

# Membrane Cleaning 101

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Straight talk about membrane fouling and how to overcome it

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In order to effectively clean a membrane, you must answer five questions:

1. What's fouling the membrane?
2. What's the method of fouling?
3. When should I clean?
4. What cleaner should I use?
5. How should I clean?

## 1. What's fouling the Membrane?

First let's take a look at the types of foulants commonly seen in membrane systems. The major foulants fall into four general categories: colloidal, organic, inorganic and biological.

### **Colloidal**

Colloids are defined as particles which are between one nanometer and one micrometer in size. Colloidal foulants typically seen in membrane systems include silica, clay and silt. The most common mode of fouling from colloidal material is soiling.

### **Organic**

Organic foulants are those that are carbon based, but non-living. Some common organic foulants include humic acids, oil, hydrocarbons and polymers. Organic materials can foul membranes via soiling as well as absorption.

### **Inorganic**

Inorganic foulants are defined as those that are non-carbon based. Common inorganic foulants seen in membrane systems include salts such as calcium carbonate, calcium sulfate, barium sulfate, strontium sulfate and calcium fluoride, as well as metal hydroxides such as iron hydroxide and aluminum hydroxide. The most common mode of fouling with inorganic foulants is precipitation.

### **Biological**

While organic, biological foulants are routinely classified separately for a variety of factors. Biological foulants commonly seen in membrane systems are single celled organisms such as bacteria, algae and fungi.

## 2. What's the method of fouling?

Now that we've identified the types of foulants, let's examine the various *methods* of fouling. While membrane fouling can occur for a variety of reasons, the three main modalities are soiling, precipitation, and absorption.

### **Soiling**

Soiling occurs when colloidal particles stick to the surface of the membrane. In cases of soiling, a negatively charged dispersant can be used to attach to the colloids, lift them off the surface and become rejected by the membrane. Soiling agents are typically colloidal foulants.

### **Precipitation**

When the saturation level of a solution is reached, precipitation occurs, causing foulants to separate from solution and bond to the membrane. In these cases, crystals actually grow on the surface of the membrane and they must be dissolved using extreme pH (usually caustic) and chelating agents. High pH can often dissolve the crystals on its own, but in many cases chelating agents are needed to change the apparent solubility of the foulants enabling their dissolution. Foulants that precipitate on the membrane surface are often inorganic salts.

### **Absorption/Adsorption**

When biological agents are present, absorption or adsorption is generally the mode of fouling. Proteins, fats, oils, greases and biological organisms can attach to the membrane surface and create biopolymers which grow on the surface of the membrane. To overcome absorption, the biopolymers must be hydrolyzed using high pH. Hydrolysis is a chemical process of decomposition involving the splitting of a bond and the addition of the hydrogen cation and the hydroxide anion of water. The caustic agent breaks the bond and hydrolyzes the proteins that make up the biopolymers, which are then easily removed from the membrane. In cases where high pH cannot be tolerated by the membrane, enzymes such as protease and amylase are used as catalysts for the hydrolysis.

## 3. When should I clean?

Generally speaking, membranes should be cleaned when the permeate rate drops off or when the differential pressure across the membrane array ( $\Delta p$ ) increases. Many membrane system operators follow a 10 percent rule; i.e. if the permeate rate drops by 10% or the  $\Delta p$  increases by 10%, they clean the system. Similarly, if the feed pressure required to produce a given amount of permeate increases by 10%, a cleaning should be initiated.

## 4. What cleaner should I use?

The two key factors to consider when choosing a membrane cleaner are the membrane type and the fouling agent. The table below shows likely membrane and foulant combinations and the recommended New Logic membrane cleaner. In many applications, two of cleaners perform markedly better than one, especially where precipitation is the mode of fouling. Consult a New Logic product specialist for more information on cleaner selection.

Membrane Type	Fouling Agent			
	Biological	Colloidal	Inorganic	Organic
Kynar	NLR 202	NLR 303	NLR 404	NLR 505
Polyamide	NLR 505*	NLR 303	NLR 404	NLR 505*
Polyamideurea	NLR 505*	NLR 303	NLR 404	NLR 505
Polyethersulfone	NLR 202	NLR 303	NLR 404	NLR 505
Polypropylene	NLR 202	NLR 303	NLR 404	NLR 505
Regenerated Cellulose	NLR 202	NLR 303	NLR 404	NLR 505
Sulfonated Sulfone	NLR 202	NLR 303	NLR 404	NLR 505
Teflon® (PTFE)	NLR 202	NLR 303	NLR 404	NLR 505
Thin Film Composite (TFC)	NLR 505	NLR 303	NLR 404	NLR 505*

\* Indicates the potential need for pH buffering.

## 5. How should I clean?

The method of cleaning is just as important as the cleaner itself. Irrespective of the membrane type, foulant and cleaner, great care *must* be taken to stay within the limits prescribed by the membrane manufacturer. These limits include pH, temperature, chlorine and peroxide tolerance.

Once you've determined the tolerances of your membrane system and have chosen the appropriate membrane cleaner(s), you can begin the real work of cleaning the membranes. The main points to consider now are the volume and concentration of cleaner as well as the order, temperature, flow rate and duration of cleaning.

### Volume and Concentration of Cleaner

The volume of cleaner required varies from system to system and is dependent on the size and number of membrane vessels. Generally speaking, you should use 60 gallons of cleaner for each 8" vessel. Most NLR cleaners are used in a 2% concentration and pH adjusted where necessary.

This will equate to adding 2 gallons of the NLR cleaner to 98 gallons of water. Below is a table outlining the volumes to use for various final cleaning solution volumes.

<b>Total Cleaning Solution</b>	<b>Volume of NLR Cleaner</b>	<b>Volume of Water</b>
5 gallons	12.8 ounces	4.85 gallons
10 gallons	25.6 ounces	9.7 gallons
30 gallons	0.6 gallons	29.1 gallons
50 gallons	1.0 gallon	48.5 gallons
55 gallons	1.1 gallons	53.35 gallons
100 gallons	2 gallon	97 gallons
200 gallons	4 gallons	194 gallons
300 gallons	6 gallons	291 gallons

### **Cleaning Order**

Since colloidal and biological fouling tends to occur on the top layer, they should be cleaned first. After these foulants have been removed, organic and inorganic foulants which occur on the lower strata can be removed with a second cleaner. For example, one of New Logic's most successful membrane cleaning combinations is NLR 505, a unique blend of surfactants and chelating agents in a caustic liquid followed by NLR 404, an acidic liquid membrane cleaner specifically formulated to effectively remove metallic-based foulants and scaling components.

It is important to note that a fresh water flush must be completed between cleaning steps to ensure that foulants dissolved by the first cleaner have completely exited the system and will not be re-precipitated by the second cleaner.

### **Cleaning Temperature**

Higher temperatures can often speed and improve the cleaning process, particularly with low and high pH cleaners. This is especially true where inorganic foulants are concerned. Of course, great care should be taken to stay within the membrane manufacturer's temperature limits at the cleaning pH.

### **Cleaning Flow Rate and Duration**

For maintenance cleanings, circulate the cleaning solution through the system (3 GPM for 4" vessels and 12 GPM for 8" vessels) sending the first 10% of the concentrate to drain. This 10% will contain a large portion of the foulants in the system and should not be recirculated.

Recirculate the remainder of the cleaning solution (6 GPM for 4" vessels and 24 GPM for 8" vessels) for 30 minutes and then flush the system with fresh water, running both concentrate and permeate to drain for 10-30 minutes. Repeat the procedure with a second cleaner if applicable.

When cleaning severely fouled systems, cleaning duration may need to be increased, especially when attempting to remove inorganic foulants. In such cases, increase the flow rate until the maximum pressure drop across the array has been reached, continually adjusting pressure as the permeate rate increases. When the permeate rate levels off, this is an indication that the membranes will not benefit from further cleaning. Flush the system thoroughly as described above.

## Conclusion

Many factors can contribute to membrane fouling, and each must be considered when devising a cleaning solution. Since 1987, New Logic has been developing effective cleaning regimens for industrial membrane systems around the world. And while it's true that there is no magic bullet for membrane cleaning, there is likely an NLR membrane cleaner or combination of cleaners that's right for your system.

Contact a product specialist today for more information on your particular application.

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