

Chlorine and Chloramine Removal by Activated Carbon

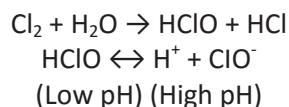
Chlorine and chloramine are commonly added to drinking water as a disinfectant. Their presence can impair taste and odour of drinking water. Removal of chlorine and chloramine can be readily achieved using Activated Carbon due to its powerful catalytic reducing effects. Combined with Activated Carbon's efficacy in removal of organic contaminants it is frequently employed in water purification systems.

This Technical Publication by Carbon Activated Europe aims to explain how the activated carbon acts as a catalyst for the removal of chlorine and chloramine.

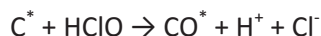
Removal of Chlorine

Chlorine is well known for its disinfectant properties and is used throughout the world for treatment of drinking water. Major areas of de-chlorination include beverage manufacture, protection of industrial water treatment processes, swimming pool water treatment and POU & POE drinking water treatment. Chlorine in water exists as Free and Combined chlorine. Combining these values together give the Total chlorine.

Chlorine is generated in water as follows:



Chlorine is removed catalytically by Activated Carbon using the following mechanism. C^* and CO^* represent the Activated Carbon's surface carbons and surface carbon oxides. These are the catalytic reducing sites for chloramine removal.



Typical design parameters for a large Activated Carbon filter for de-chlorination are

Contaminants	EBCT (minutes)	Linear Velocity (m/s)	Bed Depth (m)
Dechlorination	4-10	10-30	1-2



A number of other forms of chlorine can be found in water

1. Free chlorine from the use of sodium hypochlorite or calcium hypochlorite – Readily removed by Activated Carbon
2. Chlorine dioxide – Readily removed by Activated Carbon.
3. Chlorite – A by-product from chlorine dioxide, that is somewhat removed by Activated Carbon
4. Chlorate – A by-product from chlorine dioxide, that poorly removed by Activated Carbon
5. Chloramines – See below.

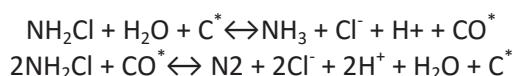
Removal of Chloramine

In areas where chlorine can produce high levels of undesirable trihalomethanes, chloramine is added as an alternative. Chloramines are found as monochloramine, dichloramine and trichloramine. Chloramines form naturally by the reaction of dissolved ammonia and residual free chlorine in water. The pH of the water and chloride to nitrogen ratio determine which chloramine form is generated.

	pH	Cl ⁻ to N Ratio
Monochloramine	7.0-9.0	< 1:5.5
Dichloramine	4.4-6.0	1:5.5 to 1:7.6
Trichloramine	< 4.4	> 1:7.6

Monochloramine is most commonly found since it forms in the conditions commonly found in treated municipal water. Monochloramine is more stable than chlorine and is more difficult to remove.

The chemistry of monochloramine removal can be written as follows. C^{*} and CO^{*} represent the Activated Carbon's surface carbons and surface carbon oxides. These are the catalytic reducing sites for chloramine removal.



Selection of Activated Carbon for Chlorine and Chloramine Removal

When selecting the right Activated Carbon for removal of chloramine, the following should be considered.

1. Number of active catalytic sites – More active sites enables higher & longer performance. Over time the catalytic sites may become oxidised and the performance decreases accordingly.
2. Hardness – The chemistry of chlorine and chloramine removal causes the formation of acids. These acids can eat away at the Activated Carbon over time resulting in particle breakdown and formation of fines. Harder Activated Carbons which are more resistant to this attack.
3. Particle size – Smaller particles provide improved removal rate and bed life for the same EBCT. Smaller particles produce higher pressure drop.
4. EBCT – Increased EBCT time provides improved removal rates

Please contact Pollet Water Group for further advice or to discuss any activated carbon requirements.

Notes:

Ozone can also be used for disinfection. Ozone is well removed by Activated Carbon.

Activated Carbon does not remove chlorine and chloramine indefinitely and the filter will need to be changed. Over time organic contaminants from the water will be adsorbed by the Activated Carbon's and slowly poisoning it. This poisoning reduces the removal efficiency.

