Primer on Polymer Handling

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There are many benefits of using liquid polymers in water-treatment applications as long as the blending equipment is able to accommodate their unique characteristics.

Introduction

A major concern at water and wastewater treatment facilities is identifying the most effective and efficient way to deal with and dispose of solid particles and materials that are found in the liquid stream. These unwanted contaminants can have an adverse affect on the plant's operation if they are not contained properly. The best way to eliminate these solid particles is to have them clumped together into a sludge that can be swept out of the water-treatment stream.

The most effective means of achieving this sludge-creating process is through the use of polyelectrolytes, or polymers, that consist of long-chain organic molecules. These polymers have the ability to attract and absorb suspended solid particles, making them easier to remove from the water that is being treated. Activated polymer molecules can perform this crucial task because they have charged sites that attract suspended solids of opposite charge.

Although their higher molecular weight makes them effective for this process, polymers can be difficult to mix and feed into the treatment process. While other typical water/wastewater chemicals such as alum, ferric chloride and sodium hypochlorite can be easily diluted or applied directly to the treatment process from a storage container, to be effective, polymers must be "activated." A polymer is activated by being hydrated and extended prior to dilution and introduction into the process stream.

Polymers are used to remove colloidal suspensions from surface waters and to condition municipal wastewater sludges to enhance the

This system simplifies the polymer blending process because it has been designed to effectively activate all types of liquid polymer.

dewatering process. While lower-cost, metallic salts like alum or ferric chloride can be used to initiate the coagulation process, high molecular weight polymers, or flocculant aids, are fed into the process to form larger, neutralized particles—called flocs—that settle faster. Some potential, negative side effects of using metallic salts for coagulation include the chance that they can contribute to high levels of residual metal content in the treated water and in some cases an excessive amount of sludge, which will increase treatment costs. A more cost-effective approach to coagulation and flocculation would be to use smaller doses of metallic salts for charge neutralization and to add polymer for bridging to create a large, settleable floc.

The Challenge

When a polymer makes initial contact with water, the outer surface of the polymer particles becomes sticky. If the particles are not properly dispersed prior to and during the initial wetting phase, agglomerations, or fish-eyes, will be formed. Agglomerations make it more difficult for water to penetrate and successfully hydrate and activate the bound-up polymer. Therefore, pumping neat (concentrated) polymer into a tank of water and using a high-speed mixer may properly disperse the polymer and prevent clumping, or the formation of agglomerations. Once activated, however, polymers are fragile. In their concentrated form, polymers are like a coiled spring. However when the molecules are uncoiled and extended, the polymer molecules become fragile and are susceptible to fracture by any high-shear device. High-speed mixers that are used to keep the sticky polymer particles separated will fracture the activated polymer strands and render them less effective in forming settleable flocs.

To compensate for any reduced effectiveness, plant operators often feed more polymer than necessary into the stream, which leads to increased chemical costs. One option that is used to eliminate fractured polymer molecules is low-speed, low-shear mixing. Unfortunately, this method requires excessively large tanks that allow for the slow dissolution of the inevitable agglomerations that are formed. Such a system also requires the batching of polymer to begin hours before the diluted polymer solution is needed, which greatly increases the capital costs of equipment and facilities.

The Solution

A better option to large and expensive tank systems is a liquid polymer blending and feed unit. An ideal polymer feed system should include a means of introducing the neat (meaning as delivered) polymer to the water to avoid the formation of agglomerations while incorporating a two-stage or tapered mixing system in its design. The first stage supplies the high-shear and high-energy needed to disperse and wet the polymer molecules, a process often referred to as inversion.

To meet these criteria, polymer feeder manufacturers have developed various ways of introducing polymer to the dilution water to prevent the formation of agglomerations. One such method is to draw the polymer out in a ribbon-like thin sheet and introduce it to a high-energy water stream. Research has shown that when polymer is introduced into the water in this fashion, it will be instantly and thoroughly wetted into a useable solution. These wetted and extended polymer molecules may be easily fractured if they remain in the high-energy zone for an extended period of time. That necessitates a second low-shear zone or tapered mixing regime that will complete the blending of the polymer with dilution water while not damaging the activated and fragile polymer strands.

Polymers are available in a variety of forms and concentrations. Developing an understanding of the different characteristics is essential when evaluating the process design that best suits your operation.

- **Dry Polymers.** Shipped in a powder form that is similar to table salt or sugar, dry polymers are considered 100 percent active when calculating for process design. The typical shelf life of dry polymers is several years, making them ideal for quantity purchase and storage.
- **Emulsion Polymers.** Available in an oil-based liquid form with a milky opaque appearance, emulsion polymers have viscosities that range from 100 to 2,000 cps, which is similar to motor oil. Emulsion polymers have an average content that is 40 percent active. The typical shelf life of emulsion polymers is four to six months.
- **Dispersion polymers.** Also available in an oil-based liquid form with a viscosity that is similar to motor oil, dispersion polymers differ from emulsion polymers in that their average content is 50 percent active when calculating process design. Their shelf life is four to six months.
- **Solution polymers.** These are known as polyamines and are used for coagulation purposes only, primarily in water plants. Solution polymers are a water-based liquid with viscosities that range from 2,000 to 10,000 cps, which is similar to honey. The average content is 10 percent active, for the purpose of calculating process design.
- **Mannich polymers.** This formaldehyde-based liquid has a clear-to-milky appearance with viscosities that range from 10,000 to 50,000 cps, which is similar to gelatin. Average content is 5 percent active for calculating process design. The typical shelf life of this polymer is several weeks.

Choosing the best polymer to use depends on a number of variables, not the least of which is the type of clarifier, filter or dewatering equipment that is being used in the water-treatment process. Equipment selection also must consider the water and wastewater characteristics, potential changes in the water or wastewater characteristics, bench test results and a comparison of savings versus ease of use.

Conclusion

Today's high molecular weight liquid polymers can represent a significant part of a water or wastewater treatment plant's chemical cost. Properly mixing and activating polymer can result in improved process performance and reduced chemical costs, making proper feeding of these chemicals of particular interest to plant operators.

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