By Clyde H. Zelch, President, Tomcat Consultants

Recommendations to help maintain good water quality in distribution systems

Most water supply operators take their work quite seriously and make their best effort to produce good quality water. Many wells provide safe drinking water that requires no (NO) treatment of any kind other than chlorination. But once that water leaves the water treatment plant or well house and flows into the distribution lines and storage tanks, the quality can deteriorate.

Most water systems try to provide high quality drinking water as well as flow capacities that are capable of meeting fire flow(s). For normal single-family houses spaced 100 feet or more apart, that is generally considered to be 500 GPM. As the houses or buildings get larger or closer together, the needed fire flow rates increase rapidly.

These two diffusers were made of scrap materials. One has a fixed 2.5-inch opening; the other is adjustable.

There is a very real difference between having enough clean water at needed pressures for domestic needs (this must focus on QUALITY) and having flow capacities sufficient for effective fire suppression (this takes QUANTITY). These aspects are not necessarily compatible since high flow capacity for any extended time requires large diameter and/or looped piping to deliver water to the fire scene, substantial storage to draw from, and reasonable water pumping (production) into the distribution system. That's just fine for fire suppression and insurance rates – but that large diameter, looped distribution system means that during NORMAL use the water moves VERY slowly and the time in the distribution lines and storage tanks (system) can be several days, or even weeks. That substantial water in storage can mean serious ice problems in winter and thermal stratification in summer. Both of these can be very detrimental to water quality. The problem will vary by system.

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I have more than 40 years of experience in storage tank maintenance, with 35-plus years of involvement with fire departments and working with distribution piping and hydrants needed for reasonable fire protection. I have worked with several systems on various water quality problems due to stratification in storage. I have done my share of line flushing, flow testing and color-coding of hydrants. I have read many articles on these issues; most make several good points, some miss the points, and some are just a little misleading. The following are some random observations.

A tank level recorder will not ensure there is an exchange of water in storage. Older tanks were constructed with a single pipe for water to enter and leave the tank. Whether there is a single pedestal or leg tank with wet or dry riser, or a standpipe, changes nothing. A level recorder is actually recording system pressure at the tank and just because it shows a pressure change of X lbs. or X ft. in no way means water has moved THROUGH storage – perhaps in and out – but not through. The difference is like day and night. So, if the storage has a single inlet / outlet pipe, I suggest re-

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piping it with a properly designed retention circulation system to put water in high and take it out low, or fill on one side and draw it out on the other. Retrofit the tank to ensure movement THROUGH storage. I suggest that new tanks be double-piped to help achieve an exchange of water. There are many fringe benefits to this; better quality water coming out of storage is the most important goal. In some situations, the effort to recirculate water may not solve the problem of loss of chlorine residual.

Next, check the tank vent or vents. Most old vents and some of the new ones used by builders or painting contractors are little more than dangerous, unsanitary junk. They are not frost proof, not insect tight and they do not keep out air borne dust to the extent possible with good venting. The Kansas Department of Health and Environment has its own standards. Some vents are entirely too short with the air intake less than one foot above the top of the tank.

Then check the roof access hatch. Many of them, even on new tanks, do not fit tight enough to keep out insects or air borne dust. Now you are asking, "Just where does this dust your talking about come from?" It's simple. Tank roofs are reasonably flat and birds roost all over some of them. Their droppings dry, the wind blows resulting in particles that can enter the tank under poorly fitted roof hatches and short vents. Most hatches need a gasket to be bug tight. That is very important.

The next concern is the overflow. An overflow should discharge near ground level. Overflows should be fitted with a .25-inch mesh screen inside of a close fitting flap gate. AWWA D-100 Standards do not require this. I also know that some states still call for a 24-mesh screen or flap gate on overflows. Fine mesh screens are quickly clogged with rust from inside the overflow pipe. The screen mesh MUST be large enough to allow fine rust or sand to pass through without clogging. That makes it large enough for insects, wasps, flies, dust, grass clippings and many other things to pass through and be drawn up by the flue effect. A good flap gate with screen will prevent most debris from entering the overflow.

There may be other sanitary problems with water storage facilities but almost every tank has the three issues mentioned earlier.

Good flushing requires velocity

Water quality problems cannot simply be "washed away" by flushing hydrants. Line flushing is a good practice – but remember, when flushing there are only two places that water can come from: production and/or storage. The reasons to flush lines include improving chlorine residuals in the distribution system or to remove turbidity or deposits from pipelines.

First, if the storage tank has not been cleaned in five years or more, then stop and clean it before draining any problem water into the distribution system. A distribution system CANNOT be cleaned by running dirty water from storage through it. I have seen this tried many times; people can get sick – in one case, some even died. Likewise, the chlorine residual cannot be increased in the water system by flushing water from the tank if the storage does not have adequate residual.

I don't believe in just flushing or dumping water from a hydrant to simply move new water into a section of piping.

Take static pressure readings first, then flow the hydrant, flush the main and take flow pressure readings that, with a little calculating will determine the gallons per minute available at that hydrant. So what's needed? A good hydrant wrench for starters. Since most systems operate between 40 to 80 PSI static pressure, use a hydrant cap with a 100-PSI gauge. If the system has higher pressure have another cap with a 150 or 200 PSI gauge.

Use gauges that can operate in their mid-ranges. It is not essential to use a pitot tube. A pitot tube is a device that measures flow. One can be devised with just a simple handheld tube fitted with a 2.5-inch or 3-inch diameter 30-PSI gauge. A higher pressure gauge is not needed if one 2.5-inch hydrant outlet can flow more than 30 PSI. Then flow two of them and try to keep the flow pressure between 15 to 25 PSI. If the pressure is less than 15, there's a risk as part of the system may be at too low of pressure. And at rates above 25 PSI, water can become rather destructive.

At least one flow deflector to disperse the water coming out of a hydrant will be needed. I have two; I made both of them. One has a fixed 2.5-inch opening; the other is adjustable at 2 inches, 1 7/8 inches, 1 9/16 inches, 1 3/8 inches and 1 1/16 inches. And, it can go smaller if needed. I made these from scrap or simple hardware store parts. As a result I can have a controlled flow of about 120 GPM at 15 PSI through the 1 1/16-inch opening and up to 1375 GPM at 25 PSI through both the 2.5-inch and the 2-inch opening, and 1505 GPM at 30 PSI. Smaller systems have few, if any, hydrants that will flow more than 1500 GPM.

It is generally accepted that a velocity of about 2.5 to 3 feet per second (F.P.S.) will begin moving sediment in piping. Velocity of 4 F.P.S will do a respectable job of removing most sediment from PVC or cement lined ductile piping, but not rust deposits from unlined cast or steel. So, the goal is to have velocity of 4 F.P.S or more to thoroughly flush most distribution systems.

There is a quick and easy way to determine rate of flow in feet per second without a calculator. Take any pipe diameter and square it, than add one 0, you now have GPM at 4 F.P.S. Here are examples:

6 x 6 = 36 + 0 = 360 GPM at 4 F.P.S.
2 x 2 = 4 + 0 = 40 GPM at 4 F.P.S.
40 divided by 4 = 10 GPM at 1 F.P.S
12 x 12 = 144 + 0 = 1440 GPM at 4 or 360 GPM at 1 F.P.S.

Is this formula exact? No, it is not. Is it close enough for what we need? Yes; it's also simple and fast.

The water that is flushed is not lost or wasted water. We know exactly where it went. It was put to good use helping to maintain water quality in the system. I have read articles suggesting to not flush at a rate for fear of stirring up sediment. My comment is that if the velocity doesn't stir up and remove sediment, the flushing is a waste of water. If the system is that dirty, it needs a thorough flushing. Quite often to get adequate flows in the direction needed some parts of distribution may have to be valved off to prevent distributing sediment that could not quickly be flushed out. There must be a directed flow of adequate velocity to clean and flow long enough to clear the water up. Some systems are so poorly valved, or they are broken or buried under six inches of blacktop that properly directed flow is not possible. If a system is really dirty, flushing should occur between 10 p.m. to 5 a.m. or when use is lowest. Doing so will help minimize the number of customer complaints. If that's what it takes, then do it. Water systems are responsible to provide customers with CLEAN DRINKING WATER, not just something to flush the toilet! Providing clean, quality water cannot be accomplished with dirty, unsanitary storage tanks and distribution piping lined with sediment. Customers have a responsibility to pay a fair price for water services. Clean water at a reasonable pressure delivered to customers costs money. It's the job of all water systems to do whatever is possible to provide water with the best quality possible.

About the author: Clyde H. Zelch is President of Tomcat Consultants, Rosebud, Missouri. His company provides a variety of services to water systems including operation of pressurized tanks during periods of tank maintenance or disasters as experienced at Greensburg, KS.