Disinfecting Water Mains Using a Trailer-Mounted Ozone System

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Abstract

Denver Water presently disinfects new or rehabilitated water mains using a trailer mounted calcium hypochlorite chemical feed system or with hypochlorite tablets fixed to the new main. Following disinfection, chlorinated water is dechlorinated using sodium metabisulfite prior to discharge to a storm or sanitary sewer. The chlorination/dechlorination process is effective in assuring adequate disinfection of the water main prior to being placed into service, but is a labor-intensive, time-consuming process. Increasing pressures by construction crews to speed up the disinfection process led Denver Water to consider ozone as an alternative process for disinfecting water mains.

In 2002, Denver Water initiated a research project to evaluate the use of ozone for disinfecting water mains. Under this project, the ozone disinfection process was evaluated in laboratory and field studies. The main objectives of the project were to: (1) evaluate ozone demand and decay characteristics of the chloraminated finished water supply, and (2) develop a Ct-based (disinfectant concentration multiplied by contact time) approach for disinfecting attached bacteria on water mains. The first objective was met through a one-year pipe loop field demonstration study using a 1,200-ft (366 m) long pipe loop constructed of 6-inch (0.152 m) cement-lined ductile iron pipe. Ozone was injected into the pipeline using a sidestream venturi injection system with flow rates varying from 40 to 160 gpm (0.151 to 0.454 m^3/d). Sample ports were located along the pipe loop to measure ozone demand and decay characteristics of the water supply for different seasons. The second objective was met through a laboratory study, completed by Colorado State University. Dose-response curves were developed for inactivation of native heterotrophic plate count (HPC) bacteria for different water temperature conditions. A special test arrangement was used to simulate disinfection exposure for attached bacteria in the water main. This included use of coupons for biofilm development and an ozone dosing procedure to maintain a constant ozone residual over time in the sample beaker.

Based on successful laboratory and field-testing results, Denver Water constructed a permanent trailer-mounted ozone treatment facility in 2003 and is presently using this system for routine disinfection of new water mains in the distribution system. The system has an ozone production capacity of 10-ppd at a concentration range of 4 to 8 percent. It receives pressurized flows up to 250 gpm (0.946 m^3/d) from the distribution system, ozonates these flows using a venturi injection and degasifer system, and discharges ozonated flows into the pipeline segment to be

disinfected. Ozone residuals of 0.2 to 0.3 mg/L are maintained at the outlet of the pipe segment for approximately 30 minutes to meet Ct-based disinfection requirements. To date, six water mains with pipe sizes of 6 to 12 inches (0.152 to 0.304 m) and lengths from 400 to 1200 ft (122 to 366 m) have been successfully disinfected using the new ozone process based on negative coliform results.

This paper will present the principles of ozone disinfection of water mains, development of Ct tables for disinfecting water mains using ozone, and results of full-scale testing of the trailer-mounted ozone system based on field trials completed in summer 2003 and spring 2004.