning

- **The Type of Charge**
- **The Charge Density**
  - Represents the quantity of + or – charge necessary to obtain the best floc formation at the lowest dose
  - Depends on the type of sludge to treat
  - Generally, the higher the VS the higher the cationic charge needed
Polymer Parameters Influencing Conditioning

- The Type of Charge
- The Charge Density
- The Molecular Weight (MW)
  - Length of the polymer chain, generally depends on the type of equipment used for dewatering
    - Centrifuge – high to very high MW due to high shear
    - Belt Press – low to medium MW to obtain good drainage
Polymer Parameters Influencing Conditioning

- **The Type of Charge**
- **The Charge Density**
- **The Molecular Weight (MW)**
- **The Molecular Structure**
  - Linear – low dosage and good performance
  - Branched – medium dosage w/ excellent drainage
  - Cross-linked – high dosage w/ exceptional drainage performance and shear resistance
Molecular Structure

- Linear
- Branched
- Crosslinked
Polymer Parameters Influencing Conditioning

- The Type of Charge
- The Charge Density
- The Molecular Weight (MW)
- The Molecular Structure
- The Type of Monomer
  - ADAM–MeCl
  - APTAC
Color is not a Property!
Drums – homogenization by gentle agitation for short periods, if necessary.

Totes – homogenization by gentle agitation for short periods, if necessary. Tote bin mixer.

Bulk Storage Tank – best method is a large blade rotating at low speeds, 20 rpm. 30 minutes, twice a week.

Skin or crust on surface – do not mix!