3-5. Silica Scale Prevention

In addition to $BaSO_4$ scaling, silica scale is also difficult to redissolve. Thus silica scaling has to be prevented. The presence of Al^{3+} and Fe^{3+} complicates the silica scaling via formation of insoluble aluminum and iron silicates. Therefore, if a silica scaling potential exists, aluminum and iron must be removed by 1 μm cartridge filtration and preventive acid cleanings.

The calculation of the silica scaling potential requires the following data of the feed solution : SiO_2 concentration, temperature, pH and total alkalinity.

The SiO_2 concentration in the concentrate stream is calculated from the SiO_2 concentration in the feed solution and the recovery of the RO system :

$$SiO_{2c} = SiO_{2f} \times \frac{1}{1-Y}$$

where SiO_{2c} = silica concentration in concentrate as SiO2 in mg/L
SiO_{2f} = silica concentration in feed as SiO2 in mg/L
Y = recovery of the RO system expressed as a decimal

Calculate the pH of the concentrate stream from the pH of the feed stream using the following equation.

$$pH = \log_{10}\left(\frac{[\text{alkalinity as } CaCO_3]}{[CO_2]}\right) + 6.3$$

$$[\text{ Alkalinity }]_c = \frac{[\text{ Alkalinity }]_f}{1-Y}$$

$$[CO_2]_c = [CO_2]_f$$

Obtain the solubility of SiO_2 as a function of temperature. Temperature of the concentrate is assumed equal to temperature of feed solution.

Example are shown in the following table :

T(°C)	Solubility of SiO2 (mg/L)
5	85
10	96
15	106
20	118
25	128
30	138
35	148

Obtain the pH correction factor for the concentrate pH.

Since the solubility of silica increases below a pH of about 7.0 and above a pH of about 7.8, the actual solubility of SiO_2 in the concentrate stream can be further affected by the pH of the concentrate stream and thus is obtained by multiplying the solubility of SiO_2 at a specific temperature by the pH correction factor to give the corrected solubility (SiO_{2cor}).

For examples, pH correction factor are 1.0 at pH 7.8 and 1.5 at pH 8.5, respectively. See ASTM D4993-89 for more details. Compare the silica concentration in the concentrate (SiO_{2c}) of the RO system with the pH corrected silica solubility (SiO_{2cor}). If SiO_{2c} is greater than SiO_{2cor}, silica scaling can occur and adjustment is required.

The easiest way to prevent the silica scaling is to lower recovery. Reiteration of the calculations can be used to optimize recovery with respect to silica scaling, once a reverse osmosis system is operating.

Lime plus soda ash softening can be used in the pretreatment system to decease the SiO_2 concentration in the feed stream. The maximum allowable recovery against silica scaling can be increased significantly by increasing the water temperature using a heat exchanger.

A dispersant such as high molecular weight polyacrylate scale inhibitor is helpful in silica scale control by slowing agglomeration of scale particulate.