Precipitation and Coagulation

An introduction to small system pretreatment

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Water treatment dealers frequently specify equipment for small and microwater systems for single homeowners or small non-community public water supplies such as resorts, hotels, restaurants and campgrounds. The water sources can be either surface, such as lakes and streams, or ground- water from wells.

Dealers often encounter circum- stances where the water contains high levels of turbidity—color caused by humic and fulvic acids—or the possibility of microbiological growth. With surface water, color that results from organic matter is often a problem in itself, but in addition, organic materials can be precursors to THM creation when the water is disinfected. These materials can speed the exhaustion of carbon beds, add to the chemical demands of chlorine or ozone, and complex with other pollutants and thus transport them through the treatment system. Filtration is thus often employed to remove these materials.

Deep bed filtration is the technique most commonly employed as a means of removing these suspended substances from groundwater. Most particles are large enough to become trapped in a media bed filter, but in some cases the particles are either too small or too dispersed to allow for settling or filtration.

The most common suspended materials are iron and manganese oxides, clays and calcium carbonate precipitates in addition to organic substances such as humic or fulvic acids. Many disease-causing organisms such as cysts and bacteria can also be suspended in water. Particle size varies widely in natural waters from only pa few nanometers (viruses, colloidal silica) to several hundred microns p(zooplankton, occysts). Concentrations of these substances also vary.

Water filtration systems are not always able to extract the suspended particles, even following oxidation. In these cases enhanced treatment is required, which often involves precipitation and coagulation.

Precipitation

Precipitation can be a result of oxidation or other physical-chemical changes where ions in solution are converted to another substance that is insoluble, and then appears out of solution and settles. Some common examples of precipitation include the conversion of iron carbonate to iron oxides through oxidation, the conversion of calcium bicarbonate to calcium carbonate scale through heat or pressure changes, and the removal of hardness through lime softening.

Coagulation

Coagulation is the process through which small particles are attracted to each other to form particles large enough to be filtered. This process is employed when the particles pare either too small to filter in bed filters, or too dispersed. When particles contain the same electric charge they repel each other, and the result- ping dispersion is said to be colloidal. Common colloidal substances include iron oxides, especially those that are complexed with organic acids or aluminum and silica particles from clay soils. Since in many cases the net charge of a colloid is opposite to that of a bacteria, the bacteria can be attracted, attached and thus transported through the filter bed.

Particles that are colloidal are generally invisible to the eye, but may discolor a water sample. In the case of humic discoloration, the color is often yellow or brown. In the case of iron colloids it can be yellow or orange, but clear. In still other cases the water may have a general "turbid" appearance, one that can be measured with a turbidimeter. Colloidal particles can also be distinguished by the fact that they do not settle under gravity. Even when they may settle over a period of many months or years, as in the case of a lake, they may not do so under sampling or in treatment conditions.

The inability to settle is, in part, a result of particles having the same electrostatic charge. In a model of colloidal stability, referred to as the Gouy-Chapman model, particles have either a positive or negative charge,