Polymer Applications in Biological Treatment Systems

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WHAT ARE POLYMERS?

- A polymer is a very large organic molecule; it is a chain of monomer subunits. Some of the monomer molecules have positive or negative charges.
- Polymer chains vary in length from thousands to millions of monomer units.
- If each monomer molecule was the size of a pearl, the chain length of most polymers would be 400 to 8,000 feet long!
- In wastewater treatment processes, polymers are used to coagulate suspended solids and produce large curds of solid materials (floc).
Polymers: Infinite Variations

1. Physical Forms: Powder, emulsion, and solution
2. Charge: Anionic (negative), Cationic (positive), Nonionic (neutral), and Amphoteric (positive and negative)
3. Charge Density: Amount of charged units along polymer chain, usually expressed as a percentage
4. Molecular Weight: Number of monomer units, 1.5 to 30 million amu
5. Molecular Structure:

   ![Linear](image1)
   ![Branched](image2)
   ![Cross-linked](image3)

   Linear  Branched  Cross-linked
Clarification System Capabilities

Primary clarification: improves solids settling and reduces BOD load on system

Secondary clarification: improves solids compaction (SVI), removes suspended solids, and increases hydraulic throughput capacity
Sludge Conditioning for Mechanical Dewatering Systems

Rotary Drum Thickener: increases solids content to 6-9% range

Belt Press: produces >20% solids content cake
Proper Makedown and Feed Techniques

• For maximum effectiveness, dry and emulsion polymers should be diluted with water up to 0.5% concentration prior to application.

• Dry polymers are diluted with a day tank and low speed mixer; polymer is added with an eductor and funnel. Most dry polymers require 1 to 4 hours of solution aging.

• Emulsion polymers may be diluted using a day tank and mixer, or they may be continuously made down and fed using an injection/dilution system.

• Cationic emulsions are unstable in high hardness/high alkalinity water and may lose their effectiveness within a few hours.

• Polymer solutions should be fed to the process using a high viscosity chemical metering pump or variable speed positive displacement pump.

• The polymer feed point should provide sufficient mixing for complete flocculation. While mechanical mixing at the point of application is preferred, most municipal WWT systems rely on turbulent mixing.
Dilution of Dry Polymers

Blending tank with mixer and eductor

Close-up view of dry polymer eductor
Continuous Injection Systems for Emulsion Polymers
Polymer Storage Recommendations

Dry polymers-- Store in a cool, dry area; prevent exposure to high humidity. Properly stored dry polymer is usable for many years.

Emulsion polymers-- Emulsions are relatively stable for 6+ months, but separation may occur. Mix regularly to minimize separation. Keep drum caps sealed when not in use; avoid contamination with water.
Onsite Testing and Evaluation

Jar testing should be performed to optimize product selection and application dosage. Jar testing applies to low-solids waste streams, such as primary clarification, secondary clarification, and SBR processes. Use Sludge Pour Test (decant method) to determine product and dosage for sludge dewatering.

Floc size and settling rate increase with increasing polymer dosage (L to R)
Pour Test for Sludge Dewatering Evaluation
Decant water volume is measured at 15 second intervals after conditioned sludge is poured into funnel