Modeling Chlorine Dissipation in Distribution Systems

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Abstract

Empirical models for chlorine dissipation in drinking water distribution systems have been developed as a function of pipe material and water quality. PVC, galvanized steel, unlined cast iron and lined ductile iron pipes were taken from actual distribution systems and used to build eighteen pilot distribution systems (PDSs), which received finished water. Operation of the pilot distribution systems simulated normal operation circumstances. Hydraulic retention time was regulated using pumps to 5 days. Free chlorine and monochloramines were used in the study. The PDSs were monitored for time, temperature, pH, and total organic carbon. Separate models for free and total chlorine decay were developed.

First-order kinetic models accurately described free and combined chlorine decay. Rate constants were dependent on pipe material, UV-254 and temperature. Rate constants were developed by material and free and total chlorine using non-linear regression. Free and combined chlorine decay was similar in PVC and lined ductile iron pipes, and was significantly less rapid than in galvanized and unlined cast iron pipes. Hence, surface reactions with the aqueous phase disinfectant were more significant than disinfectant reactions with the aqueous phase solutes. Sensitivity analyses indicated that disinfectant residuals required by regulation were difficult to achieve in summertime conditions for unlined metallic pipes.