# FILMTEC Membranes
## Troubleshooting: System Tests

After the available data of the system operation and performance have been checked and investigated, the system will be inspected and tested in more detail.

### Visual Inspection

- How clean is the plant? Mold and biogrowth in tanks and pipes are indicators of a biofouling problem. Leaking vessels may suck air when the system shuts down and lead to hydraulic shock at start-up and premature fouling, especially in SW conditions.
- Open a pressure vessel at the feed side: is there any fouling present on the face of the lead element? A biofilm on a wet surface feels slippery. Any smell? Are the elements properly shimmed (see *Shimming Element s - Section 4.3*)?
- Open a pressure vessel at the concentrate side: scaling feels like sanding paper to the touch.
- Remove the elements from one or from several vessels and check the couplers for torn, damaged or misplaced O-rings. Replace O-rings. (See *Interconnector Technology - Section 4.5*).
- Inspect the elements for fouling, scaling and mechanical damage – check at least one lead element and one tail element.

### Type of Foulant and Most Effective Cleaning

- How does the system respond to different cleanings? The efficiency of a specific cleaning is an indication for a specific fouling problem. (See *Cleaning Procedure for Specific Situations - Section 6.7*).
- How does the cleaning solution coming out of the system look? The initial cleaning solution exiting from the membrane system may contain high amounts of removed foulants. Analyze the spent cleaning chemical for metals and TOC and compare with a fresh solution. The type of foulant can be estimated from the comparison of the analyses of the used and the unused cleaning solution.

### Localization of High Solute Passage

#### Profiling

If a system exhibits high solute passage, one of the first steps in troubleshooting is to localize the source. A loss in solute rejection may be uniform throughout the system, or it could be limited to the front or to the tail end of the system. It could be a general plant failure, or it could be limited to one or few individual vessels. To localize high solute passage in a system, it is first recommended to profile the system. To profile a system, all individual vessel TDS or conductivity or other relevant quality values are checked. A well designed system contains a sample port located in the permeate stream from each vessel. Care must be taken during sampling to avoid mixing of the permeate sample with permeate from other vessels. All permeate samples are then tested for their concentration of dissolved solids with a TDS or conductivity meter. In nanofiltration applications, specific analytical methods for sulfate or other relevant compounds have to be used. The permeate samples of all pressure vessels in the same stage should give readings in the same range. Notice that from one stage to the next the average permeate TDS or conductivity usually increases, because for example the second stage is fed with the concentrate from the first stage. To determine the solute passage of all pressure vessels from their permeate concentration, the concentration of the feed stream to each stage must also be measured. The solute passage is the ratio of the permeate concentration to the feed concentration. Then the high solute passage of the system can be assigned to the first or the last stage, or to individual vessels.



Form No. 609-02111-1004

Localization of High Solute Passage (cont.)

### Probing

If one pressure vessel shows a significantly higher permeate concentration than the other vessels of the same stage, then this vessel should be probed. The procedure allows locating a problem within a pressure vessel while online without unloading elements. Probing involves the insertion of a plastic tube (approx. 1/4 inch (6 mm) in diameter) into the full length of the permeate tube (see Figure 8.1) in order to measure the permeate conductivity at different locations inside the pressure vessel. This can be accomplished by isolating the vessel from it's permeate manifolds and use the open permeate port, or by removing the opposite end cap's permeate plug. When the permeate manifolds remain in place, it must be ensured that no permeate from other vessels can influence the probing. If the system operates with a permeate backpressure, the probed vessel must be disconnected from the system permeate; otherwise permeate from the other vessels will enter into the probed vessel.

*The use of a modified tube fitting according to Figure 8.2 eliminates water leakage at the point of entry. This device can be used at the opposite end of the pressure vessel from the product header piping, with the permeate manifold remaining in place even under a moderate permeate backpressure. A ½ inch ball valve is connected to the permeate port. It is fitted with a ¼ inch plastic Parker tube fitting which has been modified by drilling the body to allow a ¼ inch plastic probe tubing to pass completely through the fitting. In addition a short piece (2 inches (5 cm)) of very supple thin wall gum rubber tubing which fits snugly over the end of the nylon probe tubing and protrudes approximately 1/2 inch will prevent hangups at the product tube adapters and the product tube interconnectors.*

While the membrane system is operating at normal operating conditions, water is diverted from the permeate stream of the vessel in question. A few minutes should be allowed to rinse out the tubing and allow the membrane system to equilibrate. For an RO system, the TDS or the conductivity of the permeate sample from the tubing can then be measured with a hand-held meter and the data recorded. It is desirable to set up the conductivity meter for continuous indication utilizing a flow through cell or the arrangement shown in Figure 8.1. This measurement should reflect the TDS of the permeate being produced by the FILMTEC™ element at that position. For a NF system, the permeate conductivity might not be sensitive enough to localize a leakage. Instead, the sulfate concentration in the sample should be determined.

The tubing is then pulled out six inches (15 cm) from the end and a sample is taken to measure the conductivity at the adaptor/element interface. Then the tubing is extracted eight inches (20 cm) and another sample is taken. The tubing is then withdrawn in further increments to obtain a conductivity profile (see Figure 8.1). The sampling locations should be every eight inches (20 cm) so that every fifth sample marks the coupler connection for two elements. This allows for multiple measurements per element plus checking of all coupler/adaptor O-rings. The tube can be marked so that the desired sampling locations can easily be accessed.

*Taking a conductivity reading at 8 inch intervals for each element, allows closer scrutiny for determining exactly which o-ring seal of a coupler (interconnector) has a leak. Similarly the probe should be positioned some distance away, as well as at the end of the adaptor, to check the integrity of the o-ring seal at the pressure vessel head assembly (end plug). Figure 8.2 illustrates this by showing how to position the probe to check for leaks at the o-ring seal for the product tube adaptors in the permeate hub of the end plug. The sketch illustrates the probe at the "start" position typical for 8" elements where the normally plugged permeate port is used to connect the probing apparatus and insert the probe tubing. The*

Localization of High Solute Passage (cont.)

*dimensions will vary depending on manufacturer and model of the actual pressure vessels. It is usually recommended to open up one of the pressure vessels to determine exactly the correct dimensions for positioning the probe tube. After this is done a table should be made listing dimensionally all the locations where pauses are required during withdrawal of the probe tubing for recording conductivity measurements.*

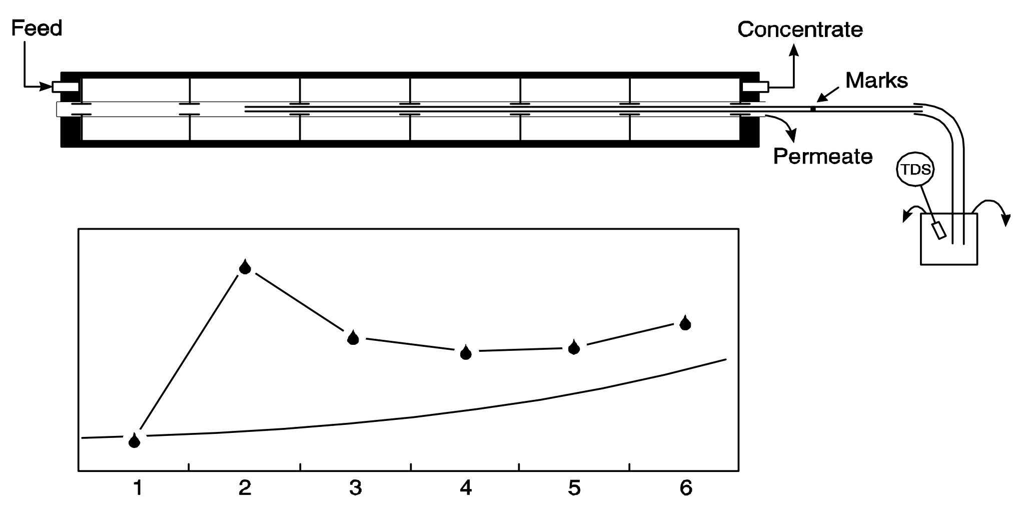
*Accurately positioning the probe for these data points can be accomplished by using an additional o-ring (size 108 for ¼" O.D. tubing) as an indicator just outside the tube fitting. With the probe completely inserted to the start position, and the indicator o-ring at the outside face of the tube fitting, the measurement for the next predetermined position can be made accurately with a tape measure since the o-ring will move along with the tubing as the probe is withdrawn. Then keeping the probe stationary slip the indicator o-ring back to the tube fitting in preparation for the next withdrawal measurement. This simple trick has proved very effective in accurately positioning the probe with as many as seven elements in series.*

A normal conductivity profile shows a steady increase of the permeate produced at the feed side of the pressure vessel towards the concentrate end of the vessel. An unusually large deviation from this profile locates the source of the high salt passage problem. O-ring problems are generally indicated by a step change in the conductivity profile at coupler/adaptor locations, while a marked increase outside this region points to a leakage from an element, e.g. due to a backpressure damage.

The normal (reference) conductivity profile depends also on the location of the probing tube entry and on the flow direction of the permeate out of the probed vessel. Figure 8.1 shows an arrangement with probing from the concentrate end of the vessel with the permeate flowing to the concentrate side as well. The first sample from the feed side end of the vessel represents the permeate produced at exactly that location. As the tube is gradually pulled out from the vessel, the sample represents the combined permeate which is produced upstream of the sample location. The last sample represents the permeate of the entire vessel.

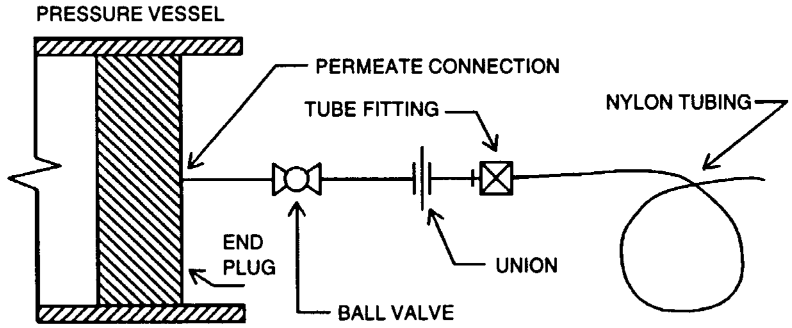
If the vessel is connected to the permeate manifolds and/or the probing tube is inserted from the feed side of the vessel, the reference conductivity profile changes accordingly. The accuracy of the method is best where the sample is least influenced by permeate from upstream membranes. This has to be born in mind when the results are evaluated.

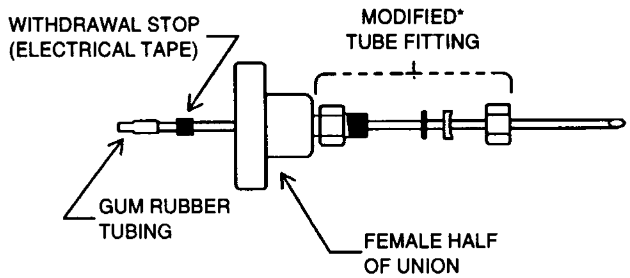
Figure 8.1 Conductivity profile



## Localization of High Solute Passage (cont.)

Figure 8.2 Permeate probing apparatus for spiral wound membrane




FILMTEC Membranes
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