Operator Quiz Corner

Understanding "CT"

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In many of my classes I ask treatment operators to show me how they would calculate CT compliance if their SCADA system was not working. The response is usually a blank stare. That is because the intricacies of calculating and reporting CT is different for every facility and almost always done automatically by someone that built it into the facility's SCADA system – which is almost never a public water system employee.

"CT" is EPA's way of gaging adequate pathogen (Giardia, viruses) inactivation. It is based on laboratory studies of different disinfectants (chlorine, chlorine dioxide, chloramines, ozone) and takes into account the impacts of water temperature and pH. "CT" is a key compliance component of the Surface Treatment Rule (SWTR) and the Groundwater Rule (GWR) and the calculation must be performed by the public water system on a daily basis.

The concept of calculating CT is straight forward: multiply the disinfectant concentration (mg/L) by the time that the disinfectant is in contact with the water (minutes). However, understanding the correct values to use for disinfectant concentration and time can get very complicated which is why EPA has hundreds of pages of information in multiple guidance documents.

Here are the key things to keep in mind when it comes to calculating a water system's CT:

"C" Disinfectant Concentration (mg/L)

EPA requires that the disinfectant concentration be the value that occurs during the "peak hourly flow" (explained in the next paragraph). The disinfectant concentration must be taken at a location prior to the first customer. If the first customer is many miles from the treatment plant, but there is not a continuous analyzer at that location, then the water system will likely use the residual reading at the treatment plant. For water systems that use chlorine it is the 'free' chlorine residual reading that will be used for compliance purposes.

"T" Time (minutes)

As is the case in nearly all regulations EPA wants to look at the 'worst case' scenario. Therefore the "T" to be used is the shortest amount of time that the disinfectant is in contact with the water. In most cases this occurs during the treatment facility's 'peak hourly flow' each day. Some important things to keep in mind when determining the "T":

- Time is calculated by dividing the volume of disinfected water (gallons) in a tank or pipeline by the flow through that tank or pipeline (gallons per minute).
- If the disinfected water is in a tank, then it cannot be assumed that the disinfectant mixes completely with all of the water in the tank, so it is necessary to use a 'baffling factor' or conduct a 'tracer study". EPA has several guidance documents on both baffling factors and tracer studies.
- If the disinfected water flows through a tank and then through a pipeline before reaching the first customer, then EPA allows the 'time' to be calculated in the tank and add to the calculated time through the pipeline. This requires monitoring the disinfectant residual independently at the outlet of the tank and at the end of the pipeline segment.

Once the water system calculates the CT it must be compared to the EPA required CT value which takes into consideration the water temperature and pH. These are examples of the EPA's CT tables for Giardia and virus inactivation: http://www.opssys.com/instantkb/article.aspx?id=14495

Common mistakes made when calculating and reporting CT:

- The disinfectant residual is not being measured at a location representative of the water at the end of its contact time (e.g. first customer).
- If a tank is being used for achieving the chlorine contact time, and it is only partially full at the time of peak hourly flow, then the 'time' calculation cannot assume a full tank of water.
- Changes to the automated SCADA CT Value calculation/reporting are not made when there is an upgrade to the treatment facility.

Operators that are interested in learning more about the proper calculating and reporting of CT may want to attend MWWA's training "How to Properly Collect & Report Turbidity & CT Data" being held at the Worcester WTP on November 2, 2023. The class is approved for 5.0 TCHs:
2023, 11-02-23, Turbidity & CT Data, Worcester (memberclicks.net)

1. The reason that the water's pH and temperature must be known for determining CT compliance is because….
    a. they impact the peak hourly flow calculation
    b. they require more frequent monitoring of disinfectant residual
    c. they impact the effectiveness of chlorine disinfection
    d. all of the above

2. When looking at Table C-8 and C-9 (http://www.opssys.com/instantkb/article.aspx?id=14495) which of the following is a true statement with regards to using chlorine dioxide as a disinfectant?
    a. Ozone is not effective at a pH < 7.0
    b. Chloramine is not effective at a pH > 7.0
    c. Chlorine dioxide effectiveness is not impacted by water temperature
    d. Virus inactivation is easier (lower CT required) than Giardia inactivation.

3. The SWTR and the GWR require that CT compliance be calculated __________.
    a. Hourly
    b. Daily
    c. Weekly
    d. Monthly

4. What should a water treatment operator do if the SCADA system is not able to automatically calculate the CT?
    a. Contact the regulatory agency to request a waiver from calculating and reporting the daily CT.
    b. Contact the SCADA programmer to fix the problem and resume the calculation and reporting as soon as it is fixed.
    c. Perform the CT calculation manually
    d. All of the above

5. Calculate the CT for chlorinated water in a 2,500 foot section of 24 inch diameter pipe flowing at a rate of 800 gpm. The free chlorine residual at the end of the pipeline segment is 0.3 mg/L.
   a. 2.9 mg/L-min
   b. 22 mg/L-min
   c. 73/4 mg/L-min
   d. 240 mg/L-min

<u>Solution:</u>
CT = (Free chlorine concentration, mg/L) X (Time, minutes)
Where C = 0.3 mg/L
T = Volume / Flow
Where Volume is the Volume of a cylinder = .785 X D^2 X L where Dia = 2 ft, L = 2,500 ft
Volume = 0.785 X 4 X 2,500 = 7,850 ft^3 X (7.48 gal/ ft^3) = 58,718 gallons
T = 58,718 gal / 800 gpm = 73.4 minutes
CT = (0.3 mg/L) X (73.4 minutes)
= 22 mg/L-min