White Paper

Drinking Water Distribution Tanks Need Active Mixing

Water column destratification and uniformity are critical to providing the best water.

There are more than 50,000 municipal water systems in the United States and most of these systems rely on a variety of towers and tanks to store their treated drinking water. Many operators rely on mixing via normal cycling of water in and out of the tank to limit water age and deterioration of disinfectant chemicals.

This is known as "passive mixing" and in most cases it is not enough to prevent thermal stratification. This can lead to a drop in residual chlorine and a resultant growth of bacteria.

When bacteria contamination occurs in a tank, a common response is to set the tank for deep drawdown. In extreme cases, a complete drain, flush and refill of the tank is performed. Not only is this strategy a big waste of water resources, it also increases cost for labor and chemicals.

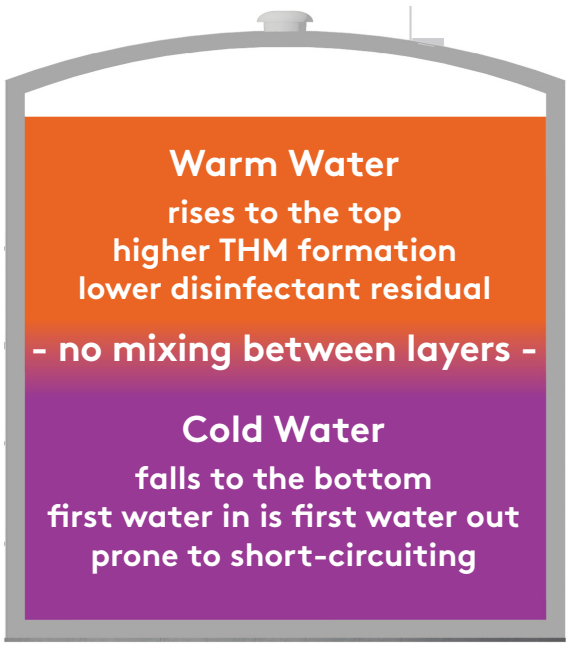
When active mechanical mixing is combined with frequent sampling and periodic chlorine boosting (when needed), water quality is maintained and less disinfectant overall is required.

This paper explores many of the common problems experienced in distribution tanks and how active mixing can solve them. We will also discuss active mixing technologies available from Ixom Watercare that can completely mix distribution tanks from the very smallest tanks (<10,000 gallons) to the very largest mega-reservoirs (100+ million gallons or more). These technologies have the additional benefits of reduced labor and chemical expenditures as well as providing a means for EPA regulatory compliance.

Active mixing eliminates thermal stratification

Thermal stratification promotes the deterioration of water quality, especially in the upper part of the tank water column. As water warms, it naturally stratifies and rises to the top.

When newly treated cold water enters the tank, it will not mix with the existing warmer water; instead, the cold water will fall to or remain at the bottom of the tank water column (depending on the inlet structure). This cold bottom water is also the first to exit the tank, creating a usage "short-circuit". This leaves the bulk of the warmer top water unmixed and unused with likely deterioration of disinfectant residual.



However, a fully and consistently mixed storage system provides a reliable means for true testing of water quality parameters, including temperature and residual disinfectant, from any sample point.

Active mixing can reduce trihalomethanes

In water systems with natural organic matter (NOM) content, chlorine added at the treatment facility can react with NOM to form a disinfection byproduct (DBP) called trihalomethane (THM). THM formation is a concern for many water systems due to of potential health risks over time. The THM compliance limit in the United States is currently 80 ug/L (parts per billion, locational running annual average) but this may be lowered at some point in the future.

Unmixed tanks with old, stratified water will tend to have high levels of THM in the upper, warmer part of the tank. Effective floor-to-surface mixing homogenizes the water into a lower THM "blend" as existing, high THM water is mixed with the new, lower THM water. The well mixed, lower THM blend can then pass out of the tank under the compliance limit and as the average water age declines with mixing, new formation of THM in the tank is further minimized.

Passive mixing during fill & drain cycles is not sufficient or consistent enough to destratify the tank water column.

Thermal stratification can start to occur with temperature gradients as small as 0.1 °C. If stratification persists, chlorine residuals may decline in the warmer, unmixed volume of the tank. This can lead to bacterial growth and an overall decrease in water quality. Stratification also introduces sampling inconsistencies that can lead to over (or under) boosting of chemical disinfectant. Since water quality testing is based on sampling from pre-selected locations within a tank, it is possible water quality testing may not reflect the real health of the entire water volume (especially in a stratified condition).

Active mixing is important in chloramine systems

About 45% of water systems in the United States use chloramines to, among other things, reduce DBP and THM formation. Active mixing is beneficial with both chloramine and chlorine disinfectants; however, good active mixing is especially important in chloraminated systems.

Here is why.

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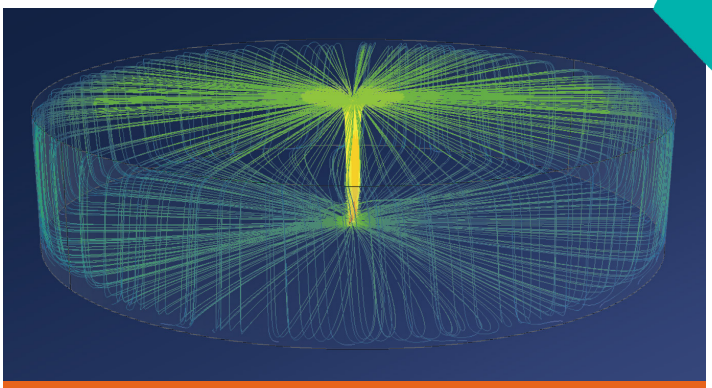
If chloraminated water is allowed to stratify and age too long due to poor mixing, ammonia-oxidizing bacteria (AOB) may convert free ammonia to nitrites. The American Water Works Association (AWWA) has noted nearly two-thirds or more of tanks with chloraminated water experience unwanted nitrification and a loss of residual disinfectant (especially when water temperatures rise during warm weather). When the temperature of chloraminated water rises above 15°C (59°F), rapid AOB growth (which are 13 times more resistant to chlorine than most bacteria) can occur particularly on the floor and walls of the tank. To avoid this scenario, it is critical for the active mixer to circulate completely along the walls and clear down to the bottom of the tank to maximize AOB exposure to available disinfectant.

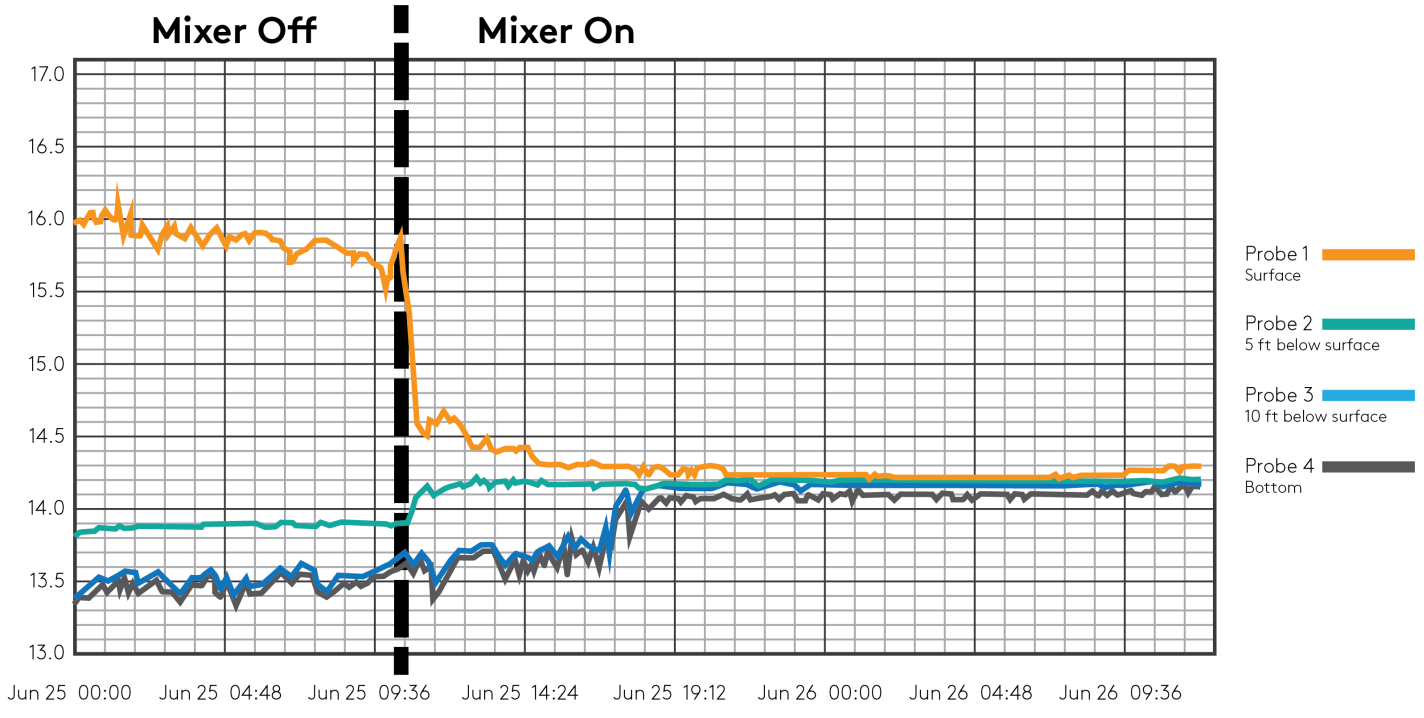


CFD modeling of a GridBee® GS Series Tank Mixer. Powerful mixing and large induced flow patterns such as this provide destratification and uniform water quality throughout the tank water column.

Active mixing helps improve water quality monitoring and disinfectant boosting

With all the active mixing benefits described earlier in this paper, water quality still needs be monitored on a regular basis to ensure it meets requirements. Active mixing ensures uniformity in the water column which creates a much higher confidence and trust in water quality testing results. Additionally, both over-chlorination (higher costs) and under-chlorination (higher risk) can be avoided when disinfectant boosting is needed.

Temperature stratification before and after active mixing.



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Active mixing can help minimize ice accumation in cold climates

Tank ice formation is an ever-present wintertime challenge faced by water utilities in cold climates. During prolonged periods of subfreezing weather, ice can form a thick surface cap, cling to tank walls, and/or encapsulate in-tank structures. Normal tank inflow and outflow can also create vertical movement of huge ice chunks. All these factors together create enormous damage potential to the tank. Active mixing can help mitigate this potential.

The water entering your tank contains critical BTUs (heat). By thoroughly and constantly mixing these available BTUs, any existing ice is "washed away", working to minimize damaging ice accumulations.

There are cases in low use, low turnover storage tanks when sufficient incoming BTUs are not available to adequately keep ice in check. These should be evaluated case by case.

Conclusions

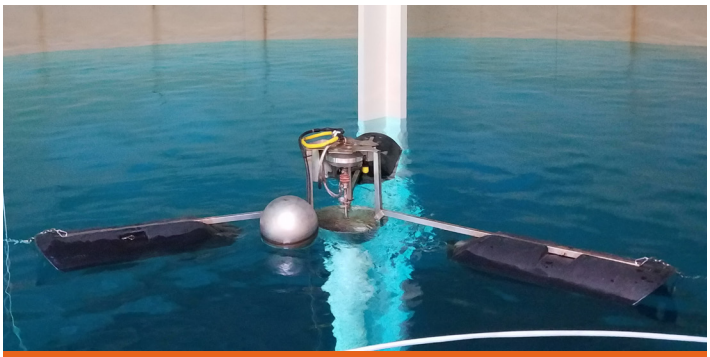
Inadequate mixing in water distribution tanks is a persistent problem for many municipal water systems. Passive mixing during fill and drain cycles just isn't enough. Tanks need consistent, effective and reliable day in/day out mixing. Problems like thermal stratification, inconsistent water age, DBP formation, low disinfectant, test sample inconsistencies and other water quality issues can all be resolved with the right active mixing strategy.

Active mixing technologies from Ixom Watercare are an industry-leading solution for tanks of all shapes and sizes (up to 100 million gallons or more!). And all Ixom Watercare products and solutions are bolstered by unmatched customer support and onsite service capabilites.

Access videos, case studies and more information on our website
www.ixomwatercare.com

GridBee® GS Series Submersible Tank Mixers

GridBee® GS Series Submersible Tank Mixers are an easy-to-deploy and versatile submersible electric option. They utlilize an extremely effective method of mixing known as sheet flow, which creates large induced flow patterns within the tank. The impeller and motor are housed in a shell, eliminating exposed impellers and any "walking" potential experienced by mixers with mounted legs. Deployment is simple (many water systems install with their own personnel) and can be performed while the tank is full and in service. Certified to NSF/ANSI 61 and 372 Standards.



SolarBee® Floating Tank Mixers

SolarBee Floating Tank Mixers pioneered the modern-day distribution tank mixing market in 2004. SolarBees utilize near laminar, high volume flow (instead of turbulence) to provide complete bottom-to-top, side-to-side mixing. This exceptionally efficient mixing requires very little power due to its minimal lift (head) and up-flow pump design. Low-power consumption and efficient control systems allow SolarBee® mixers to operate 100% from solar power, 100% from grid power or a combination of both. Certified to NSF/ANSI 61 and 372 Standards.

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