

RO/NF Polyamide Membrane Feedwater Requirements

Hydranautics manufactures polyamide thin film composite membranes which are suitable for purification of feed streams containing a wide variety of dissolved contaminants. A composite membrane, as shown in figure 1, is a three layer structure that is comprised of a 0.2 micron crosslinked polyamide layer, a 50 micron porous polysulfone layer, and a 150 micron thick polyester fabric support layer. Contaminants are typically dissolved salts such as sodium, calcium, magnesium, ammonium, chloride, fluoride, bromide, sulfate, bicarbonate, nitrate, phosphate, silica, as well as dissolved organic molecules such as natural occurring matter (NOM), and halogenated by-products.

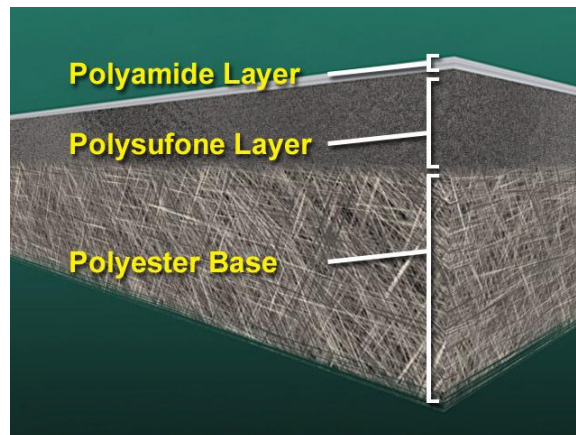


Figure 1. Composite polyamide membrane composed of three layers.

While the RO and NF membranes are designed to remove such dissolved species, certain contaminants in a feedwater can be damaging to a composite membrane. The damage is typically done by two mechanisms, mechanical and/or chemical. Both can cause an irreversible loss in performance and compromise the life of the membrane. The designer and operator of an RO or NF system should take necessary caution to protect the composite membranes from such occurrences.

Mechanical Damage

Mechanical damage occurs when particulate matter enters or is generated in the membrane module and then physically abrades or penetrates the membrane layer. It should be noted that the membrane layer is only 0.2 microns thick. Abrasion on the surface of the polyamide can potentially penetrate this layer and compromise the product water quality. Generally, the RO membrane is well-protected when a 5 micron prefilter is used to prevent large particles from entering the membrane element. Even particles in the size range of 10 to 50 microns have been known to cause damage to a membrane surface. It is also important that users maintain the prefilters in good working order, ensuring that there is no by-pass around the cartridge filter.

Additionally, the membrane element should be kept free of particles that can form insitu, that is, form by precipitation during the membrane dewatering. Again, particles can be formed which are large enough to damage or penetrate the surface when their concentration exceeds the saturation point. This precipitation during the membrane process can usually be prevented by the use of an appropriate scale inhibitor or by reducing recovery.

Chemical Damage

Chemical damage occurs when an organic or inorganic contaminant in the feed is incompatible with one of the polymers comprising the membrane. In such a case, the membrane strength is weakened and eventually gives rise to cracks in the membrane or a reduction of the polymer molecular weight or intramolecular packing.

Common chemicals which can degrade the crosslinking or packing of molecules in the polyamide layer are ozone, chlorine (e.g. hypochlorite, hypochlorous acid, chlorate, chlorite, etc.), bromine (e.g. hypobromite, hypobromous acid, bromate, bromite, etc.), peroxide, and a variety of other less common oxidants. These chemicals cause a progressive “opening” of the membrane which results in higher salt passage and higher water permeability. The damage is irreversible and continues as long as the membrane is exposed to these chemicals.

Alternatively, there are a wide variety of chemicals which swell or dissolve polysulfone material used as a supporting layer. Chemicals in this class which can rapidly damage a membrane include all aprotic solvents such as dimethyl formamide (DMF), dimethyl acedimide (DMAc), n-methyl pyrrolidone (NMP), dimethyl sulfoxide (DMSO), etc. Likewise, polysulfone can be swollen or dissolved by many ketones, aldehydes, esters, and strong ethers. Aromatic hydrocarbons such as benzene, toluene, xylene, and phenol are also damaging to the polysulfone layer. There are also a wide variety of mixed chemicals which are damaging, such as diesel fuel and gasoline. If the membrane is exposed to high concentrations,

>50 ppb levels, the membrane can lose its mechanical strength in a relatively short time. Exposure to this type of contaminant will not be seen initially. However, when the strength of the membrane reaches a critical minimum point, the salt passage can go up dramatically. It is impossible to recover the rejection of such a damaged membrane. If such a feed stream needs to be treated, extended pilot testing to characterize performance is highly recommended.

Typically, the only low molecular solvents which can be considered safe would be simple alcohols such as methanol, ethanol, propanol, and isopropanol. Also, most inorganic ions which stay dissolved in the brine solution will not cause a problem to the membrane, except for oxidizing metals such as MnO_4^- .

The polyester support and polyamide layer can also be damaged by extreme pH. This is most often seen when membranes are exposed to high pH (> pH 11.5) and high temperature (> 45 C) for an extended period.

Membrane performance may also be compromised when an incompatible chemical irreversibly fouls the membrane surface. Most foulants, such as organics, colloids and mineral scale, are removed from the membrane surface by proper cleaning, but some polymers and surfactants may chemically bond to the membrane surface in such a way that they can not be easily removed. The negatively charged membrane surface will attract the positively charged organic molecules in a cationic surfactant and in certain polymers. Once these large organic molecules come in contact with the membrane, other attractive forces take effect and form strong bonds between the molecule and the membrane surface. These bonds are very difficult to break and can permanently reduce flux by as much as 60%. Likewise, some neutral surfactants will lead to a permanent flux loss if they come in contact with the membrane surface.

The above list of foreign substances that should not be allowed into a membrane element is exemplary only. This list is not intended to be all inclusive. The actual list of specific chemicals which can damage a membrane is much more extensive. The list above is intended to identify some of the more common foreign substances which have been known to be present in feed waters and cause damage.

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