FILMTEC Membranes
Water Chemistry and Pretreatment: Scale Control

Acid Addition

Most natural surface and ground waters are almost saturated with $CaCO_3$. The solubility of $CaCO_3$ depends on the pH, as can be seen from the following equation:

$$Ca^{2+} + HCO_3^- \leftrightarrow H^+ + CaCO_3$$

By adding H^+ as acid, the equilibrium can be shifted to the left side to keep calcium carbonate dissolved. Use food-grade quality acid.

Sulfuric acid is easier to handle and in many countries more readily available than hydrochloric acid, however, additional sulfate is added to the feed stream, potentially causing sulfate scaling - see *Calcium Sulfate Scale Prevention (Sections 2.4.3)*, *Barium Sulfate Scale Prevention (2.4.4)*, *Strontium Sulfate Scale Prevention (2.4.5)*.

$CaCO_3$ tends to dissolve in the concentrate stream rather than precipitate. This tendency can be expressed by the Langelier Saturation Index (LSI) for brackish waters and the Stiff & Davis Stability Index (S&DSI) for seawaters. At the pH of saturation (pH_s), the water is in equilibrium with $CaCO_3$.

The definitions of LSI and S&DSI are:

$LSI = pH - pH_s$ (TDS < 10,000 mg/L)

$S\&DSI = pH - pH_s$ (TDS > 10,000 mg/L)

where the methods predicting pH_s are different for LSI and S&DSI - see *Calcium Carbonate Scale Calculation (Section 2.4.2)*.

To control calcium carbonate scaling by acid addition alone, the LSI or S&DSI in the concentrate stream must be negative. Acid addition is useful to control carbonate scale only.

Scale Inhibitor Addition

Scale inhibitors (antiscalants) can be used to control carbonate scaling, sulfate scaling, and calcium fluoride scaling. There are generally three different types of scale inhibitors: sodium hexametaphosphate (SHMP), organophosphonates and polyacrylates.

SHMP is inexpensive but unstable compared to polymeric organic scale inhibitors. Minor amounts adsorb to the surface of microcrystals, preventing further growth and precipitation of the crystals. Food-grade quality SHMP should be used. Care must be taken to avoid hydrolysis of SHMP in the dosing feed tank. Hydrolysis will not only decrease the scale inhibition efficiency, but also create a calcium phosphate scaling risk. Therefore, SHMP is generally not recommended.

Organophosphonates are more effective and stable than SHMP. They act as antifoulants for insoluble aluminum and iron, keeping them in solution. Polyacrylates (high molecular weight) are generally known for reducing silica scale formation via a dispersion mechanism.

Scale Inhibitor Addition (cont.)

Polymeric organic scale inhibitors are also more effective than SHMP. Precipitation reactions may occur, however, with negatively charged scale inhibitors and cationic polyelectrolytes or multivalent cations (e.g., aluminum or iron). The resulting gum-like products are very difficult to remove from the membrane elements. For dosage rates on all antiscalants, please contact the antiscalant manufacturers. Overdosing should be avoided. Make certain that no significant amounts of cationic polymers are present when adding an anionic scale inhibitor.

In RO plants operating on seawater with TDS in the range of 35,000 mg/L, scaling is not as much of a problem as in brackish water plants because the recovery of seawater plants is limited by the osmotic pressure of the concentrate stream to 30-45%. For safety reasons, however, a scale inhibitor is recommended when operating above a recovery of 35%.

FILMTEC™ Membranes
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