Cleaning guideline

This paragraph provides general information about common contaminants which affect the reverse osmosis composite polyamide membrane elements operational characteristics and methods of their removal. This information applies to the membrane elements with a diameter 2.5, 4, 8 inches.

Note #1. The reverse osmosis composite polyamide membrane elements should be at no conditions affected by the organic solvents and oil based products. Any of such impact will cause the membrane irreparable damage. Careful disinfection of the pipes and equipment is required; when preparing cleaning solutions you should make sure that there's no chlorine in feed water. In case you doubt regarding chlorine presence, we recommend to test water for free chlorine presence. Residual chlorine can be neutralized with sodium bisulfite solution. Also, make sure of contact duration for the complete dechlorination.

Note #2. It's recommended to conduct reverse osmosis membrane elements cleaning in coordination with the specialists of "RM Nanotech" Center of technical support during warranty period. When needed, RM Nanotech specialists can visit your site to provide cleaning technical support. Please, address your inquiry to check service fees.

Note #3. You should avoid to use cationic surfactants which can cause in irreversible decrease of the membrane elements recovery rate.

1. Reverse osmosis membrane elements contaminants.

Eventually in the course of standard operation the reverse osmosis membrane elements are subject to contamination with the suspended or low-solubility products which can be in the feed water. The most common materials which can be deposited on the membrane elements surface are: calcium carbonate, calcium sulfate, metal oxides, silica, organic or biological deposits.

The character and the speed of the salt scale on the membrane element surface depend on the feed water conditions. Salt scale is a progressive factor and if not to control it at the early stage it can have negative impact on the reverse osmosis membrane elements technical characteristics within a relatively short period of time.

Monitoring overall plant performance on a regular basis is an essential step in recognizing when membrane elements are becoming fouled. Fouling influence on the membrane productivity is a gradual process and depends on the contaminant nature. In table#1 you can see anticipated contaminants influence rate on the membrane elements technical performance.

2. Contaminants removal.

Cleaning, washing or operational parameters changes are required to remove contaminants. Usually, the contaminants removal should be carried out at the following conditions:

- Normalized filtrate flow (reduced to 25 ^{0}C) dropped by 10-15% compare to the calculated flow under normal pressure.
- Feed water pressure with the temperature adjustment was increased by 15% to keep preplanned flow of the permeate.
- Permeate electrical conductivity was increased by 15%; salt passage was increased by 15%.
- Pressure drop in the RO pressure vessel while product water constant flow and recovery was increased by 15%.

Excess of these parameters during operation can cause warranty cancelation.

3. Common contaminants and methods of their removal.

3.1. Calcium carbonate scale.

Calcium carbonate deposits mostly from any type of feed water if there is a failure in the antiscalant addition system or in the acid injection pH control system that results in a high feed water pH. An early detection of the resulting calcium carbonate scaling is absolutely essential to prevent the damage that crystals can cause on the active membrane layers. Calcium carbonate scale that has been detected early can be removed by lowering the feed water pH to between 3.0 and 5.0 for one or two hours. Longer resident accumulations of calcium carbonate scale can be removed by recycling of 2% citric acid and pH not less than 4.0 through the membrane elements.

Note: Make sure that pH level in any cleaning solution doesn't go below 2. Otherwise reverse osmosis membrane elements will be damaged particularly at the elevated temperatures. pH maximum level shouldn't be less than 12. To increase pH level use ammonium hydroxide, to decrease it – sulfuric or hydrochloric acids.

3.2. Calcium Sulfate scale

The best way of calcium sulfate scale removal from the reverse osmosis membrane element is to use Solution# 2.

3.3. Metal Oxides foulants

Precipitated hydroxides (e.g., ferric hydroxide) are usually removed by using calcium carbonate scale removal method.

3.4. Silica scales

Silica scales which are not related to metal hydroxides or organic substances can be removed using special cleaning methods only. Please contact RM Nanotech Center of technical support for further instructions.

3.5. Organic deposits

The best method to remove organic deposits (e.g., microbiological gum, mold) is to use solution #3. To slow down further foulants' growth it's recommended to treat membrane element with biocidal solution accepted by RM Nanotech. This requires continuous effective treatment: a biocidal solution will have high efficiency when blocked or cascade type RO unit designed for the reserved stand for more than 3 days. For more details please contact RM Nanotech Center of technical support.

4. Cleaning Solutions

Chemical solutions recommended for the RO membrane elements cleaning are listed below in table #2. Suitable solution can be determined by chemical analysis of the contaminant. A detailed study of analysis's results will provide the key information to determine the best cleaning method. Registration of the used methods and obtained results will provide information which is useful for the development of methods and solutions the most suitable for the available feed water conditions.

For mineral scale cleaning of the membrane elements we recommend solution # 1.

For cleaning of the calcium sulfate and organic substances we recommend solution #2.

Solution #3 is efficient for cleaning at high level contamination by the organic substances. All solutions are designed to be used at the highest temperatures up to 40 °C during the cleaning timeframe up to 60 minutes. Quantity information is provided for 500 liters of water. Solutions should be prepared by measuring the amount of chemicals according to the amounts of water required for cleaning. A chlorine-free permeate should be used for solutions mixing. Solutions must be thoroughly mixed before using.

5. Membrane Elements cleaning and flushing

Reverse osmosis membrane elements in pressure vessels are flushed by cleaning solution recycling from the feed side at low pressure and at a relatively high flow. System of chemical cleaning of the membrane elements is required for this purpose.

General procedures for the reverse osmosis membrane elements cleaning:

1. To flush pressure vessel by pumping clean free chlorine produced water from the cleaning tank (or equal source) for few minutes.

2. To mix fresh volume of the selected cleaning solution in the cleaning tank using produced water.

3. To circulate the cleaning solution through the pressure vessels for approximately one hour, or within a required period of time at the flow rate 10.8 m3/h for 8040 elements and at the flow rate 2-2.5 m3/h for 4040 elements.

4. To drain and wash the cleaning tank after flushing; to fill it with the produced clean water.

5. To flush the membrane elements by pumping clean free chlorine produced water from the cleaning tank (or equal source) for few minutes.

6. After reverse osmosis system flushing, launch it with the filtrate and concentrate valves open until clean water free of any foam or residuals from the cleaning substances runs (usually within 15-30 min).

Note Alkaline cleaning should be conducted first before a combined acid based chemical cleaning.

Table #1 Signs of RO membrane elements contamination

Contaminant	Common features	Contaminant's removal measures
1. Calcium precipitates (carbonates and phosphates which are usually detected at the end of system concentrate)	Significant decreasing of salt rejection and small increase of ΔP between feed flow and concentrate. There is also a slight decrease in the system performance.	To conduct system chemical cleaning with solution #1
2. Hydrated oxides (iron, nickel, copper and etc.)	Salt rejection fast decreasing and ΔP fast increase between feed flow and concentrate. There is also fast decreasing in system performance.	To conduct system chemical cleaning with solution #1
3. Mixed colloids (iron, organic substances and silicates)	Salt rejection small decreasing and gradual increase of ΔP between feed flow and concentrate. There's also gradual decrease of system performance for a few weeks	To conduct system chemical cleaning with solution #2
4. Calcium sulfate (usually detected at the end of the system concentrate)	Salt rejection considerable decreasing and ΔP small/moderate increasing between feed flow and concentrate. There's also small decreasing of system performance	To conduct system chemical cleaning with solution #2

5. Organic deposits	Salt rejection possible decreasing and ΔP gradual increasing between feed flow and concentrate. There's also gradual decreasing of system performance	Solutions #3 or 4 are recommended for high fouling rates
6. Bacteriological contamination	Salt rejection possible decreasing and ΔP notable increasing between feed flow and concentrate. There's also system performance considerable decreasing	To conduct chemical cleaning with any type of solution in case of possible mixed contamination. Use solution #4 at high contamination level

Remark: At any circumstances it's important to eliminate contamination cause. Please contact RM Nanotech Center of technical support.

Table #2. List of recommended cleaning solutions.

Solution	Component	Amount per 500 liters of RO filtrate	pH correction	Temperature
1.	Citric acid	10 kg	Adjust to pH 2 using sulfuric or hydrochloric acid	35-40 ^{0}C
2.	Sodium tripolyphosphate Tetrasodium salt of ethylenediaminetetraacetic acid (Na4EDTA)	10 kg 4 kg	Adjust to pH 10,0 using sulfuric acid (H_2SO_4) or alkaline	35-40 ^{0}C

3.	Sodium tripolyphosphate Sodium dodecylbenzene sulfonate	10 kg 1.3 kg	Adjust to pH 10,0 using sulfuric acid (H_2SO_4) or alkaline	35-40 ^{0}C
4.	Alkaline NaOH Na_4EDTA	0,5 kg 5 kgr	Adjust to pH 11,5 using sulfuric acid (H_2SO_4) or alkaline	35-40 ^{0}C

Other special cleaning solutions besides above mentioned can be used for the composite membrane elements after coordination with RM Nanotech.

Membrane elements preservation
Membrane elements should be stored wet after use.

If the reverse osmosis unit is not operating more than 5 days and all elements are stored inside the vessel the following procedures should be observed for the membranes preservation:

1. Sequentially wash elements with solution #4, then with demineralized water, then with solution #1 and again with demineralized water;

2. Prepare 1% solution of sodium metabisulphite;

3. Feel up pipes and vessels with membrane elements inside with solution, close all ingate and outgate valves.

4. When start-up resumes, it is recommended to wash an element from preservative not less than 1 hour.