FILMTEC Membranes

Water Chemistry and Pretreatment: Colloidal and Particulate Fouling Prevention

Assessment of the Colloidal Fouling Potential

Colloidal fouling of RO elements can seriously impair performance by lowering productivity and sometimes salt rejection. An early sign of colloidal fouling is often an increased pressure differential across the system.

The source of silt or colloids in reverse osmosis feed waters is varied and often includes bacteria, clay, colloidal silica, and iron corrosion products. Pretreatment chemicals used in a clarifier such as aluminum sulfate, ferric chloride, or cationic polyelectrolytes are materials that can be used to combine these fine particle size colloids resulting in an agglomeration or large particles that then can be removed more easily by either media or cartridge filtration. Such agglomeration, consequently, can reduce the performance criteria of media filtration or the pore size of cartridge filtration where these colloids are present in the feed water. It is important, however, that these pretreatment chemicals become incorporated into the agglomerates themselves since they could also become a source of fouling if not removed. In addition, cationic polymers may coprecipitate with negatively charged antiscalants and foul the membrane.

Several methods or indices have been proposed to predict a colloidal fouling potential of feed waters, including turbidity, Silt Density Index (SDI) and Modified Fouling Index (MFI). (see Table 2.9) The SDI is the most commonly used fouling index.

Table 2. 9 Various fouling indices

Index	Definition or method
Turbidity	Turbidity is an expression of the optical property of water that causes light to be scattered and absorbed rather than transmitted in straight lines through the sample. Turbidity is caused by suspended and colloidal particulate matter such as clay, silt, finely divided organic and inorganic matter, plankton and other microscopic organisms. Test methods for turbidity of water are described in ASTM D1889 /20/, in ASTM D6698 /21/ and Chapter 2130 of *Standard Methods for the Examination of Water and Wastewater 20th Editions* /1/. Turbidity is often used for online control of particle filtration processes. The turbidity of feed water to RO/NF should be less than 1 NTU as one of the minimum requirements of feedwater.
SDI	The Silt Density Index (SDI) can serve as a useful indication of the quantity of particulate matter in water and correlates with the fouling tendency of RO/NF systems. The SDI is calculated from the rate of plugging of a 0.45 µm membrane filter when water is passed through at a constant applied gauge pressure. The method is described below. For more details refer to *A*STM D4189 /22/. SDI is sometimes referred to as the Fouling Index (FI)
MFI	The Modified Fouling Index (MFI) is proportional to the concentration of suspended matter and is a more accurate index than the SDI for predicting the tendency of a water to foul RO/NF membranes. The method is the same as for the SDI except that the volume is recorded every 30 seconds over a 15 minute filtration period. The MFI is obtained graphically as the slope of the straight part of the curve when t/V is plotted against V (t is the time in seconds to collect a volume of V in liters). For more details refer to Schippers et al. /23/. A MFI value of <1 corresponds to a SDI value of about <3 and can be considered as sufficiently low to control colloidal and particulate fouling. More recently, UF membranes have been used for MFI measurements. This index is called MFI-UF in contrast to the $MFI_{0.45}$ where a 0.45 µm membrane filter is used /24/.

Assessment of the Colloidal Fouling Potential (cont.)

Measuring these indices is an important practice and should be carried out prior to designing an RO/NF pretreatment system and on a regular basis during RO/NF operation (three times a day is a recommended frequency for surface waters).

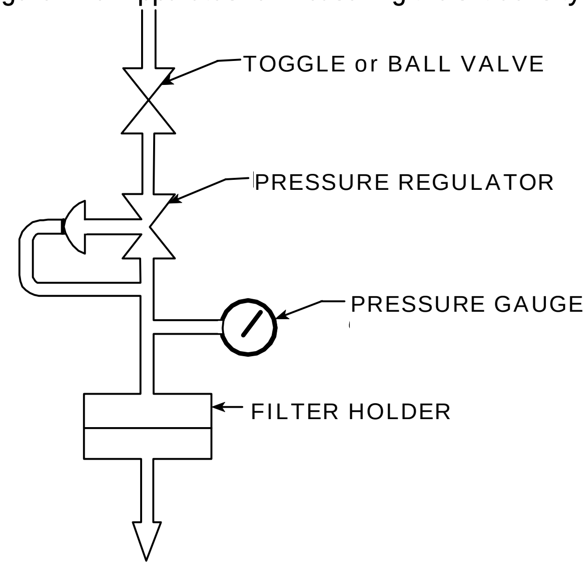
Equipment :

Figure 2.13 shows the equipment needed to measure SDI, including

- 47 mm diameter membrane filter holder
- 47 mm diameter membrane filters (0.45 µm pore size)
- 10–70 psi (1–5 bar) pressure gauge

needle valve for pressure adjustment

Figure 2.13 Apparatus for measuring the silt density index



Procedure

1. Assemble the apparatus as shown in Figure 2.13 and set the pressure regulator at 207 kPa (30 psi or 2.1 bar).
2. Place the membrane filter carefully on its support.
3. Make sure the O-ring is in good condition and properly placed. Replace the top half of the filter holder and close loosely.
4. Bleed out trapped air, close the valve and tighten the filter holder.
5. Open the valve. Simultaneously, using a stopwatch, begin measuring the time required for the flow of 500 ml. Record the time t_i. Leave the valve open for continued flow.
6. Measure and record the times to collect additional 500 mL volumes of sample, starting the collection at 5, 10, and 15 minutes of total elapsed flow time. Measure the water temperature and check the pressure as each sample is collected.
7. After completion of the test, the membrane filter may be retained for future reference. Alternatively, the filter may be left in operation after the test until clogged in order to collect suspended matter for analysis with analytical methods.
8. Calculation:

$$\mathrm{SDI}_T = \left(1 - \frac{t_i}{t_f}\right) \cdot \frac{100}{T}$$

where:

T = total elapsed flow time, min (usually 15 min, see Note)
t_i = initial time required to collect 500 mL of sample, sec
t_f = time required to collect 500 mL of sample after test time T, sec (usually 15 min)

Note: For this test method, 1-(ti/tf) should not exceed 0.75. If 1-(ti/tf) exceeds this value, use a shorter time for T; (i.e., 5 or 10 minute measurements in Step 6).

Assessment of the Colloidal Fouling Potential (cont.)

The guideline is to maintain SDI15 at ≤5. To minimize the fouling, however, SDI_{15} at <3 is recommended. A number of pretreatment technologies have proven effective in SDI reduction, including media filtration (such as sand/anthracite), ultrafiltration and cross-flow microfiltration. Polyelectrolyte addition ahead of filtration sometimes improves SDI reduction.

FILMTEC Membranes
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