High Differential Pressure

The following are general guidelines for troubleshooting Membrania® elements experiencing the effects of high differential pressure. While these guidelines are intended for elements used in water purification, they may apply to some process applications. For more information or questions, please DC Solutions Technical Service.

INTRODUCTION

Pressure drop is the loss of pressure from the feed end to the concentrate end of an element or pressure vessel and occurs due to the resistance of flow. For example, if water is flowing through a pipe of 1'' in diameter and then flows through another of 1/2'' in diameter, the water experiences a greater resistance to flow in the smaller pipe creating a pressure drop within the pipe.

Because pressure drop occurs due to the resistance of flow, it is a function of feed flow rate, feed spacer thickness and feed spacer geometry. Under normal operating conditions, the pressure drop of a reverse osmosis (RO) element is about 0.3 bar (4 to 5 psi).

Pressure drop may increase due to debris blocking the feed channels, fouling or scaling within a system, water hammer, or excessive feed flow. A high pressure drop may be problematic because it may lead to telescoping of the membrane, inefficient operation and an overall decline in system performance.

The maximum recommended pressure drop across a single fiberglass element is 1.0 bar (15 psi) or 4.0 bar (60 psi) across multiple elements in a pressure vessel, whichever value is more limiting.

Interstage pressure indicators are recommended to assess RO plant performance, especially in the case of surface and city waters since these water sources tend to contribute to high rates of fouling. Interstage pressure indicators enable the pressure drop of each stage to be calculated (feed pressure minus concentrate pressure) so the location (i.e. stage) of the potential performance problem can be more accurately identified. Measuring only the total pressure drop of a system may potentially conceal a problem within the system. While the total pressure drop value may be acceptable to determine if there is a system upset, it is possible that the pressure drop mainly occurs in one stage. In that case, the membrane elements in that particular stage may already be damaged.

CAUSES & PREVENTATIVE MEASURES FOR HIGH DIFFERENTIAL PRESSURE

The effects of high pressure drop on elements may include:
- Fiberglass elements may crack or break circumferentially near the ATD.
- The spokes of the endcap or ATD may break.
- The feed spacer may extrude past the scroll end.

Although the damage described above is easily visible, it does not normally affect the membrane performance directly. However, such damage may indicate that the differential pressure is too high. Cracks around the endcap or ATD may cause bypass of feed water and may lead to fouling and scaling.

There are a few root causes that may lead to differential pressure in a membrane system including debris, fouling and scaling, water hammer and excessive feed flow.

Debris

To prevent large debris from entering and blocking the flow channels in lead-end elements, cartridge filters are often placed before membrane systems to filter out such debris. However, when cartridge filters are loosely installed in their housing, connected without interconnectors or haven't been installed at all, debris bypass the filter and block the feed spacers. Sometimes cartridge filters will deteriorate while in operation due to water hammer or hydraulic shock, or in the presence of incompatible materials.

Occasionally, some of the finer media from sand, multimedia, carbon, weak acid cation exchange resin or diatomaceous earth pretreatment filters may break free into the system feed water.

It is recommended to check cartridge and pretreatment media filters regularly to ensure they have not deteriorated and to prevent membrane fouling downstream.

Fouling & Scaling

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). As foulants and scale tends to build up in the feed channels, the feed water experiences a greater resistance to flow and may lead to high pressure drop as well as a decline in system performance.

Because foulants or scale may cause high pressure drop, it is important to clean the system regularly using a proper cleaning regime. To determine which cleaning method to use, please refer to DC Solutions various Cleaning Guides. Additionally, ensure that the designed system recovery is not exceeded.

Water Hammer

High pressure drop may also occur when the feed pressure builds up too fast during start-up, known as water hammer. Water hammer, a hydraulic shock to the membrane element, can also occur when the system is started up before all the air has been flushed out. This can happen when the system has been allowed to drain prior to start-up. To prevent air from entering into the system, install vacuum breakers to ensure that the pressure vessels are not under vacuum when shut down. Starting up a partially drained system causes the pump to suck water at great velocities and hammering the elements. Additionally, the high pressure pump may be subject to cavitation if air bubbles are present in the partially drained system.

Excessive Feed Flow

An excessive pressure drop may also occur when the recommended maximum feed flow rates are surpassed. When systems are fed an excessive amount, pressure builds up within the elements and pressure vessel. It is important to follow the guidelines and recommendations given by the membrane supplier to determine what the maximum feed flow rates are for particular membranes.