Water Soluble Polymers For Industrial Water Treatment Applications

Presented By

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Course Objectives

Explain what water soluble polymers are.

Describe the 4 physical forms commonly used in industrial applications.

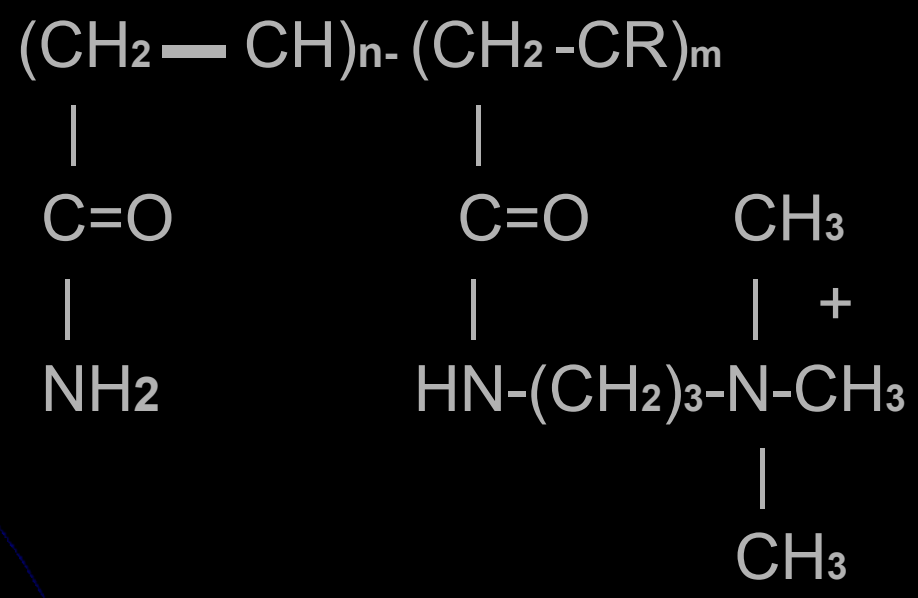
Safety and handling.

Where are polymers applied.

What factors affect polymer performance.

What is a polymer?

A polymer is a chain of organic molecules made up of many repeating units.

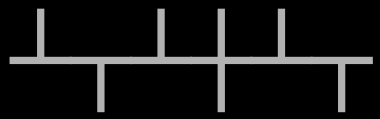
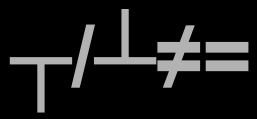


Ex. A PAM cationic polymer

Polymer Characteristics

- Molecular structure
- Molecular weight
- Charge Density
- Charge
- Physical Form
- Polymer Solids

Molecular Structure

- Linear 
- Branched 
- Cross- linked 

Types of Charges

Anionic (-)

Nonionic (neutral)

Cationic (+)

Charge Density

Charge density is defined as a percentage of repeating units that have a charge.

Molecular Weight Ranges

Low	< 100,000
Medium	100,000 - 500,000
• High	500,000 – 6,000,000
• Very High	6,000,000 – 18,000,000

Physical Forms

Aqueous Solutions

(*Polyamines, polyDADMs, resin amines, and Mannichs.*)

Dry and Beaded

Emulsions

Dispersions

Polymer Solids Content

Dry Polyacrylamides: 88-95%

Emulsion Polyacrylamides: 25-50%

Aqueous Solutions

- Polyacrylamides: 5- 10%
- Polyamines: 20- 50%
- PolyDADMs: 10- 98%
- Resin Amines: 6- 10%

Aqueous Solutions

Polyamines, Resin Amines, and PolyDADMs

- Shelf life of 6 months (Resins are 3)
- Can have a very high viscosity to an almost water like consistency.
- Range in color from amber to clear.
- pH of neat product can range from 2 to 6.

Aqueous Solutions

Mannichs

- 3 month shelf life.
- Contains formaldehyde and dimethylamine.
- Strong Odors.
- Very high viscosity.
- Can gel in very high temperatures.
- Neat polymer line should be at least 2 inches in diameter.
- Gear or progressive cavity pumps should only be used for transferring neat product.

Aqueous Solution Preparation

Gear or progressive cavity pumps should be used for neat product transfers.

Can be applied directly to the application without out aging or batch tanks.

Solution Polymer Units

Benefits:

Superior usage and dosage control by metering precise amounts of polymer and water.

Can be made fully automated to require very little operator attention

Reduces heath and safety issues related to handling

Storage and Handling

Can be supplied in 5 and 55 gallon drums, 275 gallon totes, and bulk deliveries.

Must be kept from freezing.

Water should only be added when being made down.

Stainless steel, fiberglass, and XLHDPE should be used for storage tanks.

Do not store in direct sunlight.

Spills should be cleaned up with water and a mild bleach or polymer solvent solution.

Dry Polymers

Available in granular, flake or bead form.

These products have the highest active polymer content then any other polymer.

Requires at least 1-2 tanks for batching and application to insure proper mixing for optimum performance.

Cationic dry solutions have an effective pH range of 6-8; if the value increases or decreases in the substrate, the rate of free radical chain degradation is accelerated.

Dry Polymer Preparation

Dry polymers should always be pre-wetted.

- Pre-wetting prevents clumping in the solution. (Commonly referred to as fisheyes.)
- Reduces dissolution time.
- Requires high sheer for proper inversion.
- Polymer consumption and labor can be reduced by using specially designed make-down equipment.

Dry Polymer Preparation

Dissolution:

- Requires a mixer that can provide a consistent speed in viscous solution.

- For standard granular dry products, a minimum of 1 hour is required for mixing.

Related Parameters:

- Particle size
- Charge density
- Water temperature
- Solution Concentration
- Water Hardness

Dry Polymer Units

Benefits:

Provides superior usage and dosage control control when properly calibrated.

Insures consistent and homogenous batch make-up for all dry polymers at all charges and molecular weights.

Proven to reduce handling issues.

Units are fully automated requiring less operator attention.

Storage and Handling

Bags must remained sealed until the polymer is ready for use.

Must be stored away from water.

Water should never be added to dry product spills.

Product is supplied in 5olb bags, 1 ton super sacks , or bulk deliveries.

Emulsion Polymers

Emulsion polymers are hydro-gels of water soluble polymer contained in oil.

Emulsion Polymers

Contain stabilizing surfactants that keep the polymer stable in the oil media.
Uses inverting surfactants to aid the polymer in dissolution.

Typically these products can have an active content anywhere from 20%-55%.
Standard emulsions can be distilled to prevent separation.

Distilled emulsions also have an active solids content > standard emulsions.

Requires less dilution water then aqueous solution polymers. (0.001- 0.01%)

Cationic emulsions have an effective operating range of 4 - 8; if the pH value increases or decreases beyond that range, the rate of free radical chain degradation increases.
Anionic emulsions have an effective pH range of 6 - 14.

Emulsion Polymer Handling

Emulsions are available in 5 gallon, 55 gallon drum, 275 gallon returnable totes, and bulk deliveries.

Emulsion polymers can vary in color, often they can appear clear or often milky white.

- Emulsion polymers will freeze at 32° Fahrenheit.

Store away from water.

Requires 20 minutes of aging for optimum performance; but can be applied directly to the application.

Emulsions have a shelf life of six months and should always be screened prior to being if stored for extended periods of time to prevent pump blockage.

Since emulsions do separate over time it is often necessary to mix the neat product for at least 20 minutes every other day.

Emulsion Preparation

Benefits:

Provides excellent usage control.

Deliverers precise amounts of water and polymer.

Reduces or eliminates batch tanks.

Can be manufactured to be fully automated reducing operator attention.

Reduces safety and handling issues.

Dispersion Polymers

A Dispersion polymer is a polymer precipitation in brine.

Since these polymers have no oil or surfactants, they leave a virtually no environmental thumbprint.

Easily dissolves in hard water.

These products are available in low to medium molecular weights.

Dispersion polymer have very low inversion requirements. (A static mixer will suffice.)

Wide pH range application range.

Can be used for solids dewatering, drainage, oil and grease.

Safety and Handling

Dispersion polymers have a shelf live of 3 months.

- Dispersion polymers will freeze at 32° Fahrenheit.

Dispersion polymers will separate over time they should be mixed at least 3 times a week for 20 minutes at a time.

These products should stored away from water.

Polymer spills can be cleaned with a high pressure water hose and dry sweep.

Very slippery

Coagulation

Is a phase in the overall process whereby the constituents of a given water are destabilized by charge neutralization.

Coagulant Properties

Typical low in molecular weight. (< 1,000,000.)

Possesses 100% cationic charge.

Can be organic or inorganic.

Organic vs. Inorganic

Organic

Benefits:

- Lower dosage
- Low sludge volume
- Broad pH operating range

Drawbacks:

- High cost
- Narrow application range

Inorganic

Benefits:

- Large operating range
- Low cost

Drawbacks:

- High dosages
- High sludge volume
- Affected by pH
- Heavy metals

Flocculation

Is a phase whereby the destabilized particles, or particles formed during destabilization, are induced to collect into aggregates.

Flocculants

- Are available in all charge types and densities.
- Possess a molecular weight > 1,000,000.
- Molecular weights can be as high as 20,000,000.
- Produces strong flocs that are resistant to sheering.

Coagulants vs. Flocculants

Coagulants	Flocculants
Low molecular weights	Medium to high molecular weights
Aqueous solutions	All physical forms
Cationic	All charge types and densities
Strong dilution required (Typically 1-25%)	Weak dilutions required (Typically 0.01- 1.0%)
Long reaction time	Short reaction time
Must be added first	Can be added last or alone

Applications

Coagulants

Colloidal solids removal

Filter aid

Metal sludge thickening or dewatering

Color Removal

Oily waste resolution

Flocculants

High volume solids dewatering

Thickening

(gravity and floatation)

Clarification

Oily waste resolution

Performance Factors

Three categories:

Polymer

Waste stream

Application
(physical and chemical)

Polymer Factors

Polymer type	Is the polymer the right charge type and molecular weight?
Dose	Are you applying the correct polymer dose?
Polymer concentration	Is it at a sufficient concentration to deliver the correct dose and prevent sheering?
Polymer make-down	Is the make-sown water within an acceptable pH range to prevent hydrolysis?
Make-down water quality	What's the hardness of the water?

Substrate Factors

pH

Total solids concentration.

Solids type.

Other chemical addition, primarily strong oxidizing agents.

Cationic Flocculants have a narrow pH operating range, to prevent free-radical chain degradation it is recommended that you monitor pH optimal performance.

Resin amines and Mannich polymers can not be used if the pH is > 7.2.

Surfactants and dispersants will adversely affect performance.

Application Factors

Addition Point	Is the polymer being introduced to far back or not far enough?
Mixing energy	Is there conditioning of the polymer in the substrate other then velocity?
Equipment type and condition	
Flow rates	Is there to much or to little polymer or substrate flow?
Post- Dilution	Is the polymer easier to disperse when the solution concentration Is lowered?

Industries served…

Paper mills	Waste treatment: Clarification, pulp thickening and dewatering. Process applications: Retention and drainage, Green liquor clarification, and anionic trash collection.
Public utilities	Potable water and sewage treatment.
Food Processes	Solids dewatering and thickening.
Aggregates	Clarification, solids dewatering, and thickening.
Agriculture	Water retention, erosion control, nutrient run-off prevention.