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FILMTEC™ Membranes

System Design: Membrane System Design Guidelines for Commercial Elements

Membrane System Design Guidelines Commercial Elements

The factor which has the greatest influence on the membrane system design is the fouling tendency of the feed water. Membrane fouling is caused by particles and colloidal material which are present in the feed water and are concentrated at the membrane surface. The Silt Density Index (SDI) value of the pretreated feed water correlates fairly well with the amount of fouling material present. The concentration of the fouling materials at the membrane surface increases with increasing permeate flux (the permeate flow rate per unit membrane area) and increasing FILMTEC™ element recovery (the ratio of permeate flow rate to feed flow rate for a single element). A system with high permeate flux rates is, therefore likely to experience higher fouling rates and more frequent chemical cleaning.

A membrane system should be designed such that each element of the system operates within a frame of recommended operating conditions to minimize the fouling rate and to exclude mechanical damage. These element operating conditions are limited by the maximum recovery, the maximum permeate flow rate, the minimum concentrate flow rate and the maximum feed flow rate per element. The higher the fouling tendency of the feed water the stricter are the limits of these parameters. The proposed limits are recommended guidelines based on many years of experience with FILMTEC membranes.

The average flux of the entire system, i.e. the system permeate flow rate related to the total active membrane area of the system, is a characteristic number of a design. The system flux is a useful number to quickly estimate the required number of elements for a new project. Systems operating on high quality feed waters are typically designed at high flux values whereas systems operating on poor quality feed waters are designed at low flux values. However, even within the same feed water category, systems are designed with higher or lower flux values, depending on the focus being either on minimizing the capital expenses or minimizing the long term operational expenses. The ranges of flux values given in the tables below are typical numbers for the majority of systems, but they are not meant to be limits.

A continuous RO/NF process designed according to the system design guidelines and with a well-designed and operated pretreatment system will show stable performance with no more than about four cleanings per year in standard applications. Exceeding the recommended limits may result in more frequent cleanings, reduced capacity, increased feed pressure and reduced membrane life. A moderate violation of the limits for a short time may be acceptable as long as the physical limits – the maximum pressure drop and the maximum feed pressure – are not exceeded. On the other hand, a conservative approach is to anticipate a higher fouling tendency and to design the system according to the stricter limits in order to enjoy a trouble free system operation and an increased membrane life.

Membrane System Design Guidelines for Midsize FILMTEC™ Elements

The following tables show the recommended guidelines for designing RO systems with 2.5 and 4-inch FILMTEC™ elements in light industrial and small commercial applications.

Light industrial systems in the table below have the same requirements as for large systems, requiring stable performance over several years. They are typically for piloting large systems, with continuous operation, CIP facilities and none (or minimal) concentrate recirculation. The expected membrane lifetime is more than 3 years.

Design guidelines for FILMTEC elements in light industrial and small seawater applications

Feed source	RO permeate	Well water	Softened Municipal	Surface	Wastewater (filtered tertiary effluent)		Seawater	
					MF[1]	Conventional	Well or MF[1]	Open intake
Feed silt density index	SDI < 1	SDI < 3	SDI < 3	SDI < 5	SDI < 3	SDI < 5	SDI < 3	SDI < 5
Typical target flux, gfd (l/m^{2}h)	22 (37)	18 (30)	16 (27)	14 (24)	13 (22)	11 (19)	13 (22)	11 (19)
Maximum element recovery %	30	19	17	15	14	12	15	13
Element diameter	**Maximum permeate flow rate, gpd (m^3/d)**							
2.5-inch	800 (3.0)	700 (2.6)	600 (2.3)	500 (1.9)	500 (1.9)	400 (1.5)	700 (2.6)	600 (2.3)
4.0-inch (except full-fits and LC products)	2,200 (8.4)	1,800 (6.8)	1,600 (6.0)	1,400 (5.4)	1,300 (4.8)	1,100 (4.1)	1,600 (6.0)	1,500 (5.7)
4.0-inch diameter (LC products)	2,600 (10.1)	2,100 (8.2)	1,900 (7.2)	1,700 (6.5)	1,500 (5.7)	1,300 (5.0)	-	-
Full-fit 4040	2,500 (9.7)	2,000 (7.8)	1,800 (6.9)	1,600 (6.2)	1,400 (5.5)	1,300 (5.0)	-	-
Element type	**Minimum concentrate flow rate, gpm (m^3/h)[1]**							
2.5-inch diameter	0.7 (0.16)	1 (0.2)	1 (0.2)	1 (0.2)	1 (0.2)	1 (0.2)	1 (0.2)	1 (0.2)
4.0-inch diameter (except full-fits)	2 (0.5)	3 (0.7)	3 (0.7)	3 (0.7)	4 (0.9)	5 (1.1)	3 (0.7)	4 (0.9)
Full-fit 4040	6 (1.4)	6 (1.4)	6 (1.4)	6 (1.4)	6 (1.4)	6 (1.4)	NA	NA

Element type	Maximum feed flow rate U.S. gpm (m^3/h)	Maximum pressure drop per element psig (bar)	Maximum feed pressure psig (bar)
Tape-wrapped 2540	6 (1.4)	13 (0.9)	600 (41)
Fiberglassed 2540	6 (1.4)	15 (1.0)	600 (41)
Seawater 2540	6 (1.4)	13 (0.9)	1,000 (69)
Tape-wrapped 4040	14 (3.2)	13 (0.9)	600 (41)
Fiberglassed 4040	16 (3.6)	15 (1.0)	600 (41)
SW Fiberglassed 4040	16 (3.6)	15 (1.0)	1,000 (69)
Full-fit 4040	18 (4.1)	15 (1.0)	600 (41)

Membrane System Design Guidelines for Midsize FILMTEC™ Elements (cont.)

In the table below, the small commercial systems are typically between 1–6 elements that are either regularly replaced or else cleaned (every half year or year) or performance loss is acceptable. The expected element lifetime is not more than 3 years. This is a low-cost, compact solution for intermittently operated systems.

Design guidelines for FILMTEC™ elements in small commercial applications

Feed source	RO permeate	Softened Municipal	Well water	Surface or Municipal Water
Feed silt density index	SDI < 1	SDI < 3	SDI < 3	SDI < 5
Typical target flux, gfd (l/m^{2}h)	30 (51)	30 (51)	25 (42)	20 (34)
Maximum element recovery %	30	30	25	20
Maximum permeate flow rate, gpd (m^3/d)				
2.5-inch diameter	1,100 (4.2)	1,100 (4.2)	900 (3.4)	700 (2.7)
4.0-inch diameter	3,100 (11.7)	3,100 (11.7)	2,600 (9.8)	2,100 (7.9)
Minimum concentrate flow rate[1], gpm (m^3/h)				
2.5-inch diameter	0.5 (0.11)	0.5 (0.11)	0.7 (0.16)	0.7 (0.16)
4.0-inch diameter	2 (0.5)	2 (0.5)	3 (0.7)	3 (0.7)

Element type	Maximum feed flow rate U.S. gpm (m^3/h)	Maximum pressure drop per element[1] psig (bar)	Maximum feed pressure psig (bar)
Tape-wrapped 2540	6 (1.4)	13 (0.9)	600 (41)
Fiberglassed 2540	6 (1.4)	15 (1.0)	600 (41)
Seawater 2540	6 (1.4)	13 (0.9)	1,000 (69)
Tape-wrapped 4040	14 (3.2)	13 (0.9)	600 (41)
Fiberglassed 4040	16 (3.6)	15 (1.0)	600 (41)
SW Fiberglassed 4040	16 (3.6)	15 (1.0)	1,000 (69)

Notice: The use of this product in and of itself does not necessarily guarantee the removal of cysts and pathogens from water. Effective cyst and pathogen reduction is dependent on the complete system design and on the operation and maintenance of the system.