By Peter S. Fiske

Mixing it Up

A water district uses submersible mixers to prevent a deep freeze in its storage tanks

Ice formation inside above-ground potable water storage tanks is a common occurrence in the northern U.S. and nearly all of Canada during the winter. Depending on the average air temperature, the inlet water temperature and the amount of turnover, ice formation can range from a thin skin on the top of a water tank to a massive ice cap that weighs many tons.

A massive plug of ice can scrape the sides of a water tank as the water level fluctuates. If ladders and other internal hardware inside a tank become locked in the ice, the rise and fall of the ice cap can literally tear this hardware apart. Numerous examples exist where tanks have been badly damaged or even ruptured by the action of ice. (Figures 1a-d) Damage to tank coatings can cost hundreds of thousands of dollars.

Ice Damage

In above-ground water storage tanks, ice will typically form on the northern wall of the tank, starting at the water's edge. With continued cold weather, this collar of ice will grow around the edge of the water and form a complete ring of ice. As the water level rises and falls within the tank, the collar of rime ice gets thicker. Eventually the center of the tank becomes frozen over, but it is repeatedly shattered and refrozen by the rising and falling water levels. The ring of ice expands as it freezes, pushing against the walls of the tank. When water levels fall, the ring of ice clings to the sides of the tank, pulling down on the tank. When water levels rise, the collar is submerged and its buoyancy pulls the walls of the tank in the opposite direction. This stress can cause the tank coating to spall or, in extreme cases, can buckle the sides of the tank.

The operators of the Old Town Water District in Old Town, Maine, had been aware of the dangers of ice formation for many years. Nine years ago, they purchased two new glass-lined standpipes to increase their capacity. But after only two winters, one of the tanks showed evidence of ice damage: the glass coating on the exterior of the tank had spalled off due to stress from the ice frozen inside.

Nearly all liquids in nature become heavier as they cool, but water is different. When water cools over the last few degrees toward freezing, it actually becomes less dense and is lighter than the corresponding liquid by 9%. This is why ice forms at the top of a body of water and grows downward. A water tank may have a daily supply of warmer water, but the buoyant force that would carry that warm water to the top of the tank dies as the water cools.

The water at Old Town was coming into the tanks from the plant at 42°F to 45°F, but the amount of turnover and low velocity could not disrupt the chilled layer of water at the top of the tank. As a result, the tops of their tanks would freeze solid.

Defeating Mr. Freeze

In the late fall of 2008, the operators at Old Town began a trial using a small submersible mixer made by PAX Water Technologies to mix the water inside one of the two tanks in an attempt to reduce ice formation inside the tank. They theorized that if the warmer inlet water could be physically transported to the top of the tank, it would greatly reduce the rate at which ice could form. The PAX mixer's impeller design is engineered to create a collimated vortex that transports fluid to the top of a water tank using a minimal amount of energy.

By the time the mixer was installed, Maine was already in the grip of one of the coldest winters on record. Ice had already formed on the interior walls of the tank and, once drained, massive piles of ice had to be cleared from inside the tank. Once the mixer was installed, the tank was refilled. The mixer was turned off for a period of one week, which allowed fresh ice to form at the top of the tank.

In early January, the mixer was turned on and the internal condition of the mixed and unmixed tanks observed. After a week of operation, the ice in the tank with the mixer began to break up, whereas the ice in the unmixed tank remained. After eight weeks, the mixed tank was completely ice-free, whereas the tank without the mixer remained capped with a thick rim of ice.

The temperature profile in both tanks was monitored. In the unmixed tank, the warmest spot was at the base where the inlet water came into the tank. At the top of the tank, the temperature was below freezing. In contrast, the tank with the mixer had a uniform temperature all the way to the water surface.

The trial at Old Town will continue through the summer, where the active mixer will help to prevent summer thermal stratification and improve overall water quality. WWD

Peter S. Fiske is chief technology officer for PAX Water Technologies. Fiske can be reached at 415.256.9900 or by e-mail at pfiske@paxwater.com.

For more information, write in 1105 on this issue's Reader Service Card.

Figure 1a, b, c, d.

Photos courtesy of Utility Service Co., Inc.

Figure 1a) A collar of ice several feet thick expands as it freezes, pushing against the walls of the tank. During thaws, falling ice damages coating and other hardware inside the tank. **1b)** Damage to the steel shell caused by expanding ice between the ladder and the shell, which concentrated force around the ladder attachment. **1c)** Ice damage to an interior ladder. **1d)** A falling ice cap caused this tank to buckle during a drain cycle.

ARTICLE SUMMARY

Challenge: Thick ice formation in water tanks is a common occurrence in the northern U.S. and any cold climate, and it can cause serious damage to the tank and surrounding hardware.

Solution: Old Town officials used PAX submersible water mixers for a trial period and found it successful in raising the temperature inside of the tank as well as de-icing its walls.

Conclusion: The trial will continue throughout the summer, where the mixer will help prevent thermal stratification and improve water quality.

WEBresources➤➤➤

Related search terms from www.waterinfolink.com: mixer, ice formation, water storage tanks

For more information related to this article, visit www.wwdmag.com/lm.cfm/wd050905