CHAPTER 13

13.0 Factors that influence water disinfection

13.1 CT (Contact Time)

This stands for the contact time between disinfectant and microorganism and the concentration of disinfectant. CT is used to calculate how much disinfectant is required to adequately disinfect water. C refers to the final residual concentration of a particular chemical disinfectant in mg/L. T refers to the minimum contact time (minutes) of material that is disinfected with the disinfectant. Therefore, the units of CT are expressed in mg-min/L.

CT = disinfectant concentration x contact time = C mg/L x T minutes

When a particular disinfectant is added to water, it does not only react with pathogenic microorganisms, but also with other impurities, such as soluble metals, particles of organic matter and other microorganisms. The utilization of a disinfectant for reactions with these substances make up the disinfection demand of the water.

The disinfection demand must first be satisfied, before a residual disinfectant concentration can be established. The disinfectant concentration that has to be added to water is made up by the sum of the disinfection demand and the residual disinfectant concentration. Once there is a residual disinfectant concentration, this residual concentration has to be maintained during the required contact time to kill pathogenic microorganisms.

To adequately disinfect the water it is therefore required to supply the water with a higher disinfectant concentration than the concentration required to kill pathogenic microorganisms.

Usually a dose of 12-20 mg/L chlorine is required to result in a free chlorine residual concentration of 6-8 mg/L. The time required to deactivate a particular microorganism decreases when the applied disinfectant concentration (mg/L) is increased. Laboratory tests are conducted, to find out which contact time is most effective.

The CT is commonly used to determine the affectivity of a particular disinfectant against a certain microorganism under specified conditions. There is a difference between the relative affectivity of chemical disinfectants against different microorganisms.

Often a certain level is added to the CT, for example 99%. This means that 99% of the microorganisms are deactivated by the disinfectant. CT can be used to compare the affectivity of various disinfectants against microorganisms (table 13.1).

According to table 13.1, ozone is the most effective disinfectant; the CT value of ozone is very low. Chloramines are least effective and cannot be used against Giardia Lambia. Chlorine is effective against E. coli bacteria and Polio virus. The CT value of
chlorine used against Giardia Lambia is a lot higher than that of chlorine used against E. Coli bacteria and Polio virus.

**Table 13.1. Comparison of CT values for the 99% inactivation of microorganisms at 5 °C**

<table>
<thead>
<tr>
<th>Organism</th>
<th>Free chlorine (pH 6-7)</th>
<th>Chloramines (pH 8-9)</th>
<th>Chlorine dioxide (pH 6-7)</th>
<th>Ozone (pH 6-7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>E. coli bacteria</td>
<td>0,034 - 0,05</td>
<td>95 - 180</td>
<td>0,4 - 0,75</td>
<td>0,02</td>
</tr>
<tr>
<td>Polio virus</td>
<td>1,1 - 2,5</td>
<td>770 - 3740</td>
<td>0,2 - 6,7</td>
<td>0,1 - 0,2</td>
</tr>
<tr>
<td>Giardia lambia cyst</td>
<td>47 - 150</td>
<td>-</td>
<td>-</td>
<td>0,5 - 0,6</td>
</tr>
</tbody>
</table>

**13.2 The type of microorganism**

Disinfectants can effectively kill pathogenic microorganisms (bacteria, viruses and parasites). Some microorganisms can be resistant. E. coli bacteria, for example, are more resistant to disinfectants than other bacteria and are therefore used as indicator organisms. Several viruses are even more resistant than E. coli. The absence of E. coli bacteria does not mean that the water is safe. Protozoan parasites like Cryptosporidium and Giardia are very resistant to chlorine.

**13.3 The age of the microorganism**

The affectivity of a particular disinfectant also depends upon the age of the microorganism. Young bacteria are easier to kill than older bacteria. When bacteria grow older, they develop a polysaccharide shell over their cell wall, which makes them more resistant to disinfectants. When 2,0 mg/L chlorine is used, the required contact time to deactivate bacteria that are 10 days old is 30 minutes. For bacteria of the same species and of the age of 1 day 1 minute, contact time is sufficient. Bacterial spores can be very resistant. Most disinfectants are not effective against bacterial spores.

**13.4 Water that requires treatment**

The nature of the water that requires treatment has its influence on the disinfection. Materials in the water, for example iron, manganese, hydrogen sulphide and nitrates often react with disinfectants, which disturbs disinfection. Turbidity of the water also reduces the affectivity of disinfection. Microorganisms are protected against disinfection by turbidity.

**13.5 Temperature**

The temperature also influences the affectivity of disinfection. Increasing temperatures usually increases the speed of reactions and of disinfection. Increasing temperatures can also decrease disinfection, because the disinfectant falls apart or is volatized.