

We have been baffled.....Why would any one use membranes for a microfiltration application?

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The membrane industry continues to drive the use of membranes for all encompassing applications. Although there are numerous benefits in the use of membranes for ultrapure water applications, membranes are a major impediment to cost efficiency when they are used as the first barrier. **In particular they are not well suited for microfiltration applications.**

Scaling and biofouling problems continue to plague this technology and certainly when the membrane acts as the initial particle separation step, these fouling problems are even more exasperated.

The recent literature is now very clear on this problem

1. **Frost and Sullivan** reported in their recent 2006 assessment of the membrane market that
 - a. “An optimistic view for the future of membrane technology must be tempered by recognition of the remaining technical and cost issues that must be addressed. Of these issues, the fouling of membranes by rejected chemicals and microbes continues to demand considerable attention from the research community” and;
 - b. “Recovery rates are in the order of 80% and membrane systems that tout higher recovery rates end up with higher fouling issues due to the higher concentration of solids in the concentrate” and;
 - c. “Significant research is being carried out to understand membrane fouling through several autopsies which suggest there are a number of factors contributing to membrane fouling and proper pre-treatment is necessary” and finally
 - d. “Typically over the life of a membrane system, operating costs often become a greater expense than the purchase price itself”
2. Natural Organic Material (NOM) is considered a major component of ambient membrane fouling in water separation applications. Typically the negative charge of most membranes repels like charged organic substances. However calcium greatly enhances NOM fouling. The size of NOM compounds can also affect fouling. For low pressure membranes (microfiltration membranes) inorganic particles such as silica foul membranes. This has been recognized by many manufacturers for years. However the lack of understanding of the chemical and

physical interactions simply has not allowed a clear view of membrane fouling. **(Li and Elimelech,2004)**

3. Coagulation and flocculation are being used for MF and UF pre-treatment to reduce fouling. Results have varied but in general high doses of coagulants have improved membrane performance **(Howe and Clark 2002a,Howe et al, 2001; Judd & Hillis, 2001;Fu and Dempsey, 1997)**

4. A very significant study by the **American Water Works Association Membrane Technology Research Committee made a number of interesting statements in a paper entitled “Recent Advances in Research Needs in Membrane Fouling”**. The papers authors are the consensus of the premier research committee in the world as it relates to membranes. Their comments are as follows:
 - a. “Fouling occurs as a result of scaling and biofouling. Biofouling is a major problem because it leads to higher operating pressures, the need for frequent chemical cleaning, membrane deterioration and compromised product water quality”
 - b. “Cleaning techniques are not well established. In fact they are developed more on a trial and error basis than on a research basis. Use of air is common in MF and UF systems. There have been attempts to use vibratory or ultrasonic cleaning of membranes but the polymeric materials have not held up well”.
 - c. “Soluble microbial by- products have a profound negative effect on membrane performance and should be removed prior to membranes to reduce membrane fouling. One of the methods is chlorination but typically many membranes, particularly TFC membranes, have a low tolerance to oxidants. The other approach is to use monochloramine but it can be a problem with membranes in the presence of ferrous iron. Another problem with chloramines appears to be the need for frequent cleanings of RO membranes.”
 - d. The paper concludes that a complete understanding of the fouling process itself is still lacking. The nature of the foulants differs not only with the source water but also with the type of membrane process applied. (Low pressure versus high pressure). The article goes on to say that the critical flux concept remains relatively unproven under practical operating conditions in low pressure systems and the introduction of submerged membrane technology raises new research questions with regards to the use and optimization of air sparging systems.

5. **A second article written by Howe and Clarke (AWWA Journal April 2006)** focussed in on pre-treatment through the use of coagulation. This article is interesting in that it confirms the need for high dosages of coagulant to improve membrane performance. Dosages as high as 30 to 210 mg/l for alum were found to improve membrane performance. This information coincides well with the need to manage Total Organic Carbon (TOC’s). If the objective is to remove TOC’s, high levels of coagulant are recommended. There are two fallacies however in the rationalization to use more chemistry. First, if we use a

disinfectant such as UV to disinfect, the need for TOC removal is not as important and increased chemistry is not necessary. So who is driving these solutions? Is it the chemical manufacturers??? Maybe it is the membrane manufacturers. For years we were told as professionals that one of the benefits of membranes was the reduced use of chemistry. However chemistry usage is much greater with membrane technology either through the cleaning process, the reduction in biofouling or the need to pre-treat to improve membrane performance. When membrane manufacturers are questioned on this fact we are diverted to the suggestion that increased chemistry is a result of the Disinfection By Products rule (i.e. there is a need to reduce TOC with chemistry to satisfy the need to reduce disinfection byproducts such as tri halomethanes). The truth is that the chemistry is needed to contain criticism on poor membrane economics and performance. To put it succinctly, to ensure good membrane performance, TOC's have to be reduced via the use of high amounts of chemistry (known as enhanced coagulation)

The Howe Clark study revealed that the use of alum with pre-filtration provided excellent pre-treatment for membranes. In addition they also found that the use of a cationic polymer as a coagulant aid plus alum improved permeability significantly. Finally the other significant observation was that “ in nearly every experiment with the raw water the ability to remove particulate matter reduced the fouling potential

Conclusion

If you intend to use membranes for microfiltration in such applications as potable water treatment or pre-filtration for nano filtration and reverse osmosis applications expect to use high levels of chemistry. You will need enhanced coagulation levels of chemistry for pre-treatment to prevent organic fouling (i.e. 30 to 200 mg/l of alum or ferric sulphate) and significant clean in place chemistry. In addition do not be surprised with short time frames between membrane module replacements.

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