

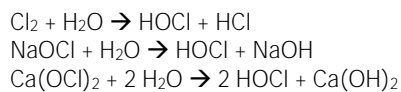
Pretreatment Chloramine

The following are general recommendations for chloramine removal prior to TRISEP® membranes. For additional instructions, please contact MANN+HUMMEL Water & Fluid Solutions Technical Service.

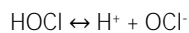
INTRODUCTION

Chlorine (Cl₂) has been used for many years to treat municipal and industrial wastewaters as a disinfectant, however free chlorine may react with the membrane surface leading to possible decline in membrane performance. Because of this, dechlorination prior to the reverse osmosis (RO) or nanofiltration (NF) membrane system is highly recommended to prevent oxidation of the membrane. Please refer to MANN+HUMMEL Water & Fluid Solutions' **Pretreatment – Dechlorination Using Sodium Metabisulfite** (TSG-C-012) guide for more information on dechlorination methods.

Chlorine is most commonly available as chlorine gas and the hypochlorites of sodium and calcium. In water, they hydrolyze to produce hypochlorous acid (HOCl):



Hypochlorous acid dissociates in water to hydrogen ions and hypochlorite ions:



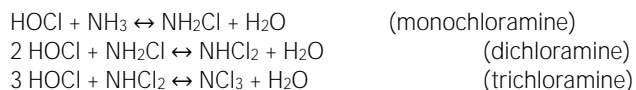
The sum of Cl₂, NaOCl, Ca(OCl)₂, HOCl and OCl⁻ is referred to as free available chlorine (FAC) or free residual chlorine (FRC), given as mg/L Cl₂.

Because free chlorine may react with the membrane surface, many applications look to chloramine as a disinfectant.

CHLORAMINE

Chloramine, like chlorine, is an oxidizing biocide used for disinfection.

When chlorine and ammonia react, inorganic chloramines (also known as combined chlorine) are formed. Inorganic chloramines consist of three species: monochloramine (NH₂Cl), dichloramine (NHCl₂) and trichloramine (NCl₃):



The relative amounts of chloramines formed are dependent on the chlorine-to-ammonia ratio, temperature and pH. In general, monochloramine is formed above pH 7 and predominates at pH 8.4 (at 25°C (77°F)). Dichloramine predominates at pH 4.5. Between these pH values, a mixture of monochloramines and dichloramines exist. Below pH 4.5, trichloramine is the primary product.

Of these, monochloramine has the highest standard reduction potential and is less prone to yield chlorinous taste and odor to water like other forms of chloramine. As a result, monochloramine is the preferred form of chloramine for disinfection applications. In fact, monochloramine may be just as effective as chlorine in terms of disrupting the metabolism of microorganisms and oxidizing compounds such as disulfides. However, monochloramine has only 0.4% of the biocidal capability as hypochlorous acid and has slower kinetics. The slow kinetics of monochloramine is desirable for municipal water systems because residuals remain in the system

longer than with the use of chlorine. On the other hand, the slower kinetics also means that it might take days or weeks to accomplish acceptable disinfection.

Although thin-film composite membranes may tolerate up to 300,000 ppm-hrs, this exposure is calculated based on pure chloramine. Because most RO and NF systems operate at a pH of around 7, most of the chloramine present will be in the form of monochloramine, as explained above. If operated at a pH closer to 4.5 however, increasing amounts of dichloramines and trichloramines will be present. Since dichloramines and trichloramines are more aggressive towards the membrane, the membrane's tolerance becomes less than 300,000 ppm-hrs.

Because free chlorine is in equilibrium with monochloramine, dichloramine and trichloramine, as shown in the equations above, it is highly recommended to remove all chloramines prior to RO and NF membranes. In addition, the presence of iron, aluminum and other transition metals may act as catalysts to significantly accelerate polyamide oxidation reactions in the presence of chloramines and other oxidizing agents. For these reasons, it is not recommended to consider use of chloramines without dechlorination prior to the RO/NF system. There are several methods to remove chloramine (i.e. sodium thiosulfate, UV and ascorbic acid), but the most common methods include carbon filtration and sodium bisulfite (please refer to **Pretreatment - Dechlorination Using Sodium Metabisulfite** (TSG-C-012)).

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