Most water systems experience problems with slow-moving or stagnant water in their distribution systems. These problems can be customer complaints about taste and odor, corrosion problems that lead to buildup of slime and chemical deposits in pipeline or loss of disinfection residual and growth of coliform bacteria, to name a few. To minimize these types of problems, most water systems resort to flushing.

By Robert D. McVay

Distribution DETOX

Effective flushing techniques for water systems

Unfortunately, unless consideration is given to the methods used in the flushing program, flushing can actually cause additional problems and complaints and result in large quantities of lost water and ineffective use of limited personnel.

This article examines methods that have been found to be effective in eliminating many problems caused by slow-moving water and provides simple tools that can be used by water system operators to improve current flushing programs.

Preventing Problems

To avoid problems in water distribution systems, a water operator has three basic tasks: ensuring that water is turned over in the water distribution system's pipelines to maintain disinfection residual; ensuring that sediment in dead-end lines is removed to minimize chlorine demand and buildup of regulated disinfection byproducts; and ensuring that water detention time in storage tanks is not causing loss of disinfection or pipeline problems when the water is released. Fortunately, a proper flushing program can solve all of these problems.

Studies of water distribution systems have repeatedly shown that bacteriological hot spots are three to four times more likely to occur at dead-end areas in a distribution system. Studies of water movement in storage tanks also confirm that water in tanks tends to stratify and does not mix.

Other studies have shown that most water systems have water detention times of seven to 24 days and that the smaller the water system, the more likely it is to have a longer detention time. In essence, all water systems will benefit from a well-designed flushing program.

Flushing Program Components

The components of a well-designed flushing program include basic procedures that operators can easily understand and implement. The eight steps are:

1) Locate dead-end mains and low-use areas on a water distribution map;
2) Locate all flush points such as fire hydrants and flush valves nearest to the affected areas;
3) Label flush points in the field to aid in timely field identification;
4) Schedule the flushing program in the hours of the lowest flow or when disinfection byproduct formation is at its highest;
5) Always notify the customers in the affected areas;
6) Where flushing is directed at specific problems, place these areas on a monthly schedule;
7) Place the rest of the hydrants and valves on less frequent flushing schedules; and
8) Make sure that water storage tanks are turning over by using a tank-level recorder.

Estimating flow from blow off valves and fire hydrants for flow ranges below 150 gpm in gpm

X	Flow = 2 in.	Flow = 2½ in.
6	21	30
8	28	40
10	35	50
12	42	60
14	49	70
16	56	80
18	63	90
20	70	100
30	77	150

Determining the flow velocity using estimated GPM

	Velocity in pipeline	
Size of main dia.	3 fps	5 fps
2	30	50
4	120	200
6	260	450
8	470	755
12	1,060	1,750
16	7,500	12,500

Determining how long to flush in minutes for flow velocity estimated

Length	100 ft	200 ft	300 ft	400 ft	500 ft
Flush Vel.	Time for 3 volumes of pipeline (min.)				
3 fps	1:40	3:20	5:00	6:40	8:20
4 fps	1:15	2:230	3:45	5:00	6:15
5 fps	1:00	2:00	3:00	4:00	5:00

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There are two types of flushing programs that have been used successfully by water system operators, and they are targeted to address very specific problems: traditional/conventional flushing and unidirectional flushing.

Conventional flushing is directed at reducing water age, raising disinfection residuals and removing coloration caused by iron problems. In a conventional flushing program, only one flushing point is generally used at a time and water velocity is held to less than 2.5 ft per second. In general, conventional flushing is successful when about three pipelines of water volume is flushed from the main.

A unidirectional flushing program is directed at removing solid deposits and biofilm from pipelines. Unidirectional flushing can often remove deposits and slime growth that exert chlorine demand and cause corrosion problems. Flushing is much less expensive than all other alternatives.

Recommended Turnover for Water Storage Tanks

Georgia: Daily goal, 50% of storage volume
Virginia: Complete turnover every 72 hours
Ohio: Daily goal, 20% of storage volume; Recommended, 25%

Source: *Finished Water Storage Facilities, U.S. EPA, August 2002*

Achieving Desired Results

Flow velocities for various pipeline sizes can be estimated for flushing purposes within reasonable accuracy in the field, without the use of meters or pitot tubes.

Flow from a fire hydrant can be approximated by attaching a pressure gauge to the 2.5-in. nozzle and flowing from the other nozzle. The table below will provide reasonable accuracy when using this method.

For conventional flushing, do not exceed 3 ft per second to avoid stirring up deposits that can enter customer residences. When flushing, always alert customers to avoid using water and doing laundry on the day that flushing is being performed. This will keep sediment from entering residences. Generally, door hangers and personal notification are effective in avoiding these types of customer complaints.

Now all that is left to do is to determine how long to flush to achieve the desired result. Flushing too long will waste valuable water and flushing at too high a rate will move sediment and rust, making problems worse.

Conclusion

The methods described above can greatly enhance the water distribution system operator's success in achieving flushing goals. When combined with a good public notification program, the flushing program can achieve the desired goals while achieving improved customer satisfaction and improved water quality. WWD

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