NANOSTONE Cleaning Guidelines for Spiral E-Coat Elements

The following guidelines are presented with the understanding that they will help restore the permeate rate for an element used on electro-deposition paint. They will encompass most of the situations you will run across. However, there is always that new problem or the problem that is only seen once in great while, that may not be covered below.

The permeate rate of an element in an ultrafiltration (UF) system will decline over time due to various factors. These include but are not limited to the following:

1. Drag-in contamination from the pretreatment line and / or the parts themselves.
2. Bacteria in the bath.
3. Low paint flow to the UF system due to: poor paint feed pump performance; clogged bag filters; the paint inlet valve throttled close too much to name a few causes.
4. Low differential pressure across the UF system.
5. Excessive paint by-pass around the UF system. This occurs most often when the by-pass around the UF system ties into the UF paint return line from the UF paint feed line.
6. The elements sitting in paint due to a power outage in the plant. The longer the elements sit in paint, the more difficult it is to clean the element(s).
7. Allowing the permeate rate to decline more than 20% from the steady state rate. With today's cathodic paint formulations, UF system operators would probably achieve better cleaning results and hence, longer membrane life by cleaning elements when they have lost no more than 20% of the permeate rate from the steady state value.

Delaying cleaning can lead to irreversible fouling of the membrane which can make it impossible to recover the permeate rate. When an unexpected shutdown of the UF system happens, the paint should be flushed from the UF system as soon as possible with clean DI or RO water. The UF element(s) should then be cleaned.

Large additions of paint solids or acid, done quickly, can cause the element(s) permeate rate to drop quickly. Additions to the paint bath should be done slowly, per the paint suppliers recommendations and guidelines.

When cleaning an element or a system, the paint should first be flushed from the element back to the paint tank. Ideally, this should be done with UF permeate. If UF permeate is not available, "artificial" permeate can be used by adding acid (follow the paint suppliers recommendations) to DI or RO water in the cleaning tank. This water should be heated to the same temperature as the bath before flushing the paint from the element. This is to keep from "setting" the paint on the membrane surface.
Using cold DI or RO water to flush paint from an element or UF system can "shock" the membrane(s).
Once the paint has been flushed from the element back to the paint tank, the element should be flushed with clean DI or RO water directly to drain if possible or with several cleaning tank volumes before starting to clean it. Always follow the system manufacturer's operating instructions when flushing and cleaning an element or an UF system. Make sure your valves are in good working order to prevent contaminating the paint bath with cleaning chemicals.

Once a cleaning has been completed, always drain the cleaning solution from the cleaning tank and thoroughly flush the element to drain with clean DI or RO water before going back on paint. A good way to determine if the element has been thoroughly flushed is to measure the

pH of the permeate while flushing the element. Also, always send the permeate to drain for the first 5-10 minutes after cleaning the element and putting it back on line, on paint.

The following formulas have been used in the e-coat industry for a number of years. They are a compilation of formulas from the various membrane manufacturers, including Nanostone, Inc. The first formulations below are for cathodic paint baths.

All percentages are based on the volume of the cleaning tank and the hold up volume of the housing with the element installed. When cleaning the entire UF system, the cleaning feed and return piping hold up volumes should also be calculated so the correct amount of chemicals can be added. Substitute RO water for DI water if that is what is used in your facility. See examples of each formula on the last page.

Marking of safety instructions

The technical documentation may be noted in addition to the safety regulations, to the different potential hazards. Safety precautions must always be observed. The commonly used labels are:

Tip	***Proposal to improve or facilitate operation of the facility***
 Attention	***Indication of possible problems or threats***
 Caution	***The plant can be damaged if the operation is not done this as instructed.***
 Danger	***Risk of personal injury and machine damage if the operation of the system not done as instructed.***

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Cleaning Formulations

Cleaning Formula #1

To 92% – 94% DI water add 3% butyl cellosolve, 5% glacial acetic acid or 3% formic acid or *up to* 3% hydrochloric (muriatic) acid, and 2% by weight of granular citric acid**. The initial volume of DI/RO water depends on which acid is used for cleaning.

This formulation is for normal paint fouling. Circulation time is typically 1-2 hours at 40.6° C) [do not go over the maximum temperature your paint supplier would want to see in the paint tank] maximum temperature. Measure the pH of the cleaning solution before circulating it through the element. **Maintain the pH between pH2.0 and pH 2.3**. ***DO NOT GO BELOW pH 2.0*** or damage to the element could occur. Measure the pH of the cleaning solution as time goes by and add acid to maintain the pH as listed above.

** - The weight of citric acid, in pounds to add is determined by multiplying the total volume being circulated in gallons by 8.34 pounds, then multiplying that answer by 0.02.

Note: Citric acid is used to remove free iron from the membrane surface. If you have not received a report from your paint supplier that there is free iron in the bath over 20 PPM, you do not need to add citric acid to the cleaning formulation.

Personal protective clothing has to be worn!

Heavy fouling can make a higher detergent concentration required. In this case, NANOSTONE representative have to contact.

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Cleaning Formulation #2

To 91.5% – 93.5% DI water add 3% butyl cellosolve, 5% glacial acetic acid or 3% formic acid or *up to* 3% hydrochloric (muriatic) acid, and 2% by weight of granular citric acid**. Add 0.5% by volume of Triton X-100 (available from Union Carbide) to the cleaning solution for the last 30 minutes only. Make sure the cleaning return and the permeate cleaning return pipes are below the liquid level in the cleaning tank or you will generate excessive amounts of foam and suds. The initial volume of DI/RO water depends on which acid is used for cleaning.

This formulation is for severe paint fouling and it is typically circulated for 2-4 hours at 41°C maximum temperature.

Note: If your elements are severely fouled, and/or you notice that the cleaning solution is really dirty (evidence of a lot of paint in it), consider circulating the cleaning solution you are using for an hour, and then stopping. Drain the cleaning solution from the cleaning tank, flush the element thoroughly and start to clean again with a fresh cleaning solution, starting to circulate it when it is at the same temperature as the paint in the paint tank.

Alternate Premixed Cleaning Formulations

There are a number of premixed UF membrane cleaning solution available from various chemical suppliers. When using these, always check with your element supplier and fax or e-mail a copy of the MSDS for the cleaner to them so they can check for chemical compatibility.

Follow the supplier's dilution recommendations unless the diluted concentration *would exceed 3% butyl cellosolve.* In addition, measure the pH of the cleaning solution. Add one of the above referenced acids (always check for compatibility with the paint bath with your paint supplier!) to bring the pH to between 2.0 and pH 2.3 as well as to maintain it at that level.

Cleaning Formulation #3

This formulation is for lead and phosphate fouling. It is done after cleaning the element with either of the first 2 formulations listed above. Circulate this solution for 30 minutes only.

To 99.5% DI or RO water, add 0.5% technical grade nitric acid, Ph 2.0 to pH 2.3.

Before adding cleaning chemicals fill containers with water.
Danger of a chemical reaction.

Ensure adequate ventilation of the plant!

Personal protective clothing has to be worn!

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Cleaning Formulation #4

This formulation is used when there is evidence of iron fouling in the paint bath, as measured by your paint supplier. This solution is circulated after cleaning the elements with either of the first 2 formulations listed above.

To 100% DI water, add 2% by weight, of granular citric acid. Monitor the pH level and do not allow it to go below pH 2.0.

Cleaning Formulation #5

This formulation is used when bacteria (biological fouling) is found or suspected in the paint bath. Also use this formulation to clean the elements when a "bacteria kill" has been done to any of the paint tank post rinses or to the final pretreatment post rinse before the e-coat tank.

To 100% DI water, add enough hydrogen peroxide to reach a level of 500 PPM. This procedure is covered under a separate cleaning regimen.

Some membrane manufacturers will list a cleaning procedure for bacteria or biological fouling using chlorine bleach. Most of the paint suppliers do not approve of using chlorine bleach to clean UF elements because of the risk of contamination to the paint bath as well as possible damage to the stainless steel anodes used in the e-coat tank.

For cleaning UF elements used in **anodic paint baths**, the following formulations are used. On very rare occasions, you may have to clean an element used in an anodic tank with **Cleaning Formulation #5** due to bacteria or biological fouling**.**

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Cleaning Formulation #6

To 99.8% UF permeate, add 0.2% solubilizing amine. The amine is to be specified by the paint supplier. Circulate this cleaning solution for 30 minutes.

This formulation is used for mild paint fouling or preventative maintenance.

Cleaning Formulation #7

To 89.7% permeate; add 10% butyl cellosolve and 0.3% solubilizing amine. The amine is to be specified by the paint supplier. Circulate this cleaning solution for 1 hour.

This formulation is used for severe paint fouling.

The above cleaning guidelines will help maintain the useful life of an ultrafiltration membrane, provided the elements are cleaned before the permeate rate has dropped below the 20% from steady state level. If the permeate rate has dropped more than 50% before being cleaned, repeated cleaning will be necessary in order to try and restore the permeate rate. It may not work.

The effectiveness of cleaning an element may be enhanced by installing a standard 304L stainless steel 2 long bag filter vessel in the cleaning return line and using 1 micron or tighter glazed polypropylene bag filters to capture the paint solids removed from the membrane and held in suspension.

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Post Cleaning Treatment

The use of a post cleaning membrane "conditioner" has been recommended by several membrane manufacturers in the past and at the present time, for elements used with cathodic paints. The hypothesis is that by "fouling" the membrane with a positive electrical charge, you can better restore the permeate rate of an element as well as possibly extend the time between cleanings by causing the membrane to reject the positively charged paint particles. This "conditioner" is Polymin P made by BASF.

The extent that this conditioning works depends to a great extent on how successful a person is with cleaning the element(s) in his UF system.

The standard ratio for this solution has been 1 gallon of membrane conditioner (known as P-3 and Power Charge Concentrate by two of the membrane manufacturers) to 500 gallons of DI or RO water for the P-3 and to 250 gallons of RO or DI water for the Power Charge Concentrate. In the case of P-3, the solution is premixed in a pail with the pH adjusted to the pH range of the paint bath. It is then added to the cleaning tank (filled with clean DI or RO water) where the pH is again checked and a final adjustment made before circulating it through the element(s).

In the case of Power Charge Concentrate, the conditioner is premixed with acid close to the required pH range. Once it is added to the cleaning tank, check the pH and make a final adjustment before circulating it through the element(s).

The dilution ratio for the membrane conditioner can be reduced to as low as 1 gallon to 125 gallons of water in order to try and maximize its effectiveness.

Follow the vendors' recommendations for using a post cleaning treatment membrane conditioner.

This is not needed with Nanostone Membranes Inc. e-coat elements.
Please call Nanostone with your questions about cleaning spiral paint elements at:
+49 173 21 68 737
We will work with you to provide a cleaning regimen that will best work for your facility.

Only a clean Membrane brings a good performance!

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