FILMTEC Membranes
Water Chemistry and Pretreatment: Calcium Sulphate Scale Prevention

Calcium Sulphate Scale Prevention

For the determination of the calcium sulfate scaling potential, a complete feed water analysis is required.

Calculation /8/

1. Calculate the ionic strength of the concentrate stream (I_c) following the procedure described in *Scaling Calculations General (Section 2.4.1)*:

$$I_c - I_f\left(\frac{1}{1-Y}\right) \qquad \text{Eq. 5}$$

2. Calculate the ion product (IP_c) for $CaSO_4$ in the concentrate stream:

$$IP_c = \left[\left({}^{m}Ca^{2+}\right)_f\left(\frac{1}{1-Y}\right)\right]\left[\left({}^{m}SO_4{}^{2-}\right)_f\left(\frac{1}{1-Y}\right)\right]$$

where:

$({}^{m}Ca^{2+})_f$ = M Ca^{2+} in feed, mol/L

$({}^{m}SO_4{}^{2-})_f$ = M SO_4^{2-} in feed, mol/L

3. Compare IP_c for $CaSO_4$ with the solubility product (K_{sp}) of $CaSO_4$ at the ionic strength of the concentrate stream, Figure 2.6. If $IP_c \geq K_{sp}$, $CaSO_4$ scaling can occur, and adjustment is required. For a safe and conservative pretreatment design, adjustment should be made if $IP_c > 0.8\ K_{sp}$.

Calculation Example (continued from *Scaling Calculations General (Section 2.4.1)*:

$I_c = 0.178$

$IP_c = \left[4\left(5\times10^{-3}\right)\right]\left[4\left(5\times10^{-3}\right)\right] = 4\times10^{-4}$

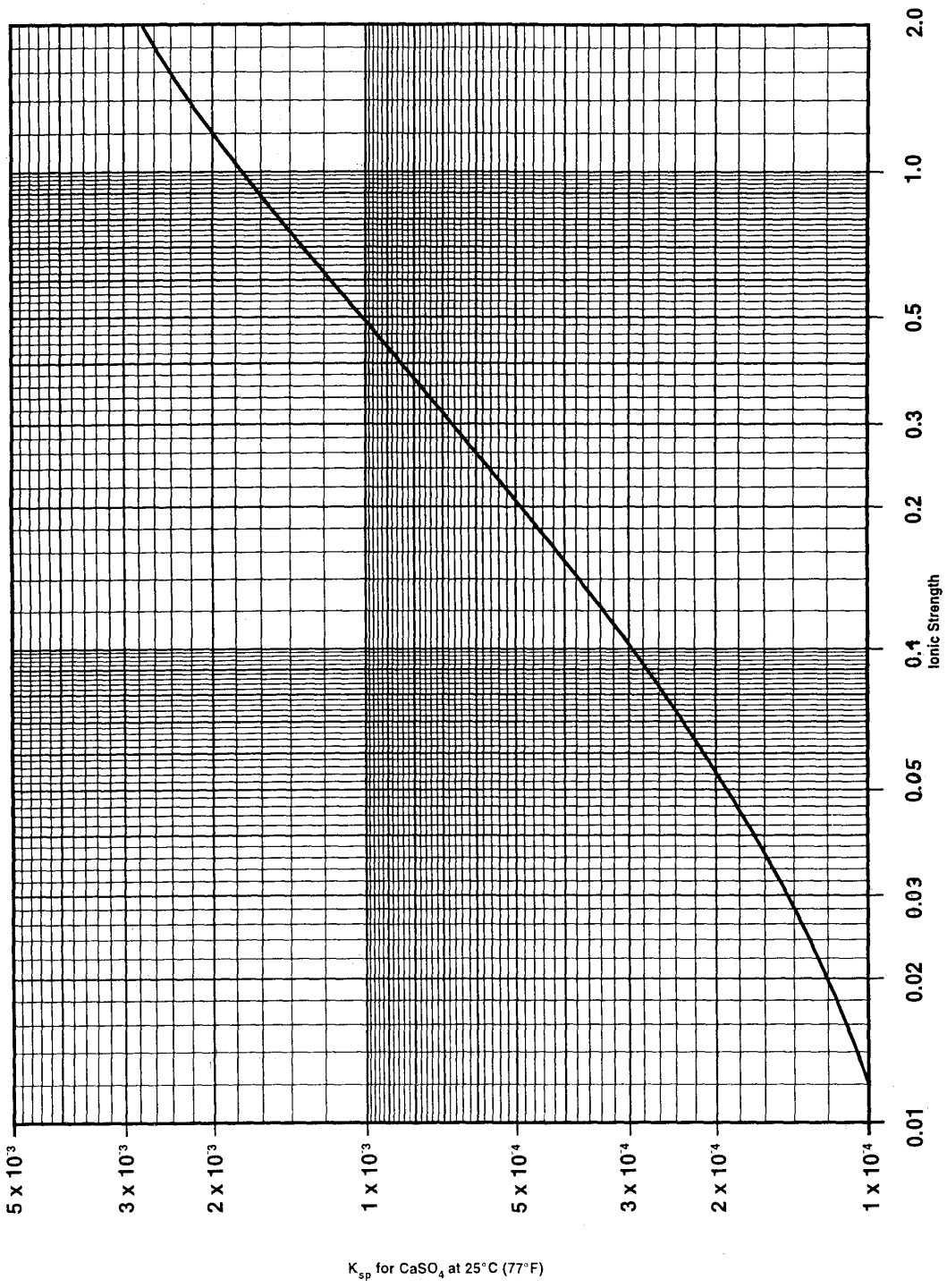
$K_{sp} = 4.4\times10^{-4}$ (from Figure 2.2)

$IP_c = 0.9\ K_{sp}$ therefore adjustments are required.

Adjustments for $CaSO_4$ Scale Control

- If the IP_c for $CaSO_4$ is less than $0.8\ K_{sp}$, a higher recovery can be used with respect to $CaSO_4$ scaling. Reiteration of the calculations at higher recovery can be used to determine the maximum conversion with respect to $CaSO_4$ scaling.
- If the IP_c for $CaSO_4$ is greater than $0.8\ K_{sp}$, a lower recovery must be used to prevent scaling. Reiteration of the calculations at lower recovery can be used to determine the allowable recovery with respect to $CaSO_4$ scaling.
- If the maximum allowable recovery is lower than desired, *strong acid cation exchange resin softening (Section 2.3.4)* or *weak acid cation exchange resin dealkalization (Section 2.3.5)* can be used to remove all or part of the Ca^{2+}. This will permit higher recovery of the reverse osmosis system with respect to $CaSO_4$ scaling.
- Lime softening with lime or lime plus soda ash (see *Liming Softening, Section 2.3.6*) will decrease the Ca^{2+} concentration and thus permit higher recovery with respect to scaling by $CaSO_4$.
- Addition of a scale inhibitor to the feed stream permits operation of the RO system above the K_{sp} value, when adequate scale inhibitor is added according to the scale inhibitor manufacturer's instructions.

Figure 2.6 Ksp for $CaSO_4$ versus ionic strength /9/



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