Potable Organic Polymers—Types and Applications

The use of organic polymers for treating potable water supplies has become a standard treatment over the past several decades.

The largest category of organic polymers are known as DMDAACS, which is an abbreviation for dimethyldiallylammonium chloride. Essentially, a polymer consists of a long chain of carbon atoms molecularly bound to each other with cationic (positive) or anionic (negative) groups, which render it either cationic or anionic in nature. Polymers without any charge groups are considered nonionic. Cationic polymers are most frequently used. There are three main groups of polymers; cationic, anionic and nonionic:

Classifications

DMDAAC. DMDAACs are used as the work horse of the industry. Municipalities such as Chicago, Los Angeles, and Denver, among others, are using this product to treat their water supplies. DMDAACs are generally found to work well under a wide range of environments and are not significantly effected oxidants such as chlorine.

POLYAMINES. Polyamines are typically lower in molecular weight then DMDAACs and commercially available in concentrations up to 50 percent solids. They often are a better choice where low turbidity waters and/or highly colored waters are found. Polyamines are also found to be effective in certain wastewater applications and for process applications at some industrial sites.

ANIONIC. Anionic and nonionic polymers use acrylamine as the building block in their construction. Characteristically, these polymers are extremely high in molecular weight (greater then 10 million units) as compared to cationic polymers (generally less than 500,000 units). Anionic and nonionic polymers are typically used to aid settling and filtration. Whereas, cationic polymers are typically used as primary coagulants. An anionic polymer is negatively charged.

NONIONIC. The properties associated with a nonionic polymer are identical to the properties previously described under anionic polymers, with the exception of having no charge. In theory, most nonionic polymers are actually low charged anionic polymers.

Applications

PRIMARY COAGULANTS. A primary coagulant is, by definition, a coagulant used to initiate the coagulation process. In essence, the primary coagulant is used to make a turbid (cloudy) water begin to form floc particles that are subsequently removed later in the treatment processes. In a nutshell, a primary coagulant is used to initiate the treatment process.

FLOCCULATION AND SETTLING AIDS. These products are typically higher in molecular weight then primary coagulants. They are used to increase the particle size and density of a floc particle. This increased density and particle size allows for a faster settling rate, which improves the treatment process. Either a high molecular weight DMDAAC or a low dosage of anionic or nonionic polymer is used for this application.

FILTER AIDS. Filter aids improve the performance in both the operation and finished water quality of a treatment plant filter. Any of the three types of polymers (cationic, anionic, nonionic) can be used as a filter aid, depending upon the nature of the problem being addressed.

OTHER. There are other smaller uses for polymers in treating potable water. One such application is in the conditioning of the filter media through polymer backwash injection. One characteristic of bringing a freshly washed filter back on line is the initial spike in turbidity, which over a period of 30 to 60 minutes lowers to expected values. The injection of polymer into the last portion of backwash water used to clean a filter can condition the media so as to reduce or eliminate the spike in turbidity once the filter is brought back on line. Another use for polymers is in settling backwash water so that it can be reused more rapidly in the treatment process. Backwash water is typically high in turbidity and is often stored in recovery basins at a treatment facility so as to be reclaimed later. The use of a polymer in backwash water greatly increases the settling rate of the contained turbidity so as to significantly reduce the time required before this water can be reclaimed.

Benefits

Water Quality. The use of polymers in potable water treatment will often optimize the treatment process, thus yielding better quality water that could not be obtained otherwise. Concerns about Giardia cysts, asbestos fibers, etc., can be greatly reduced through the proper selection and application of a polymer.

Economics. The proper selection and use of a polymer will often significantly reduce the overall treatment costs of producing potable water. Sometimes these savings are hidden through less obvious concerns, such as sludge disposal costs, labor costs, or reduced backwash costs.

Sludge Disposal. The use of a polymer, in lieu of an inorganic coagulant such as alum, significantly reduces the amount of sludge that is generated in the treatment process. The cost of disposing of these sludges in landfills has steadily increased. Consequently, it is a significant economic benefit when polymer is employed.

Labor and Maintenance Costs. The proper selection and use of a polymer often results in extended filter runs, reduced backwash times, and lower energy costs, resulting in significant savings as well.

Operations. The proper selection and application of a polymer can simplify operations by improving overall performance of the treatment process, thus reducing the probability of treatment plant upsets.

Environmental. The use of polymers can reduce environmental hazards such as sludge disposal. Additionally, health concerns such as the reduction of Giardia cysts are also lessened through the use of polymers, as compared to other treatment alternatives.

Theories

Primary Coagulants. A primary coagulant is used to initiate the coagulation process. A turbid body of water contains colloidal particles that typically have an anionic charge. Having the same charge, these particles tend to repel each other, thus they remain in suspension. A cationic polymer performs two functions when introduced into this environment; 1) being cationically (positively) charged a cationic polymer will neutralize the negative charge associated with the colloidal particle allowing for interparticle collisions and agglomeration to occur and 2) the primary coagulant is a long chained molecule that destabilizes colloidal particles, which become entrapped in the molecular chain, much like a net would capture fish. Through these two actions the initialization of coagulation process is started.

Flocculation and Settling Aids. Once the initial step of coagulation has begun it is the object of the treatment process to increase the size and density of these colloidal particles into larger particles, which can then be removed more easily. There are two additional steps in a conventional treatment process (sedimentation and filtration) where these particles can be more easily removed. A settling aid, which is typically a higher molecular weight polymer, is used to build a larger floc particle, which in turn will settle faster in the sedimentation process. Any additional floc particles not removed in the sedimentation process will be more easily removed in the filtration process, due to its increased size and density.

Filter Aids. There are three general theories as to the method by which a filter aid polymer works: 1) conditioning the filter media 2) bridging mechanism between the filter media and 3) coating the surface of the filter media.

Conditioning the Filter Media. Filter media usually has an anionic (negative) surface charge that may repel particles which may otherwise be captured within the filter. The application of a small dosage of cationic polymer can serve to neutralize this anionic charge, rendering the filter more efficient in removing particles.

Bridging Mechanism between the Filter Media. A small dosage of polymer can also serve to tighten the pore size of the filter media through a physical bridging of the polymer molecule between the filter media itself. This bridging mechanism serves to capture additional particles that may otherwise find their way through the filter media.

Coating the Surface of the Filter Media. This process is similar to the bridging mechanism noted above, but limited to the very upper portions of the filter media. When somewhat larger doses than would be normally fed for just a bridging mechanism are used, there is a tendency for the polymer to coat just the top portions of the filter without penetration into the lower depths of the filter. This condition can serve to tighten the filter in the same way as the bridging mechanism, however extreme care must be exercised when employing this technique to avoid sealing off the filter through an overdose condition rendering the filter essentially impervious to the flow of significant volumes of water through the filter media. Of course, such a condition is almost always not considered desirable. GE

The preceding is courtesy of Sweetwater Technologies, www.sweetwatertech.com. Part 6 of this series will discuss lead and copper corrosion control.