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Membrane filtration:

*A User's Guide and
Reference Manual*

Thomas D. Brock



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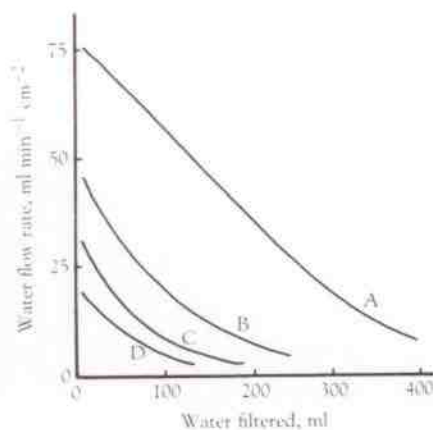
Figure 4.9. Water flow rate versus pressure for several kinds of filters. The anisotropic filter data are from Kesting et al. (1981), the other data from manufacturers' literature.

Filter types are given in a wide range of flow rates. Pore size, other factors of the same nominal pore size, water will flow more isotropic.

Fluid flow rate with time, important parameters of a clogging rate, the higher the flow rate the filter must be changed. **Decay test.** Incremental flow rate filter under constant pressure. Representative results of a decay test can be seen that clogging is a function of the porosity of the filter. With time on the upper side of the filter, while still

clogging rate, filters with high flow rates will clog rapidly. One method for cleaning filters is **backwashing**, which is used through the filter, resulting in a decrease in forward-flow rate. In large installations, where backwashing is not practical, the best procedure is to use depth filters, and can

Figure 4.10. Clogging rate of several kinds of filters, as measured by the drop in flow rate with increasing volume filtered. The solution filtered was 0.01% Triton X-400, intended as a model contaminant. Filter types: A, anisotropic; B, conventional mixed ester; C, polyamide (Nylon); D, polyvinylidene fluoride (probably hydrophilic Durapore). (Kesting et al., 1981)



be obtained in nominal pore sizes down to about $1 \mu\text{m}$. A comparison of the clogging rate for a membrane filter and a glass microfiber filter of the same nominal pore size was shown in Figure 2.8.

A detailed study on the clogging rates of various brands of membrane filters during the filtration of food suspensions for microbiological analysis is given by Sharpe et al. (1979). Filtration of such particle-rich suspensions leads to rapid clogging, and various factors influence the process. One of the most important factors is the degree of anisotropy of the filter; even conventional membrane filters, not considered to be very anisotropic, showed marked differences in clogging rate between the upper and lower surfaces. Some manufacturers recommend a specific orientation of their filters, whereas others make no mention of which side should go up. As a general rule, the side of the filter which is facing up in the package is the air side during the manufacturing process, and would have larger pores. However, it should be emphasized that for many types of filtration applications, the orientation of the filter in the filter holder makes no difference.

4.5 Chemical compatibilities of membrane filters

In many industrial and chemical applications, membrane filters are used to filter solutions or suspensions containing liquids other than water. There is a wide variation in the susceptibility of membrane filters to attack by alcohols, hydrocarbons, acids, alkalis, and unusual mixtures of the types used in photographic and industrial work. For any particular use, it is essential that the user test the filter material to determine compatibility. A test should involve subjecting a series of filters to the desired solvent or solution under the temperature con-

ditions and for the period of time that will be used in the application. Visual observations of the appearance of the filter may indicate that it has been attacked by the fluid. Measurements may indicate that the filter diameter has changed, usually increasing if solvent action occurs. If no obvious changes can be seen, then the integrity of the treated filters should be further assessed by measuring water flow rate, as described above, and the bubble point, described in Section 4.2. In general, it will be found that if the filter is affected by the solvent, the flow rate will decrease and the bubble-point will increase. This is because solvent action usually causes a plasticization of the filter material, leading to a relaxation of the molecular chain stress in the polymer molecules. The polymer chains hence swell, reducing the sizes of the pores. Scanning electron microscopy may be useful in showing some of the effects of solvents on filter materials. A discussion of membrane filter compatibilities is given by Lukaszewicz and Meltzer (1980).

In general, four different responses of a filter to a solvent can be recognized:

1. No chemical effect.
2. Slight swelling or distortion of the filter. The filter may be compatible with this solvent for short-term use.
3. Extensive swelling and slow dissolution of the filter.
4. Complete dissolution or disintegration of the filter.

The compatibility of a filter with a given solvent will depend on the chemical composition of the filter and on the temperature and pressure of the treatment. Certain rules can be given for the chemical resistance of various filter types:

1. Cellulose nitrate filters are susceptible to most solvents except aliphatic hydrocarbons, and to most acids and alkalies. Of the common filter types, they are the least tolerant to organic solvents.
2. Cellulose acetate filters are similar to cellulose nitrate, except they are more resistant to alcohols.
3. Regenerated cellulose filters are resistant to most solvents, but they are not resistant to alkalies or acids.
4. Vinyl filters are resistant to alcohols and alkalies, but they are not resistant to most other solvents, or to acids.
5. Polyvinyl chloride (PVC) filters are resistant to most solvents, but are sensitive to acids, ketones and dioxane.
6. Acrylic filters are sensitive to acids and ketones, but are resistant to most other materials.
7. Nylon filters are resistant to most solvents, but not to acids.

8. Polycarbonate and organic solvents sensitive to strong alkali

9. Teflon (PTFE) resistant to almost anything. Teflon is resistant to solvents composed of a different material. Teflon is resistant to sulfuric acid, n-butyl

10. Aluminum alloy commercially from the water soluble by treatment. can be used for filter retrieve the particulate

Two other aspects of an aggressive substance filtered, as it might action on the filter and filters may be attacked may be harmless. The of the chosen filter material

Each manufacturer's compatibility tests on filter literature or technical information.

In addition to the effect of sterilization membrane filters can oxide gaseous sterilization that must be followed filters are given in

4.6 Bacterial retention

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8. Polycarbonate (Nuclepore) filters are resistant to most acids and organic solvents except halogenated hydrocarbons, and are sensitive to strong alkalies.

9. Teflon (PTFE) and other fluorocarbon-based filters are resistant to almost anything. The Durapore filters of Millipore, which are composed of a different fluorocarbon than Teflon, are somewhat less resistant to solvents than Teflon. For instance, solvents to which Teflon is resistant but which attack Durapore include acetone, hot sulfuric acid, n-butylamine, and dimethylformamide.

10. Aluminum alginate filters (see Section 3.8; possibly available commercially from the German branch of Sartorius) can be rendered water soluble by treatment with a sodium citrate solution. These filters can be used for filtration of aqueous materials when it is desired to retrieve the particulate matter that has been retained by the filter.

Two other aspects of filter incompatibility should be noted: 1) If an aggressive substance is only a minor component of the fluid to be filtered, as it might be in a formulation or mixture, its detrimental action on the filter may be greatly diminished. 2) On the other hand, filters may be attacked by mixtures of substances, any of which alone may be harmless. Thus, the user should assess chemical compatibility of the chosen filter material with the exact formulation being filtered.

Each manufacturer has carried out extensive chemical compatibility tests on the filters that it markets. The manufacturers' literature or technical representatives can be sought for more detailed information.

In addition to compatibility of filters with various solvents, the effect of sterilization procedures on filters must be considered. Most membrane filters can be sterilized by autoclaving or by use of ethylene oxide gaseous sterilization, but there are a number of precautions that must be followed. Details on the sterilization of membrane filters are given in Chapter 7.

4.6 Bacterial retention methods

Bacterial retention methods are frequently used to evaluate the performance of membrane filters. Bacterial retention measurements serve to characterize the pore size of the filter, and permit evaluation of the utility of a filter for the sterilization of fluids under actual use conditions. The bubble-point test is a precisely defined procedure for characterizing filter pore size, but bacterial retention measurements bolster confidence that the bubble-point test is providing proper information.

In the most common bacterial retention procedure, the filter



Polycarbonate Membrane Filters

Chemical compatibility information

Introduction:

The question of chemical compatibility of the polycarbonate track etch membrane filters often times arises, since one often times has the need to filter a liquid other than water. We find the two brands offered by SPI Supplies, both our own SPI-Pore™ as well as the Nuclepore® brands are quite similar, if indeed one can measure any difference in their chemical compatibilities.



We offer the following information:

Not recommended

- Acetone
- Ammonia, 6N
- Carbon tetrachloride
- Chloroform
- Dioxane
- DMSO
- Nitric acid 6N
- Nitrobenzene
- Pyridine
- Sodium hydroxide 6N
- Sulfuric acid, concentrated
- Trichloroethane

Resistant to following solvents:

- Acetic acid 5%
- Amyl acetate
- Boric acid
- Butyl alcohol
- Cyclohexane
- Ethanol
- Ethers
- Ethylene glycol
- Formaldehyde
- Freon® TF

Precision Cleaning Agent®
Hydrochloric acid, concentrated
Hexane
Isobutyl alcohol
Methanol
Nitric acid, concentrated
Pentane

The above information should be used only as a guide to your selection of membrane and solvents. For filtration of a liquid for which polycarbonate track etch membrane filters are not the right choice, consider the [SPI-Pore™ Silver Membranes](#) or the [Anodisc® aluminum oxide membrane filters](#).

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