# Clean Tanks Deliver Quality Water

Finished water in distribution system storage facilities can undergo changes in water quality. However, with regular storage inspection and cleaning, utilities can preserve water quality and extend tank operating life and their capital budgets. **BY BOB CASHION AND JASON PETERS**

***Editor's Note:*** *This is the second in a three-part series about the importance of regular infrastructure cleaning and maintenance for equipment life and functionality, overall treatment performance, water quality, chemical requirements, and primary and secondary disinfection as well as disinfection by-product control. The first article, Regular Filter Cleaning Improves Bottom Line, appeared in the November 2013 issue. The third article will examine how cleaning the distribution system improves water quality and will appear in the January 2014 issue.*

DISTRIBUTION SYSTEM storage tanks are designed to provide water storage for fire protection, static water pressure, and reserve supplies. However, the quality of finished water in storage facilities can decline because of detention time, temperature fluctuation, surface deposits, and sediment. Combined, these elements cause taste-and-odor problems, dirty-water complaints, low chlorine residuals, and elevated disinfection by-products (DBPs). In addition, bacteria can hide in biofilms, scale, and debris, propagating rapidly, especially during warm weather.

If water utility personnel do nothing, these elements can put a community at risk, degrade the infrastructure through microbiologically induced corrosion (MIC) in metal tanks, and break down concrete storage structures. When disinfectant levels decrease or biofilm and scale are disturbed, public health is at risk. Although finished water storage tanks are enclosed, vents allow airborne and animal-borne contaminants to enter.

### THE VALUE OF CLEANING

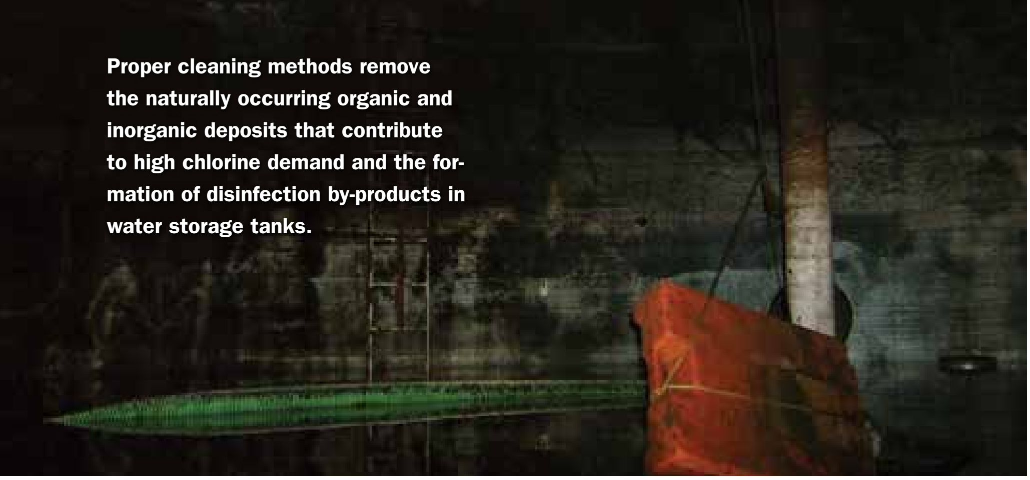
AWWA Manual of Water Supply Practices M42: *Steel Water Storage Tanks* suggests all metal storage tanks should be drained, cleaned, inspected, and disinfected every three years and, where sediment is a problem, washed out annually. Regardless of a structure's composition, however, all water storage facilities play a significant part in Total Coliform Rule compliance because of contamination risks and structure degradation.

State regulations vary in range and scope, with some requiring annual tank inspection but without the requirement that tanks be drained or cleaned. Some states require cleanings every three to five years. However, as responsible water utility personnel know, regular inspection and tank cleaning are critical to improving water quality and reducing treatment costs, both of which minimize customer complaints, unplanned expenses, and risks to public health. Regular inspection and cleaning, with interim monitoring of inbound and outbound disinfectant levels, also make an operator's life easier by reducing the likelihood of dirty water complaints, preventing quick loss of residual chlorine, and helping forecast tank turnover problems.

Monitoring disinfection levels of water entering and exiting a pressure zone or storage facility is one of the simplest, most-effective ways to determine if cleaning is needed. Continuous monitoring systems, although expensive, may be one of the best investments a utility can make. Such systems provide immediate results to help personnel analyze any increased turbidity, fluctuating temperature, residual or total chlorine, and the need for operational changes or immediate on-site visits.

### CLEANING AND INSPECTION METHODS

When utility personnel suspect a storage tank is the source of chlorine demand or biological intrusion, the tank should be inspected and possibly cleaned. Although inspections and cleaning methods vary greatly because of operational limitations,



Proper cleaning methods remove the naturally occurring organic and inorganic deposits that contribute to high chlorine demand and the formation of disinfection by-products in water storage tanks.

PHOTOGRAPHS: BLUE EARTH LABS

http://dx.doi.org/10.5991/OPF.2013.39.0073

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such as tank availability, water stress, and simple accessibility, a range of services can be customized to fit most budgets. However, using any cleaning and inspection method improves water quality and reduces the costs of treatment, maintenance, operations, customer service, and regulatory compliance. Following are some common methods:

**Remotely Operated Vehicles (ROVs).** Inspection cost is usually about $500 to $1,500 per tank, depending on size. The least-intrusive inspection method, ROV cleaning is effective in tanks as large as 500,000 gal with no depth limit. ROV inspections can determine if a complete cleaning is needed or if coating failures necessitate repair. Although ROVs can perform some cleaning, an ROV operator usually tries to avoid disturbing bottom sediments that could affect water turbidity.

ROV use doesn't require a storage tank to be drained or taken out of service. However, inspecting a tank while it's out of service is ideal for preventing removed or disturbed sediments from entering the distribution system. After an ROV is disinfected and placed in a tank, it's controlled by a single operator who uses an onboard camera to photograph or videotape the walls and floor. The disadvantage of such an approach is that an inspection is only effective for areas the ROV can reach, so headspace problems can't be detected clearly. In addition, ROVs used to vacuum sediment and brush walls aren't well equipped to thoroughly remove surface attachments.

**Divers.** The cost for divers to inspect a structure and vacuum sediment can be $1,500–$3,000 in water less than 100 ft deep—more for deeper tanks requiring additional personnel. A tank doesn't need to be drained, but it should be taken out of service for diver protection. Divers must be certified for commercial work, work in a team of three as in any confined space, and follow well-defined pre- and post-dive disinfection processes if required. Allowing noncommercial divers who use noncommercial dive equipment to inspect a structure is dangerous for the divers and risks significant liability to a utility. If the structure is a standpipe more than 100 ft deep, the team must consist of five divers who have access to a decompression chamber.

Divers can clean debris that settles on the tank floor by vacuuming and flushing the debris to waste or discharge. Preliminary inspection can be performed, but low light limits the scope and efficacy. Sidewall cleaning is limited to spot surface interaction. Divers are tethered to an outside air source, so their movement is limited. Unless biofilms are removed (an arduous task for a single diver), these inspections will miss less obvious degradation of coatings and metal. Concrete tanks are more difficult to clean, and headspace is difficult for divers to reach and inspect.

**Power Washing.** Performed offline with a drained tank, power washing costs from $3,000 to $5,000. Power washers used at high pressure can more effectively remove accumulated biofilms than divers or ROVs. After flushing, accumulated debris and dislodged material can be removed. Power washing requires confined-space certification, and the crew must be mindful of exhaustion due to the work required to handle high-pressure equipment in larger tanks. Scaffolding may be required so workers can reach the roofs of larger tanks.

Power washing's disadvantage is that the biofilms may appear to have been removed but remain microscopically attached. Further, if scale is present on the surfaces—from calcium or other minerals present in the water—power washing can't effectively remove it. In this case, the scale provides a rich bed for biofilm regrowth, which still consumes residuals in the finished water. Regrowth will occur within a few months and consume residuals in the finished water, adding to DBP formation, particularly when long tank-turnover times exist. In some cases, power washing can damage coatings or pit concrete walls.

**Chemical Cleaning.** Chemical cleaning, which costs $3,000–$6,500, is the best way to clean a tank completely. Chemicals used can vary from simple acids to more sophisticated formulas. Simple acids are usually less expensive, but they can damage and etch (in the case of metal) tank walls, damaging coatings and providing attachment points for biofilm and scale. This is because simple acids lack the chemical components needed to attack organic materials while protecting metals and coatings.

In the past few years, several NSF Standard 60-certified chemical formulations

Before and after photos show the results of a chemically treated concrete clearwell.

have been developed that reduce and eliminate risks to tank structures. These chemicals are spray on/rinse off, so they allow more effective cleaning, are easier to use, and act faster, allowing tanks to be out of service hours instead of days. These chemistries can act on biofilms and scale. Ease of use enables teams to be in and out of a tank in a single day, regardless of size. As with most chemicals, the application can be hazardous and requires training for handling and working in confined spaces. In addition, the hazardous chemical waste must be neutralized before disposal.

### SEDIMENT DISPOSAL

Sedimentation in tanks can result from simple source water organics and natural sedimentation that slips through filters or an accumulation of coagulants, phosphates, manganese, arsenic, or any material that falls out of solution. In some groundwater systems, low-level finished water radionuclides (also known as alpha particles or paleo-minerals) can build up in the sediment to significant levels. Particulate lead also can build up in this sediment, and microbes grow and feast on the nutrients. These microbes include nonpathogenic microbes that can consume metals in tanks as well as pathogenic microbes, such as *E. coli*, *Cryptosporidium*, and *Legionella*. Possibly introduced through tank vents, these microbes thrive in a tank environment.

All sediment must be carefully removed and disposed of. Ignoring the problem or allowing sediment to simply drain to a watershed should be avoided and is prohibited in many states.

### AN OUNCE OF PREVENTION

Several cleaning options are available. Cleaning a structure and keeping it clean goes a long way toward improving and maintaining water quality and prolonging infrastructure life.

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CASE STUDY

## CHEMICAL CLEANING HELPS UTILITY COMPLY

A South Central Kentucky public utility that owns and operates a surface water treatment facility provides potable water to county water district customers through 2,550 connections. The facility treats water from a man-made lake in a watershed that encompasses about 1,800 acres of strip mines, pine forest runoff, an 18-hole golf course, and a state park. The raw water is

- low in total alkalinity.
- high in manganese and iron from mine runoff and well systems used for mine drainage.
- high in nitrates from fertilizers used in golf course maintenance.

### PROBLEM

During eight years of required sampling, the public water system couldn't comply with disinfection by-product (DBP) requirements. Total trihalomethane (TTHM) levels in water leaving the facility were elevated and continued to increase in the distribution system. Chlorine residuals were decreased 75 percent through the filtration process.

Plant personnel tried various coagulants, pre-oxidants, and lake treatments to achieve compliance and determined the six-year-old filters required cleaning. Despite improved flow and making changes to total organic carbon removal methods, the problems persisted. After the filters were cleaned, TTHMs more than doubled through the clearwell system. In addition, the secondary chlorination feed was nearly consumed in the clearwell storage. Despite filter rehabilitation, TTHMs in water leaving the clearwell still exceeded regulatory limits.

### SOLUTIONS

The 250,000-gal belowground concrete clearwell was visually inspected. Divers provided pictures, videos, and samples of materials on the clearwell walls and floor for analysis. When customized scale-control chemicals were applied to clearwell samples, the materials dissolved, and biofilm broke up with little effort.

The clearwell was chemically cleaned, and the sludge, sand, and debris were removed with a vacuum truck during a 12-hour facility shutdown. The system was disinfected and placed back in service. A distribution system point-of-entry sample, leaving the clearwell, was taken every four hours. After 24 hours of continued operation, the free and total chlorine had stabilized, and the chlorine demand had dropped 75 percent. TTHM and haloacetic acid levels were tested after one week of operation, and the results showed a 70 percent drop in TTHMs.

The utility implemented a maintenance program to inspect, clean, and test filtration media and storage reservoirs on a three- to five-year schedule. The ongoing maintenance program is helping the utility continually improve water quality.