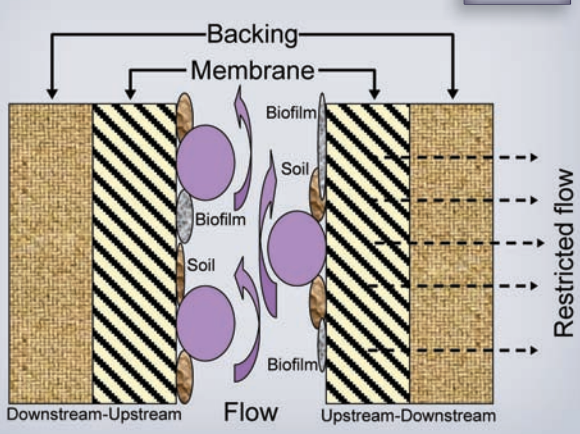
CLO$_2$IX™ APPLICATIONS

Overview

Biofilm is the last great challenge in reverse osmosis system design and operation. Technological advances have increased flux and rejection, brought down costs, and increased membrane life, but biofilm remains a problem. It decreases flux rate, which causes energy costs to rise and production to suffer. It decreases the time between membrane cleanings, because it cannot fully be removed, and the membranes reinoculate themselves with their own bacteria. It shortens membrane life, because it causes the membranes to reach a point where they can just no longer be cleaned. In other words, biofilm is the enemy of reverse osmosis membranes.

Fig. 1



But why is biofilm more difficult in RO membranes than in other water treatment situations? The answer is twofold, but both answers relate to the construction of the membranes. First, most RO membranes are made of thin film composite (TFC) material, which is destroyed by traditional biocides such as chlorine or bromine. The second reason is that the membranes are multilayered as shown in *Figure 1*. Biofilm hides out within the layers, making it extremely difficult to remove.

The existing protocol has been to disinfect the membranes with an ionic disinfectant, peroxyacetic acid, when the flux falls below a set point. Although the best available technology until now, the ionic property of the peroxyacetic acid causes it to be rejected by the membrane, preventing it from disinfecting the permeate side. By not disinfecting the permeate side, the bacteria remain free to grow within the membrane structure. In addition, peroxyacetic acid is only somewhat effective at removing the biofilm layer. For these reasons, this disinfection cycle repeats itself more frequently as the membranes age, increasing downtime, chemical costs, and labor costs.

Many biocides have been tried on RO membranes with varying success. Strong oxidizers such as chlorine, bromine, and ozone attack and destroy the membranes. Formaldehyde and Gluteraldehyde are good disinfectants, but they are toxic and difficult to rinse. Peroxyacetic acid, a weaker oxidizer and the current disinfectant of choice, does not cause harm to the membranes, but it also does not fully disinfect or remove biofilm. These factors make Chlorine Dioxide the obvious choice for membrane disinfection.

Chlorine Dioxide is the Best Disinfectant

Chlorine Dioxide is a non-ionic weak oxidizer and a dissolved gas in solution. As such, it can pass through the membrane, disinfecting the feed, permeate, and reject sides, without harming the membrane itself. However, because Chlorine Dioxide is still an oxidizer, its dosage must be metered such that the concentration never exceeds 1.0 mg/l. In practice, no more than 0.2 mg/l of Chlorine Dioxide should be needed if used routinely. Since Chlorine Dioxide must be produced at the point of use, the method of production and metering of solution is critical for successful disinfection without membrane degradation.

Disinfecting Water Wisely

CLO_2 Production Methods

Some methods of producing Chlorine Dioxide result in a solution containing chlorine, which is harmful to the membranes. For example, methods exist which mix sodium chlorite ($NaClO_2$), hydrochloric acid (HCl), and either bleach or chlorine gas (Cl_2) together to form Chlorine Dioxide (ClO_2). The resultant Chlorine Dioxide solution contains unreacted chlorine as a byproduct, causing these methods to be excluded from consideration.

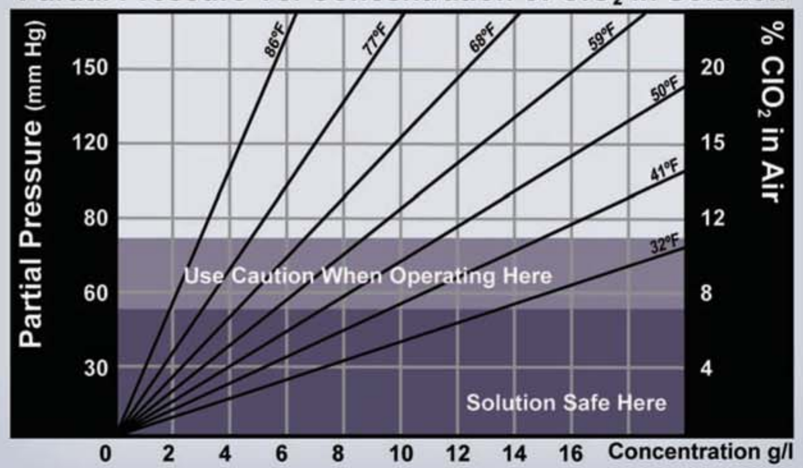
Electrochemical methods of generating Chlorine Dioxide have the potential to produce both chlorine and ozone at the anode surface. This mixture of strong oxidizers is extremely harmful to the membranes and should be avoided.

Other methods produce high concentrations of Chlorine Dioxide which are difficult to dose in a controlled manner. To overcome this problem, many store the solutions and then use a chemical dosing pump to meter the Chlorine Dioxide into the process. However, the storage of Chlorine Dioxide must engineered carefully to avoid spillage and off-gassing. The *Figure 2* chart demonstrates the relationship between Chlorine Dioxide concentration, partial pressure, and temperature to determine safe conditions for storage. As can be seen, at 3,000 mg/l, caution must be used during storage to maintain a temperature below 77 degrees F.

Fig. 2

Courtesy of Oxychem

Partial Pressure Vs. Concentration of ClO_2 in Solution



CLO_2IX^{TM} is the Best Choice

The best method of producing Chlorine Dioxide for RO membranes is CLO_2IX^{TM}. This novel patented technology produces Chlorine Dioxide from sodium chlorite through a combined process of ion exchange and catalysis. By utilizing the combination of these technologies, the CLO_2IX^{TM} systems are able to instantaneously produce a low concentration Chlorine Dioxide solution free of chlorine and ozone without the need for storage. This 700 mg/l solution is inherently safe and can be easily metered into the feed stream of the RO systems as desired to control the feed concentration.

The choice of CLO_2IX^{TM} system is dependent upon the specific needs of the application site. A summary of the CLO_2IX^{TM} systems is in the table in *Figure 3*. However, all CLO_2IX^{TM} systems have certain features, see *Figure 4*, which make them the ideal choice for the production of Chlorine Dioxide.

CLO_2IX^{TM} Systems

Fig. 3

CLO_2IX^{TM} System	Production Rate (lb/day)	Installation Type	Ion Exchange
Commercial	0.1 - 1.5	Permanent	Replaceable
Service DI	0.1 - 1.5	Permanent	Regenerated Off-Site
Industrial	0.1 - 50	Permanent	Regenerated On-Site
Portable	0.1 - 20	Temporary	Replaceable or Regenerated

CLO_2IX^{TM} Systems Features

- Wide Range of Sizes Available for Every Application
- No ClO_2 Storage Required – Not a Batch Process
- Dilute ClO_2 Solution Produced – Inherently Safe
- Self Monitoring and Self Correcting Operation
- Industry-Proven Reliable Components
- Efficient Conversion

Fig. 4