FILMTEC Membranes
Troubleshooting: Symptoms of Trouble, Causes and Corrective Measures

High Pressure Drop

High differential pressure, also called pressure drop or Δp from feed to concentrate, is a problem in system operation because the flux profile of the system is disturbed in such a way that the lead elements have to operate at excessively high flux while the tail elements operate at a very low flux. The feed pressure goes up which means increased energy consumption. A high differential pressure causes a high force in flow direction on the feed side of the element. This force has to be taken by the permeate tubes and, in the case of 8" elements, by the membrane scrolls and the fiberglass shells of adjacent elements in the same vessel. The stress on the last element in the vessel is the highest: it has to bear the sum of the forces created by the pressure drops of upstream elements.

The upper limit of the differential pressure per multi-element vessel is 50 psi (3.5 bar), per single fiberglassed element 15 psi (1 bar). When these limits are exceeded, even for a very short time, the FILMTEC™ elements might become telescoped and mechanically damaged.

Eight-inch elements will break circumferentially at any location of the fiberglass shell, or the endcap will be pushed out, or the spokes of the endcap will break, or the feedspacer will be pushed out from the concentrate channels. Although such damage is easily visible, it does not normally affect the membrane performance directly. However, they indicate that the differential pressure has been too high. Cracks around the endcap cause bypass of feedwater and may lead to fouling and scaling.

Photos of elements with telescoping damage are shown below.

Figure 8.9 The endcap has been pushed off

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High Pressure Drop (cont.)

Figure 8.10 Picture of damaged fiberglass shell

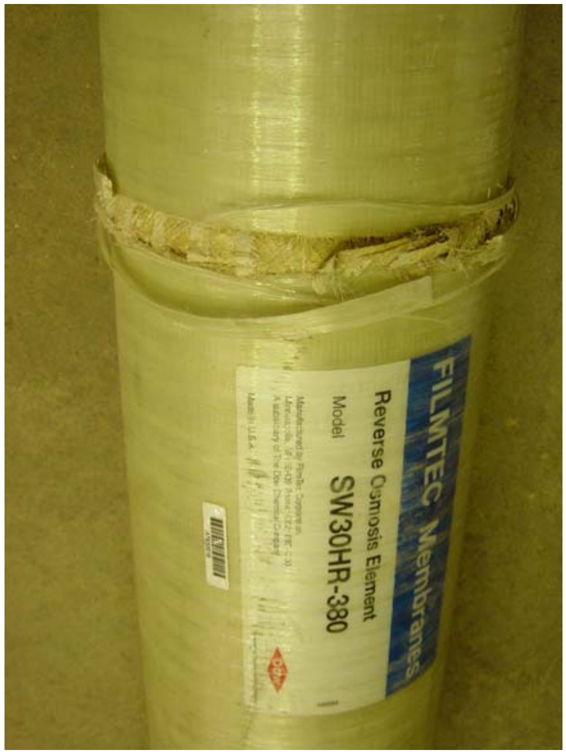
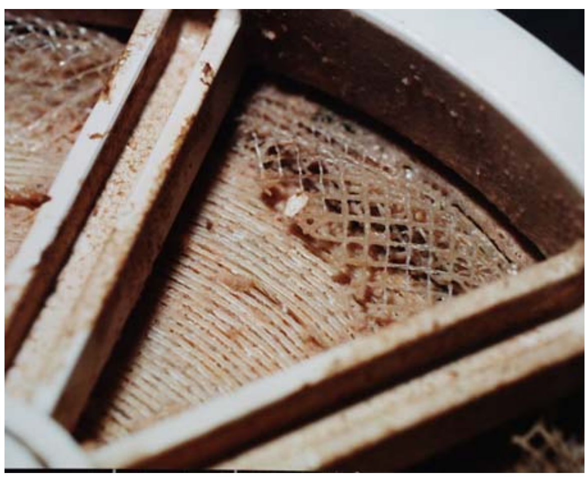


Figure 8.11 High pressure drop due to biofouling has pushed out the feed spacer



An increase in differential pressure at constant flow rates is usually due to the presence of debris, foulants or scale within the element flow channels (feed spacer). It usually occurs together with a decreasing permeate flow, and the causes for that have been discussed in *Symptoms of Trouble, Causes and Corrective Measures (Section 8.5.1)*.

An excessive pressure drop occurs when the recommended maximum feed flow rates (*Membrane System Design Guidelines - Section 3.9.1*, Tables 3.4 - 3.6) are exceeded. It can also occur when the feed pressure builds up too fast during start-up (water hammer). The effect is dramatically increased with a foulant being present, especially biofilm causes a high pressure drop.

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High Pressure Drop (cont.)

Water hammer, a hydraulic shock to the membrane element, can also happen when the system is started up before all air has been flushed out. This could be the case at initial start-up or at operational start-ups, when the system has been allowed to drain. Ensure that the pressure vessels are not under vacuum when the plant is shut down (e.g. by installation of a vacuum breaker); otherwise air might enter into the system. In starting up a partially drained RO system, the pump may behave as if it had little or no backpressure. It will suck water at great velocities, thus hammering the elements. Also the high pressure pump can be damaged by cavitation.

The feed-to-concentrate differential pressure is a measure of the resistance to the hydraulic flow of water through the system. It is very dependent on the flow rates through the element flow channels and on the water temperature. It is therefore suggested that the permeate and concentrate flow rates be maintained as constant as possible in order to notice and monitor any element plugging that is causing an increase in differential pressure.

The knowledge of the extent and the location of the differential pressure increase provide a valuable tool to identify the cause(s) of a problem. Therefore it is useful to monitor the differential pressure across each array as well as the overall feed-to-concentrate differential pressure.

Some of the common causes and prevention of high differential pressure are discussed below.

a. Bypass in Cartridge Filters

Cartridge filters have to protect the RO system from large debris that can physically block the flow channels in the lead-end elements. Such blocking can happen when cartridge filters are loosely installed in their housing, connected without using interconnectors, or completely forgotten.

Sometimes cartridge filters will deteriorate while in operation due to hydraulic shock or the presence of incompatible materials. Cellulose- based filters should be avoided because they may deteriorate and plug the FILMTEC elements.

b. Pretreatment Media Filter Breakthrough

Occasionally, some of the finer media from sand, multimedia, carbon, weak acid cation exchange resin, or diatomaceous earth pretreatment filters may break through into the RO feedwater.

c. Pump Impeller Deterioration

Most of the multistage centrifugal pumps employ at least one plastic impeller. When a pump problem such as misalignment of the pump shaft develops, the impellers have been known to deteriorate and throw off small plastic shavings. The shavings can enter and physically plug the lead-end RO elements. It is suggested that the discharge pressure of RO pumps be monitored before any control valves as part of a routine maintenance schedule to see if the pump is maintaining its output pressure. If not, it may be deteriorating.

d. Scaling

Scaling can cause the tail-end differential pressure to increase. Make sure that scale control is properly taken into account (see *Scaling Control - Section 2.3*), and clean the membranes with the appropriate chemicals (see *Cleaning Chemicals - Section 6.8*). Ensure that the designed system recovery will not be exceeded.

High Pressure Drop (cont.)

e. Brine Seal Issues

Brine seal damage can cause a random increase in differential pressure. Brine seals can be damaged or "turned over" during installation or due to hydraulic surges. This results in a certain amount of feedwater bypass around the element and less flow and velocity through the element, thus exceeding the limit for maximum element recovery. When this occurs, the element is more prone to fouling and scaling. As a fouled element in one of several multi-element pressure vessels becomes more plugged, there is a greater tendency for the down-stream elements to become fouled due to insufficient concentrate flow rates within that vessel.

In case of fullfit or heat sanitizable elements there are no brine seals installed. This is to deliberately encourage a flow around the sides of the elements to keep them free from bacterial growth. Brine seals should not be installed in plants that use fullfit elements as there is no groove in the element to keep the brine seal in place, it would eventually become dislodged and cause unpredictable problems in the system.

f. Biological Fouling

Biological fouling is typically associated with a marked increase of the differential pressure at the lead end of the RO system. Biofilms are gelatinous and quite thick, thus creating a high flow resistance. Corrective measures have been described in *Symptoms of Trouble, Causes and Corrective Measures (Section 8.5.1.1)*.

g. Precipitated Antiscalants

When polymeric organic anti-scalants come into contact with multivalent cations like aluminium, or with residual cationic polymeric flocculants, they will form gumlike precipitants which can heavily foul the lead elements. Cleaning will be difficult; repeated application of an alkaline EDTA solution may help.

FILMTEC Membranes
For more information about FILMTEC membranes, call the Dow Liquid Separations business:

North America:	1-800-447-4369
Latin America:	(+55) 11-5188-9222
Europe:	(+32) 3-450-2240
Pacific:	+60 3 7958 3392
Japan:	+813 5460 2100
China:	+86 21 2301 9000

http://www.filmtec.com

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