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Disinfection
in industrial applications

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Disinfection of a polymer membrane system is a difficult challenge, even when the plant is sanitary. Ceramic membranes are much more robust and have few limitations. Here shall be stated some points of view about polymer membranes.

Heat.

- Probably the most efficient and thorough method.
- Seen by some as **the only** method.
- Microbes can not develop resistance.
- Heat will reach all the cracks and threads and other places which can not easily be reached by chemicals.
- 65°C wet 30 minutes : low pasteurization
- 72°C wet 20 seconds : high pasteurization.
- 140°C wet 2 seconds : UHT treatment
- 121°C wet 30 minutes : sterilization
- 140°C dry 30 minutes : sterilization
- 160°C dry 30 minutes : sterilization which also takes care of spores.

Maximum allowed temperature		Standard	Emergency Use very controlled conditions
Standard water element	CA-RO All other	35°C 50°C	35°C 50°C
Water element with PSO parts Food grade element Pharmaceutical elements	CA-RO CA-UF Other membranes	35°C 50°C 50°C	35 °C 50 °C 80 °C
Hot water sanitizable Often called HS or HWS		80°C	90°C

About Heating

Up to 50°C Heating and cooling can be quite rapid.

Above 50°C Heat and cool slowly (3°C per minute recommended). However suppliers say between 3 and 8 °C per minute. Heating slowly means less chance for overheating, local or global.

Typical heating cycle for a HS-element.

Heat to >80 °C, hold temperature for 30 minutes and cool. Instead of cooling by recirculation of cold water you can simply stop the system and allow it to cool at its own pace.

In order to disinfect chemically it should not be a surprise that a toxic chemical is needed. And toxic chemicals are seen as unwanted. That is a dilemma.

Hypochlorite, ozone, hydrogen peroxide and peracetic acid are oxidizers. They are quite efficient. However,

Hypochlorite ozone	thin film polyamide membranes do not tolerate them in any quantity.
Hydrogen peroxide peracetic acid	Information about resistance vary. If transitions metals like Fe is absent, most thin film RO will tolerate a weekly disinfection.

Reducing agents like SO_2 are safe for all membranes and not very efficient.

Aldehydes are efficient. Formaldehyde has been known for many years. It is in many countries forbidden, except for special use (e.g. phenol-formaldehyde glue and anatomical institutes). Glutaraldehyde is less volatile but still efficient. Notice that aldehydes may cause some loss of flux on brand new membranes. To prevent that at least one cleaning is recommended before subjecting the membranes to an aldehyde.

Methylisothiazolinone (Trade name KETHON) belongs to a group of chemicals which are efficient, rarely used and definitely not food grade. The operator can develop hypersensitivity when subjected to the concentrated chemical.

Storage solution containing SO_2

If a plant shall be stored for more than 1 week the following is recommended.

I. Clean the plant.
II. Flush out
III. Prepare a solution of (at least) 0,1 g/l Sodium Hydrogen Sulphite ($NaHSO_3$) or sodium metabisulphite ($Na_2S_2O_5$) in soft water. Adjust pH to 4,5 with mineral acid, e.g. HCl or H_2SO_4. Recirculate in system under low pressure for 30 - 40 minutes. Better too long than too short.
IV. Stop plant with the solution inside
V. It is recommended to repeat II, III and IV every 2 weeks.

This method is valid for all types of membranes.

NOTICE.
The solution will smell of SO_2. That is a nuisance more than anything else.
FYI: SO_2 is used as preservative for wine.

Overview

	Killing effect	Positive	Negative
Formaldehyde Glutaraldehyde Furfural Ortho-phtalaldehyde	Highly efficient	Harmless for membranes FDA approved	Harmful for humans. Do not use on membranes with protein deposits
Surfacine Ag-based	Efficient	Non-toxic to mammalian cells	Price
Isothiazolin	Highly efficient	Harmless for membranes when used with care	Harmful for humans. Do not use in plants with food grade products
$NaHSO_3$ Sodiummetabisulphite SO_2	Not efficient	Reducing agents Harmless to membranes.	Not very efficient
Phenol Cresol	Efficient		Toxic Waste disposal problem Smell
70% EtOH (and MeOH)	Efficient	Not toxic Harmless to membranes.	Price
0,5% $HgCl_2$	Highly efficient	Not an oxidizer	Toxic Waste disposal problem
Ethylene oxide	Efficient		Gas, Toxic
Ag^+	Efficient	Harmless to membranes.	Toxic, price
pH 13,5	Efficient		tolerated by few membranes
pH 0	Efficient		tolerated by few membranes
HNO_3	Efficient	Cheap	Oxidizer Do not use on TFM
NaOCl Cl_2 ClO_2 (Halogenides)	Highly efficient Highly efficient Highly efficient	CA, PSO and PVDF has good resistance	Oxidizer Do not use on TFM
O_3 H_2O_2 CH_3COOOH	Highly efficient Efficient Highly efficient	CA, PSO and PVDF has good resistance	Oxidizer Do not use on TFM
Perborate Persulfate Percarbonate	Efficient Rarely used	CA, PSO and PVDF has good resistance	Oxidizer Do not use on TFM.
Quaternary ammonia compounds	Not efficient		May reduce flux severely on thin film membranes

http://www.cdc.gov/ncidod/eid/vol7no2/rutala.htm (CDC - New Disinfection and Sterilization Methods)