Rapid Pipeline Disinfection

New disinfection method for municipal water distribution pipelines using ozone

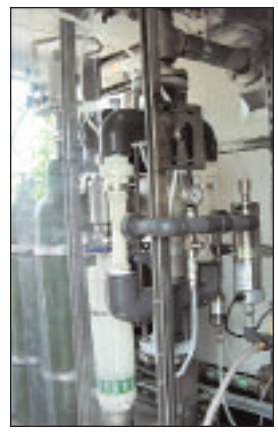
Two years of research has produced a new disinfection method for drinking water distribution system using ozone technology. This innovation is called Rapid Pipeline Disinfection and can disinfect a pipeline in about one hour as compared to traditional methods using chlorine that can take up to 24 hours or more.

Water quality leaving treatment plants of North American water utilities is exceptional and protects public health thanks to a variety of treatment tools these water treatment professionals have at their disposal. From the carefully controlled water treatment plants, this high quality water travels through miles and miles of water mains and distribution pipelines to reach our homes, schools, parks, recreation centers and businesses (distribution system).

By Paul K. Overbeck and Brian Johnson

Sadly, on the way, this once safe, high quality potable water can be contaminated in the distribution system. In a 1991 study, Herwaldt noted that microbial contamination in new or repaired water mains has been associated with several waterborne disease outbreaks in public water supply systems. In 2000, Kirkmeyer stated there were 35 reported cases of waterborne disease outbreaks associated with contamination of water mains during the period from1920 to 1984. That study also showed that pathogens and fecal coliform bacteria are present at detectable levels in soil and trench water at water main repair sites. For these reasons, proper disinfection of water mains and pipelines is required by law and is an essential public health protection measure.

A few years ago, Denver Water and their consultant Camp Dresser and McKee investigated dissolved ozone as a pipeline disinfectant. Denver Water used continuous feed or slug dose method for larger mains (12 to 108 in.), and the tablet method for smaller mains (2 to 12 in.), in accordance with AWWA Standard C651. Chlorine and Sodium Bisulfite solutions are fed from trailer-mounted storage tanks; however, the process was costly, time consuming, and considered inefficient.



Top left: 150-285 gpm FR Skid; Top right: Rapid pipeline disinfection performed from ozone disinfection trailer using ozone technology; Bottom left: Ozone trailer injector manifold and destruct - Efficient ozone mass transfer and off gas decomposer for quick pipeline disinfection; Bottom right: Easy to access pipeline and water supply connections from the rear of the ozone trailer.

An extended pilot system evaluation on 4- to 6-in. pipelines was conducted by Denver Water based on positive results performed in small-scale laboratory ozone disinfection studies. In 2003, they assembled a mobile, trailer-mounted ozone system for use on 6- to 12-in. pipelines for real-world operation.

The result is the patent-pending innovation from Denver Water and Camp Dresser and McKee that uses patented pressurized mass transfer and degas technology from Mazzei Injector-GDT Corporation and patented Floating Plate air-cooled ozone generating from Pacific Ozone Technology for Rapid Pipeline Disinfection.

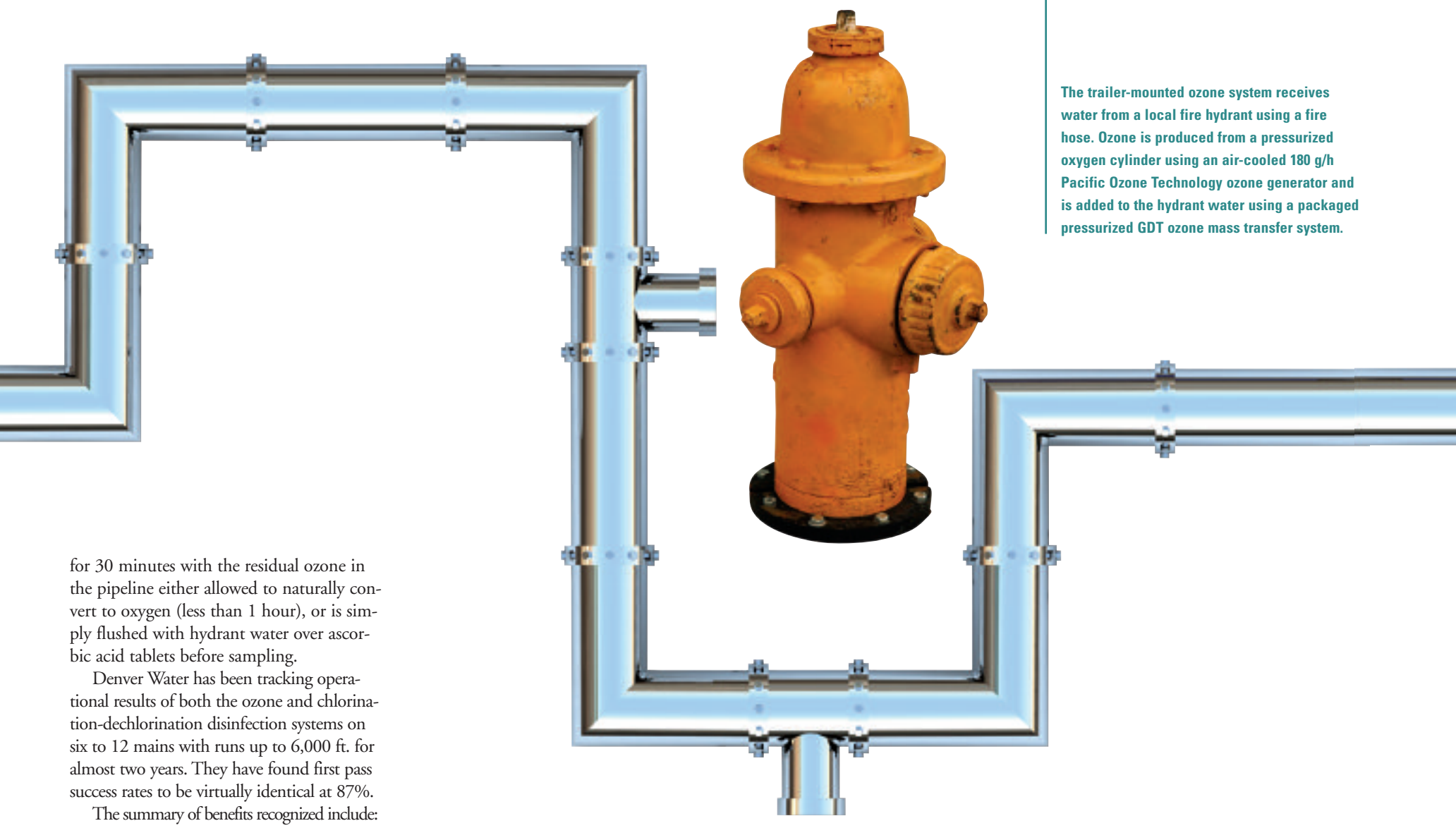
How it Works

The trailer-mounted ozone system receives water from a local fire hydrant using a fire hose. Ozone is produced from a pressurized oxygen cylinder using an air-cooled 180 g/h Pacific Ozone Technology ozone generator and is added to the hydrant water using a packaged pressurized GDT ozone mass transfer system. More than 90% of the ozone gas is dissolved in the GDT process with the off-gas removed and discharged through an ozone destruct unit. This allows only water with dissolved ozone to enter the pipeline, go near plug flow transit and disinfection. Operators and the environment are not exposed to ozone due to the unique process design. The high ozone residual at the entrance to the pipeline reacts with organisms and decays as it moves down the pipeline before discharging to a sewer at approximately 0.1 ppm, which is neutralized by ascorbic acid for discharge.

A pressure regulator controls inlet pressure to the trailer resulting in ozonated water flows to a pipeline between 200 and 260 gpm depending on line size with maximum applied dosages of 4 and 3 mg/L respectively.

The concentration x time (Ct) value at the end of pipe is the monitored value for pipeline disinfection. By using the end of pipeline ozone residual value it is assured that higher disinfection will occur earlier in the pipeline since it is exposed to a higher dissolved ozone level (C) for the same time (t).

The ozone trailer is typically operated



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for 30 minutes with the residual ozone in the pipeline either allowed to naturally convert to oxygen (less than 1 hour), or is simply flushed with hydrant water over ascorbic acid tablets before sampling.

Denver Water has been tracking operational results of both the ozone and chlorination-dechlorination disinfection systems on six to 12 mains with runs up to 6,000 ft. for almost two years. They have found first pass success rates to be virtually identical at 87%.

The summary of benefits recognized include:

- No dechlorination step – chemical and labor cost reduction;
- No hazardous chemical storage of transportation – ozone generated on site; and
- Effective and Rapid Disinfection – minutes not hours/day before flush and sampling.

Traditional Process

Current practices for water main disinfection depend on chlorine as the disinfectant with its associated chemical handling, time-consuming application, measurement, detention and lengthy flush periods and problematical wastewater disposal requirements as summarized in the American Water Works Association Standard C651 (AWWA 1993). Currently the three widely used and generally effective methods are:

1. Flush of the pipeline with a high concentration chlorine solution (>100 ppm) flowed by pipeline fill at a minimum 25 ppm with final residual free chlorine greater than 10 ppm held for 24 hours. Dechlorinate and dispose of wastewater.
2. Slow flush/fill with free chlorine at greater than 100 ppm for a minimum of three hours. Dechlorinate and dispose of wastewater.
3. Calcium hypochlorite tablets are added to the pipeline and then the pipeline is filled with water achieving a minimum 25 ppm free chlorine residual and held for 24 hours. Dechlorinate and dispose of wastewater.

Each of these three options can be effective but have significant drawbacks.

- Dechlorination of these highly chlorinated water volumes is recommended prior to discharge to a sanitary or storm sewer, storage pond, or flood control channel to prevent harm to wastewater treatment facilities and the environment;
- Chemical storage, transportation and handling of hazardous chemicals (hypochlorite and sodium bisulfite) are concerns of the utility or contractor employees and the area residents where mobile chemical trailers are used; and
- Labor-intense process for utility and/or contractor staff limited by contracted time constraints to go to the site, conduct disinfectant addition, depart and allow the 24-hour hold time and return for dechlorination, flush and sample.

A 1998 AWWA survey by Haas of 250 public water utilities found that most water utilities (87%) fail to practice dechlorination to prevent harm to wastewater treatment plant (WWTP) facilities, fish kills and other environmental hazards. Now there is a better way.

Ozone Technology for Pipeline Disinfection

Ozone is recognized as the strongest commercially available oxidant and disinfectant, and now it can be applied for safe, efficient and thorough pipeline disinfection without the negative drawbacks of the outdated methods. The new method using safe and efficient ozone technology can be summarized as: Flush pipeline using the Rapid Pipeline Disinfection ozonated water system for usually less than one hour. Ozone naturally decomposes and converts to oxygen. No disposition of wastewater required.

Ozone technology has been successfully employed within drinking water treatment facilities for more than 100 years. With more than 400 municipal water treatment ozone systems operating in the U.S. alone, ozone technology provides multiple benefits such as color reduction, taste and odor control, microflocculation, iron, manganese and hydrogen sulfide oxidation, and disinfection of bacteria, virus and parasitic cysts. In addition, ozone is used effectively for piping disinfection/clean-in-place in the food, beverage, pharmaceutical, cosmetics and electronics industries for many years.

Denver Water's testing has shown trailer-mounted ozone treatment is a strong and viable alternative to chlorination-dechlorination practice for municipal main/pipeline disinfection. *wqp*

References

AWWA and ANSI. 1993. Disinfection of Water Mains. ANSI/AWWA Standard C651-92. Denver, Colo.

Buelow, R.W., R.H Taylor, E.E Geldreich, A. Goodenkauf, L. Wilwerding, F. Holdren, M. Hutchinson, and I.H. Irvin. 1976. "Disinfection of New Water Mains", AWWA. 68(6): 283-288.

Haas, C.N, R.B. Chitluru, M.Gupta, W. Pipes, G. Burlingame. 1998. Development of Disinfection Guidelines for the Installation and Replacement of Water Mains. AWWA Research Foundation: Denver, Colo.

Herwaldt, B.L., G.F. Craun, S.L. Stokes, and D.D. Juranek. 1991. "Waterborne-Disease Outbreaks 1989-1990." Morbidity and Mortality Weekly Report. 40(SS-3): 1-21.

Kirkmeyer, G., M. LeChevallier, M. Friedman, J. Funk, K. Martel, M. Karim, and T. Harbour. 2002. "Pathogen Intrusion Into the Distribution System." AWWARF and AWWA, Denver, Colo.

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