Highland Tank | TechNews

Chlorine Contact Tanks & Surface Water Treatment Rules

June 2021

Chlorine Contact Tanks (CCT) are typically used with chlorine injection equipment in a well water system to help comply with strict new drinking water standards

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CHLORINE CONTACT TANKS & SURFACE WATER TREATMENT RULES

Here in the United States, the Safe Drinking Water Act (SDWA) requires the EPA to publish primary drinking water regulations that:

1) specify criteria under which filtration would be required,

2) require disinfection as a treatment process for all public water systems, and

3) treatment requirements for the control of Giardia lamblia, viruses, legionella, bacteria and turbidity.

There are 155,000 public water systems in the United States. The EPA classifies these water systems based on population served and the source of their water.

Many of these public systems rely on surface water as a primary source for drinking water consumption. The EPA's Surface Water Treatment Rule (SWTR) dictates to public water systems using surface water, or ground water under the direct influence of surface water, and requires minimum disinfection to Giardia Lamblia, enteric viruses, and bacteria. The treatment techniques are required to achieve at least 99.9% removal and/or inactivation of the pathogens listed above.

Chlorine is the primary disinfectant used across the United States for surface water and ground water systems. Chlorination is the addition of chlorine (Cl_2) to water to form hypochlorous acid (HOCl).

Benefits of chlorination include strong oxidizing powers, taste and odor control, prevention of algae growth, removal of iron and manganese, biofilm control, water main sterilization, and distribution system residual. The chlorine reacts with pathogens to satisfy the chlorine demand. The chlorine remaining after the demand is the chlorine residual. The effective destruction of these pathogens by chlorination is dependent on a number of factors including water temperature, pH, chlorine contact time (CT), turbidity, and concentration of chlorine available after treatment (residual).

The most important factor is the Chlorine Contact Time (CT). CT measures the effectiveness of the disinfection process. This is important in complying with the 4-log treatment of pathogens standard found in SWTR.

CT = Concentration of free chlorine x contact time. Free chlorine is measured in milligrams per liter (mg/L).

Process vessels have been used for the application of chlorine in both large and small community water systems. One of the process tanks that have evolved since the introduction of chlorine is the chlorine contact tank.

This tank was designed specifically to achieve sufficient contact time between the injected chlorine and the water that needs disinfection. The CT rule was adopted to use a more representative value of actual contact time. The effective contact time is designated T_{10} and is the time required for 10% of the water to pass through the process vessel. The formula for T_{10} is as follows:

T_{10} = Effective Contact Time = V/Q x BF
V = Volume of process vessel
Q = flow rate
BF = Baffling Factor

As you can see from above, the process vessel relies heavily on flow and the baffling factor to determine effective contact time for disinfection.

The baffling factor will determine the actual residence time within the process vessel.

By increasing the baffling factor the overall efficiency of the process is increased. Below is a table outlining estimating baffling efficiencies for various storage and pressure vessels.

Baffling Condition	T10/T	Baffling Description
Un-baffled (mixed flow)	0.1	None, agitated basin, very low length to width ration, high inlet and outlet flow velocities
Poor	0.3	Single or multiple un-baffled inlets and outlets, no intra-basin baffles
Average	0.5	Baffled inlet or outlet with some intra-basin baffles
Superior	0.7	Perforated inlet baffle, serpentine or perforated intra-basin baffles, outlet weir or perforated launders
Perfect (plug flow)	1.0	Very high length to width ratio (pipeline flow) perforated inlet, outlet, and intra-basin baffles

This table can be found in USEPA's "Guidance Manual for Compliance with the Filtration and Disinfection Requirements for Public Water Systems Using Surface Water Sources", 1991 edition. The guidance manual can be found at http://www.epa.gov.

T10/T limited to 0.5 unless supported tracer study, filters and pipes excepted.

The "baffling efficiency" or circulation effectiveness of a tank is used to determine CT. If the raw water used to calculate disinfection moves through a process vessel or pipe too quickly the scenario is called short circuiting.

Table B-2. CT Values* for 4-Log Inactivation of Viruses by Free Chlorine

	pH	
Temperature (°C)	6-9	10
0.5	12	90
5	8	60
10	6	45
15	4	30
20	3	22
25	2	15

*Although units did not appear in the original tables, units are min-mg/L.

The CT_{10} requirements also influence tank size. An inefficient tank with a normalized T_{10} of 0.1 requires a tank 7 times the size of a normalized T_{10} of 0.7 if the same concentration is assumed. Therefore, it can be stated that for the same level of disinfection, tank size can be related to tank efficiency. Tank efficiency can in turn be related to the number of baffles (and placement) in the chlorine contact tank.

There have been many studies done to determine the optimum design for chlorine contact tanks to maximize the treatment process and maintain safe drinking water. The primary aim of these studies was to devise a means for improving the operating conditions of the tank's contact chamber. The difficulty facing engineers has always been how to apply the accumulated knowledge to an equipment technology for the benefit of society.

Highland Tank and Mfg. Co. of Stoystown, PA has developed a Chlorine Contact Tank (CCT) that meets the 0.7 Baffling factor.

By utilizing the length to width ratio and by implementing flow dispersion techniques, Highland Tank was able to produce a vessel that has obtained approval for PA, NJ, and NY DEP Bureau of Water Management for Ground Water Rule 4-Log Treatment Demonstration. Use of this improved CCT results in superior CT, decreased treatment costs, and a reduction in the probability of disinfectant/disinfectant by-products.

The design and operation of the Highland Tank CCT is simple. Highland Tank vessels are pressurized ASME vessels utilizing a vortex breaker as well as porous media to create a laminar flow pattern in the CCT.

This is a benefit when calculating chlorination requirements. Chlorine is injected on the inlet side of the vessel and the flow carries it to the point of application. Because Highland Tank CCT is under pressure, the minimum residence time, based on raw water temperature (see table B-2 above), is adequate to achieve the treatment and subsequent residual at the first test point.

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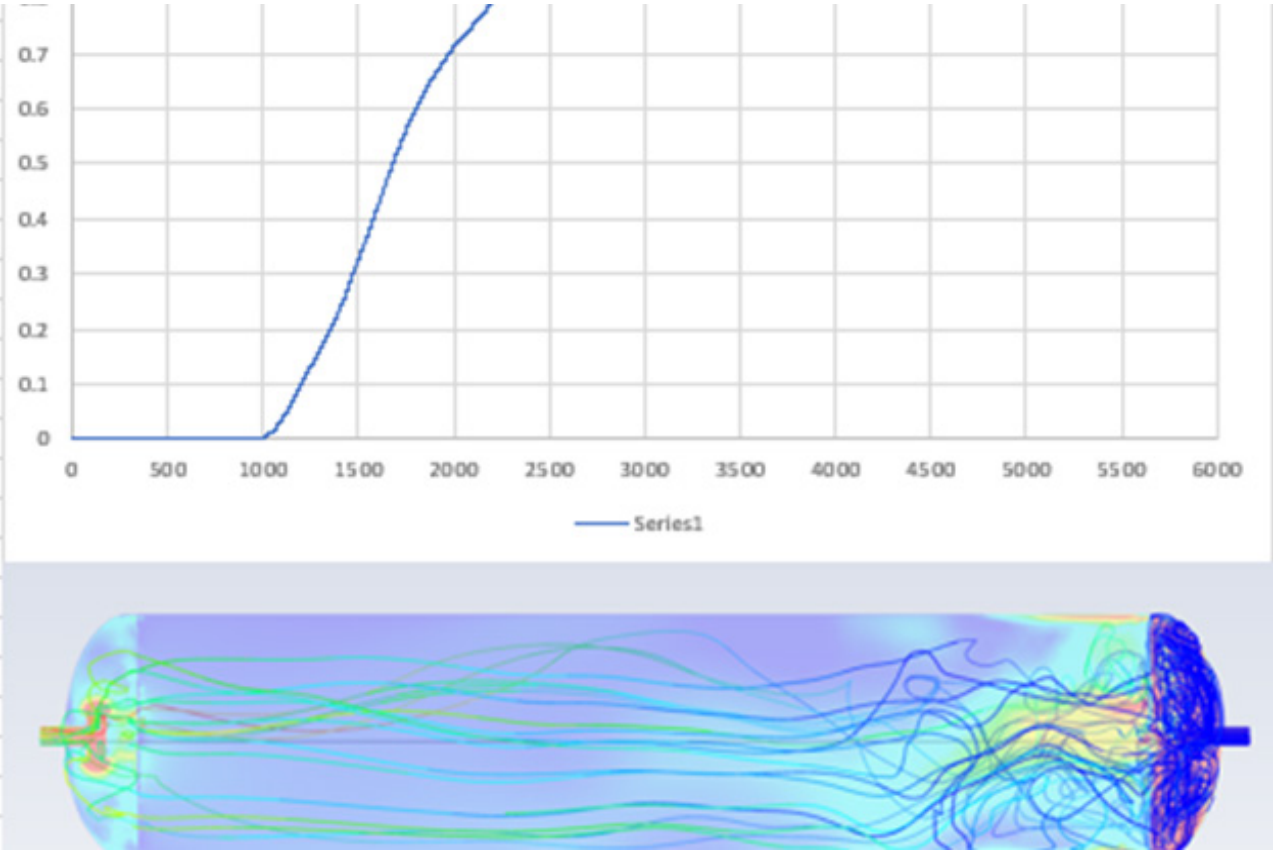

The inlet and outlet structures in the CCT are designed to distribute the water flow uniformly within the cross-sectional area of the contact chamber. Strategically positioned porous media within the contact chamber aid in achieving the minimum residence time requirements. The Highland Tank CCT hydraulic flow characteristics are proven to meet or exceed industry standards by providing an efficient engineered system to meet requirements of the EPA's Surface Water Treatment Rule.

The alternative to a CCT, based on table C-5, is the 1.0 baffling factor which would require hundreds of feet of transmission main to achieve a perfect plug flow. This is no longer a cost-effective means of chlorination nor is it viable in today's modern treatment process.

In summary, and as a general rule, hydraulically inefficient tanks are not suited for chlorine contact tanks as their use will result in ineffective disinfection and higher disinfection dosage to meet the CT_{10} requirement. Various state governments are now requiring all community water systems, either derived from surface and/or ground water, to comply with the 4-log treatment of viruses prior to the first customer for each of their groundwater sources. This will require municipalities to allocate the necessary funds towards proper vessels and equipment for compliance.

A smaller more efficient system is not only more cost effective but will provide the municipality and its customer's years of uninterrupted service for its precious water supply.

Call 814-893-5701 today or visit us at www.highlandtank.com for more information.

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