Designation: D 4993 – 89 (Reapproved 2003)

Standard Practice for Calculation and Adjustment of Silica (SiO_2) Scaling for Reverse Osmosis[1]

This standard is issued under the fixed designation D 4993; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the calculation and adjustment of silica (SiO_2) for the concentrate stream of a reverse osmosis system. The calculations are used to determine the need for scale control in the operation and design of reverse osmosis installations. This practice is applicable for all types of reverse osmosis devices (tubular, spiral wound, and hollow fiber).

1.2 This practice is applicable to both brackish waters and seawaters.

1.3 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

D 859 Test Method for Silica in Water[2]

D 1067 Test Methods for Acidity or Alkalinity of Water[2]

D 1129 Terminology Relating to Water[2]

D 1293 Test Methods for pH of Water[2]

D 3739 Practice for Calculation and Adjustment of Langelier Saturation Index for Reverse Osmosis[3]

D 4194 Test Methods for Operating Characteristics of Reverse Osmosis and Nanofiltration Devices[3]

3. Terminology

3.1 For definitions of terms relating to water used in this practice, refer to Terminology D 1129. For terms relating to reverse osmosis, refer to Test Methods D 4194.

4. Summary of Practice

4.1 This practice consists of calculating the potential for scaling by SiO_2 in a reverse osmosis concentrate stream from the concentration of SiO_2 in the feed solution and the recovery of the reverse osmosis system.

4.2 This practice also presents techniques to eliminate scaling by decreasing the recovery, decreasing the SiO_2 concentration in the feedwater, adjusting the pH of the feedwater, and increasing the temperature of the feedwater.

5. Significance and Use

5.1 In the design and operation of reverse osmosis installations, it is important to predict the SiO_2 scaling properties of the concentrate stream. Because of the increase in the concentration of SiO_2 and the change in pH, the scaling property of the concentrate stream will be quite different from that of the feed solution. This practice permits the calculation of the scaling potential for the concentrate stream from the feedwater analysis and the reverse osmosis operating parameters.

5.2 Scaling by SiO_2 will adversely affect the reverse osmosis performance. This practice gives various procedures for the prevention of scaling.

5.3 The presence of certain metals, for example, Al^{+3}, may significantly alter the solubility of SiO_2 via formation of insoluble metal silicates. This practice does not address this phenomena.

6. Procedure

6.1 Determine the concentration of SiO_2 in the feed stream in accordance with Test Method D 859.

6.2 Measure the temperature of the feed solution.

6.3 Measure the pH of the feed solution using Test Methods D 1293.

NOTE 1—If acid is used for control of $CaCO_3$ scale, measure the pH after acid addition.

6.4 Determine the total alkalinity of the feed solution using Test Methods D 1067 and express as $CaCO_3$.

NOTE 2—If acid is used for control of calcium carbonate ($CaCO_3$) scale, determine the total alkalinity after acid addition.

[1] This practice is under the jurisdiction of ASTM Committee D19 on Water and is the direct responsibility of Subcommittee D19.08 on Membranes and Ion Exchange Materials.

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[2] *Annual Book of ASTM Standards*, Vol 11.01.

[3] *Annual Book of ASTM Standards*, Vol 11.02.