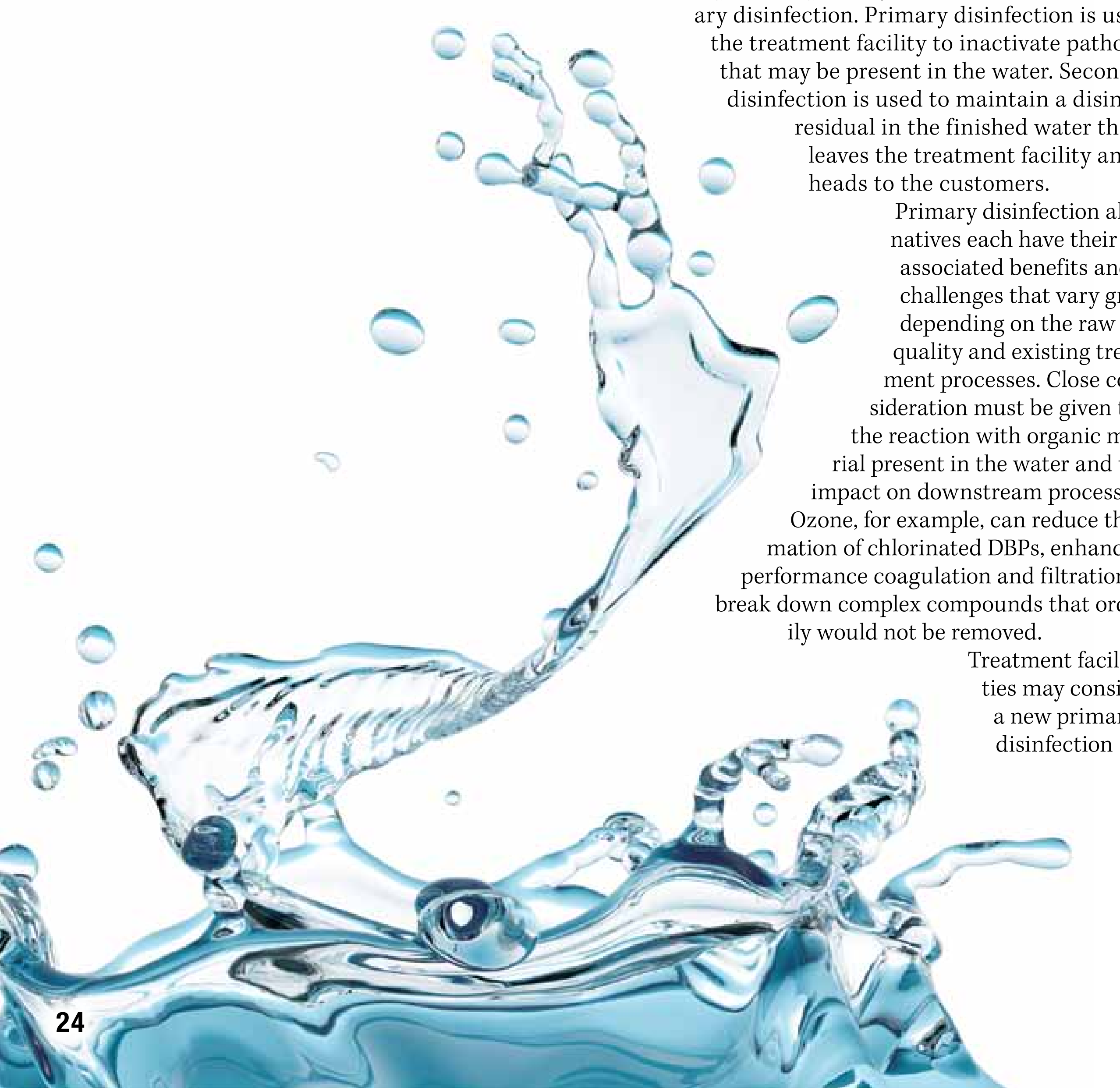
strategic disinfection

By Nathan Dunahee & Rachel Thompson

Combining treatment solutions to develop a new disinfection strategy



Disinfection of drinking water began in the U.S. in the early 1900s and often has been hailed as one of the most significant advances in public health. As water treatment technologies have developed and advanced in complexity over the past century, disinfection has remained at the forefront as arguably the most important aspect of water treatment.

Many of the basic disinfection principles have remained fairly consistent throughout the decades, with chlorine traditionally being utilized as the most common disinfectant in the U.S. In recent years, however, improved scientific knowledge of chlorine-resistant pathogens, emerging contaminants, disinfection byproducts (DBPs) and the associated health issues have spurred an increased use of alternative disinfection methods. As regulatory and treatment goals continue to dictate increasingly higher degrees of treatment, alternative disinfectants continue to gain popularity within the industry.

In light of these developments and regulatory requirements, many treatment facilities have been forced to reevaluate their existing disinfection methods. While switching disinfectant type is an obvious choice, it is not always the best option. Some treatment facilities may find that the most practical solution is combining improved primary treatment performance with relocation of the disinfectant application point. That said, many treatment facilities can benefit from considering the available alternatives and exploring the potential benefits these alternatives may offer to the process and finished water goals.

Considering a New Strategy

Disinfection generally consists of two main components: primary disinfection and secondary disinfection. Primary disinfection is used at the treatment facility to inactivate pathogens that may be present in the water. Secondary disinfection is used to maintain a disinfect residual in the finished water that leaves the treatment facility and heads to the customers.

Primary disinfection alternatives each have their own associated benefits and challenges that vary greatly depending on the raw water quality and existing treatment processes. Close consideration must be given to the reaction with organic material present in the water and the impact on downstream processes. Ozone, for example, can reduce the formation of chlorinated DBPs, enhance the performance coagulation and filtration, and break down complex compounds that ordinarily would not be removed.

Treatment facilities may consider a new primary disinfection strategy for several reasons, including:

1. Formation of DBPs;
2. Potential enhancement to conventional treatment processes; and
3. Oxidation of compounds (e.g., natural organic matter, taste and odor, iron and manganese, metals, pharmaceuticals, personal care products, endocrine disruptors and other emerging contaminants).

Treatment facilities provide secondary disinfection using either free chlorine or monochloramine to proactively prevent the growth of dangerous bacteria and maintain the quality of water in the drinking water distribution system. Secondary disinfection must take into account the need to maintain a residual, chemical behavior over an extended period of time, and impact on the distribution system. Because monochloramine is less reactive, it is more stable compared with free chlorine. Monochloramine decay, however, generates excess ammonia in the distribution system, which can lead to problems with nitrification, biological activity, corrosion, and taste and odor. Some utilities switch to monochloramine as a means to reducing chlorinated DBP formation in the distribution system. The tradeoff, however, is the formation of new DBPs that are not currently being regulated. Some of these compounds are actually more toxic, including N-Nitrosodimethylamine.

Key Items to Consider

Many disinfection alternatives exist and can be applied in a number of combinations to produce an effective treatment strategy. Misapplication or combination of the wrong disinfectants, however, can be ineffective, expensive and even harmful. Before selecting an appropriate disinfectant, there must be a thorough understanding of the existing treatment process, finished water goals and benefits/drawbacks of each disinfectant being considered.

The following questions should be answered when evaluating alternative disinfection.

1. What is the existing method of disinfection and where are the points of application?
2. What are the existing problems with the current method of disinfection (e.g., high DBP formation, excessive chemical use, etc.)?
3. Are there foreseeable future problems with the disinfection technique (e.g., upcoming regulations on emerging contaminants, degradation of water supply source, etc.)?
4. What benefits do the alternatives provide in addition to disinfection (e.g., improved TOC removal, oxidation of metals, etc.)?
5. What is the supply availability of the alternative chemical?
6. What type of modifications and/or additions to the existing facility are required to implement the alternative?
7. How cost-effective is the alternative, both for capital investments and for long-term operation and maintenance?

Disinfection Alternatives

Many disinfectant strategies are available and extensive research should be conducted when considering the use of each approach. Bench-scale and pilot testing can be performed to determine the best alternative for a particular scenario. This type of

alternatives

testing also will generate important information regarding dosing, size requirements and the benefits/drawbacks.

Advanced oxidation processes (AOP) can be implemented by combining the use of hydrogen peroxide with UV or ozone. AOP processes are defined by their ability to generate hydroxyl radicals, which are highly reactive and the most powerful type of oxidant in water treatment. Due to their reactivity, hydroxyl radicals can be used to treat compounds that are highly resistant to other oxidants. While AOP is generally more expensive and complex than other alternatives, AOP is often a good option where treatment of compounds such as pharmaceuticals, pesticides, and taste and odor (MIB and geosmin) is required. WWD

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