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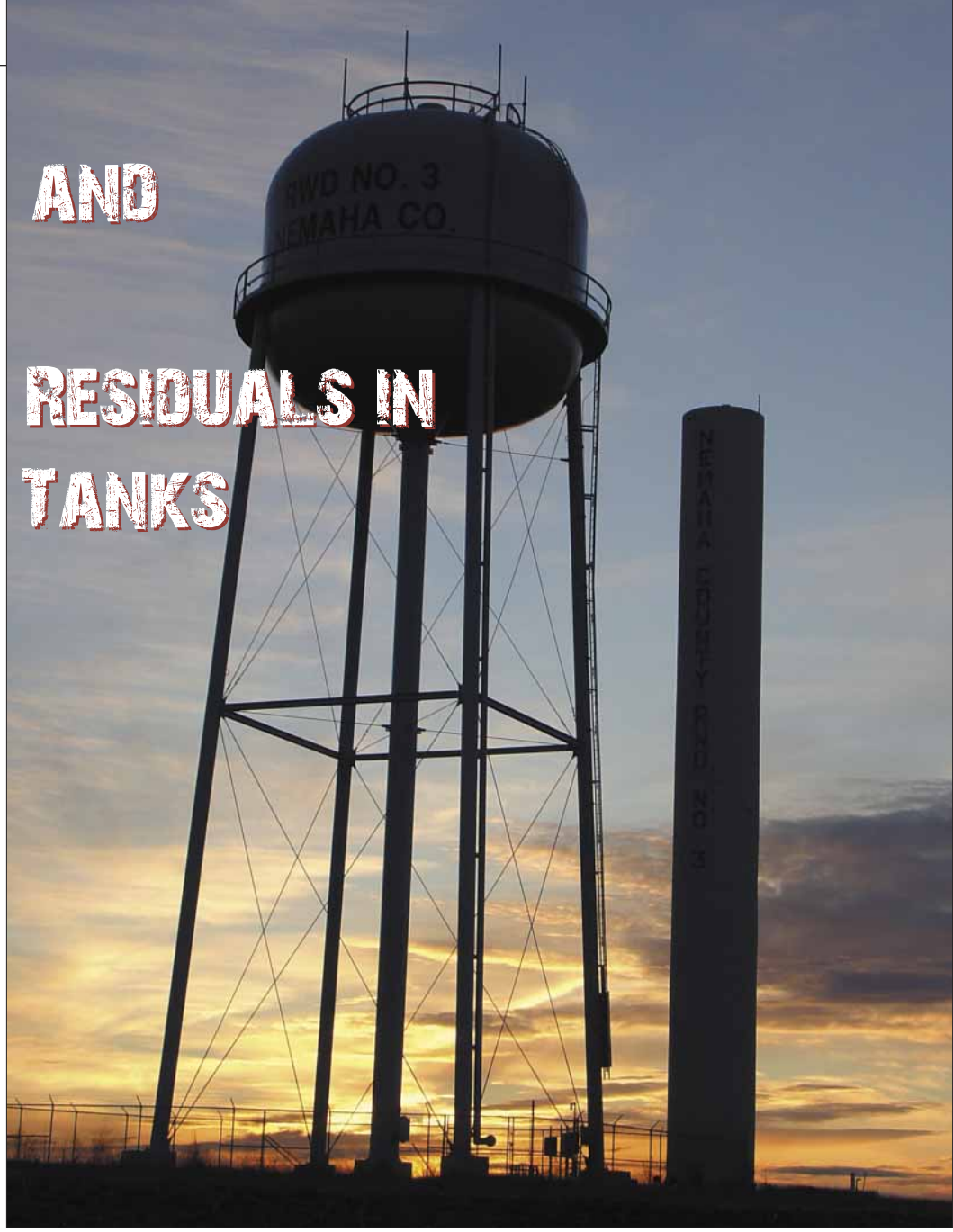
Monitoring and Maintaining Chlorine Residuals in Storage Tanks



Many rural water districts and cities have increased storage tank capacity as shown in this photo taken in Nemaha RWD 3 where a new 500,000-gallon tank replaced a 12 x 110 standpipe. While not the case in this district, many cities and RWDs have tank capacity beyond what can be effectively utilized without causing concerns for freezing in winter and loss of water quality during summer and fall months.

Many public water supplies in Kansas use monochloramine residual in order to meet disinfection byproducts (DBPs) maximum contaminant levels (MCLs). Monochloramine is also known as combined chlorine.

Monochloramine residual is used by water suppliers with a surface water supply source or a groundwater source that produces high DBPs. Monochloramine residual is formed at the treatment plant when free chlorine reacts with added ammonia. The ammonia added is usually around 1.0 mg/l. Some groundwater systems also have naturally-occurring ammonia.

Kansas regulations require that a minimum chlorine residual of either 0.2 mg/l free chlorine or 1.0 mg/l combined chlorine (monochloramine) be maintained in water distribution systems. Federal law does not require chlorine residual in water distribution systems.

Nitrifying bacteria

In distribution systems with monochloramine residual, maintaining residual during months when the water temperature is warming – mainly in July through October – can be difficult. In warmer water, nitrifying bacteria grow and form bacteria growth on the wetted surfaces of storage tanks and water lines. These bacteria do not show up in required, routine bacteriological analyses. Nitrifying bacteria use the ammonia of monochloramine as a food source; this results in the destruction and decrease of monochloramine residual.

Water warms considerably in water storage tanks in the late spring and early summer. The water temperature increase is due to the warm air and

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sunlight on the tank while the ground is still relatively colder. This temperature rise causes nitrifying bacteria growth in the tanks and a resultant decrease in the residual in the tanks.

Operators of systems using monochloramine should monitor residuals at the water storage tanks to determine when the low residuals first occur and to observe any implemented low chlorine mitigation in these storage facilities.

Measuring residual at storage tanks

Chlorine residual at the storage tank should be taken regularly and recorded to monitor chlorine loss and to monitor corrective measures that might mitigate the loss. If and when chlorine loss occurs in these tanks, the tank's low chlorine residual water will then enter water lines, thus spreading the low residual throughout the distribution system.

When monitoring the residuals at the tanks, the residual should be taken at or near the tank when the water in the tank is at its lowest level. Thus, the residual would probably represent the lowest residual entering the distribution system. If such a residual were taken when the tank was filling or when the tank is 60 to 100 percent from the low level to the high level, then the residual would probably represent the higher residual of the water recently filling the tank.

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If possible, residual should also be taken of the tank overflow. This residual would probably be the lowest residual in the tank as the residual stratifies from higher at the bottom to much lower at the top. Of course, this does not apply to a tank that is designed to fill at the top and draw off at the bottom.

It is vital to monitor tanks in the December through mid-May colder period to determine if any and how much chlorine loss occurs before the water temperature increases and nitrifying bacteria occurs. The data should be taken on a two-week or monthly basis during this colder period.

Many systems monitor the residual at the tank with continuous chlorine residual analyzers connected to the system's SCADA system. The continuous readings can be shut down during colder months to save money (if the residual loss is not significant) or to avoid freezing problems. Once the warmer water temperature months arrive, residuals should be taken weekly or more often as needed to determine when the chlorine loss problem starts and its severity.

Storage tank operation

The reason for monitoring the residual at the tanks is that is where the chlorine loss first occurs and may be the sole source of the chorine loss later in the water lines. If the residual loss at the tank can be lessened or

"controlled", then a system-wide residual loss in the lines can be delayed and possibly avoided in all or some years.

With respect to residual loss, all tanks are somewhat similar but have different design and operational characteristics. The differences are due to several factors. For instance, the storage capacity in relation to the number of customers served, quantity of flow, and service area all impact operations.

These factors determine, among other things, the number of fill-and-draw cycles in a day. The lower the storage capacity in reference to the variables mentioned earlier, the more likely the residual loss, due to more fill-and-draw cycles, will be low or will occur for fewer days. Unfortunately, many tanks are quite large in Kansas, and maintaining residual is a challenge.

Once the residual loss begins at the tanks, the operator has several choices how to address the matter. First, varying the water levels more (by decreasing the pump start level and raising the pump stop water level) might help bring more "fresh", high residual water into the tank when it is filled. Unfortunately, this will result in fewer fillings of the tank also.

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An operator might use a tank to much less than its capacity. In Kansas, where some tanks are too large, this is a possible choice. For instance, if a tank was filled to only 35 percent to 65 percent of its capacity, the filling cycles per day would be increased, and possibly the residual loss would be less as compared to filling the tank 100 percent. The method has been performed to much success in some systems in Kansas.

The operator might overflow the tank to use the lowest residual water and put more high residual water in the tank. Periodically overflowing the tank perhaps on a bi-weekly basis, might keep the problem of low residual water in the top of the tank and not let it spread to the distribution system. Of course, this does not apply to a tank that is designed to fill at the top and draw off at the bottom.

Also, the tank could be drained to waste and then filled with high residual water. The tank piping would need to have the necessary discharge hydrant and valves to accomplish such. This "flushing" method is much better in getting rid of low residual water early than waiting and trying flushing low residual water from the water lines especially considering that the low residual water in the line probably came from the storage.

"Flushing" at the tank by dumping the water or overflowing the tank will probably be more beneficial and take much less time than "flushing" waterlines once the problem spreads to the distribution system. Sometimes, flushing of water lines just spreads the problems and accomplishes little.

Think! Be smart when flushing

Many operators flush water lines that have low chlorine residual. Flushing can result in additional, more low chlorine residual or no chlorine residual water from storage being drawn into the distribution system; thus, it is counterproductive. Flushing should be carried out when high chlorine water is entering the tank and is raising the tank water level. Or residual readings at the tank must be monitored when flushing. Think and be smart when flushing.

Free chlorine “burnout”

When systems cannot maintain residual in the water lines, then systems perform free chlorine "burnout"; that is, the systems go back to a free residual for approximately two or three weeks. The free chlorine kills the nitrifying bacteria. It is most important that the “burnout" include a complete "burnout" of the storage tanks.

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Some water suppliers have had to do a second "burnout" a few weeks after returning to monochloramine residual soon after the first "burnout" because the elevated storage tank was not affected by the “burnout" with free chlorine. It is most important that the storage tanks are included in the “burnout”; otherwise the chlorine loss will soon reoccur. During a “burnout”, be sure to drain the tank and fill with free chlorine water or overflow the tank until a free residual is obtained in the overflow.

In conclusion, it is essential for operators using monochloramine residual to monitor and record residuals at the storage tanks. Then operators can try different tank operations to hopefully maintain residuals at the tanks and not let the loss of residual spread throughout the distribution system.

I encourage any system to call KRWA with issues of maintaining residual. Each system and storage tanke may be significantly different; there will be variances and how to address the issues. There are not necessarily always known direct answers; Operators have to think, try operations, and keep records.

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