



Designation: D 4692 – 87 (Reapproved 1996)

AMERICAN SOCIETY FOR TESTING AND MATERIALS
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Standard Practice for Calculation and Adjustment of Sulfate Scaling Salts (CaSO₄, SrSO₄, and BaSO₄) for Reverse Osmosis¹

This standard is issued under the fixed designation D 4692; 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 calcium, strontium, and barium sulfates 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.

2. Referenced Documents

2.1 ASTM Standards:

D 511 Test Methods for Calcium and Magnesium in Water²

D 516 Test Method for Sulfate Ion in Water²

D 1129 Terminology Relating to Water²

D 3352 Test Method for Strontium Ion in Brackish Water, Seawater, and Brines³

D 4194 Test Methods for Operating Characteristics of Reverse Osmosis Devices³

D 4195 Guide for Water Analysis for Reverse Osmosis Application³

D 4382 Test Method for Barium in Water, Atomic Absorption Spectrophotometry, Graphite Furnace²

3. Terminology

3.1 *Definitions*—For definitions of terms used in this practice, refer to Terminology D 1129.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 For definitions of terms relating to reverse osmosis, refer to Test Methods D 4194.

4. Summary of Practices

4.1 This practice consists of calculating the potential for scaling by CaSO₄, SrSO₄, and BaSO₄ in a reverse osmosis concentrate stream from the concentration of Ca⁺⁺, Sr⁺⁺, Ba⁺⁺, and SO₄⁼ 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, by decreasing the Ca⁺⁺, Sr⁺⁺, and Ba⁺⁺ concentrations in the feed water, and by addition of scale inhibitors.

5. Significance and Use

5.1 In the design and operation of reverse osmosis installations, it is important to predict the CaSO₄, SrSO₄, and BaSO₄ scaling properties of the concentrate stream. Because of the increase in total dissolved solids and the increase in concentration of the scaling salts, the scaling properties of the concentrate stream will be quite different from those of the feed solution. This practice permits the calculation of the scaling potential for the concentrate stream from the feed water analyses and the reverse osmosis operating parameters.

5.2 Scaling by CaSO₄, SrSO₄, and BaSO₄ will adversely affect the reverse osmosis performance. This practice gives various procedures for the prevention of scaling.

6. Procedure

6.1 Determine the concentrations of Ca⁺⁺, Sr⁺⁺, Ba⁺⁺, and SO₄⁼ in the feed stream in accordance with Test Methods D 511, D 3352, D 4382, and D 516, respectively.

NOTE 1—If H₂SO₄ is used for control of CaCO₃ scale, measure the SO₄⁼ after acid addition.

6.2 Determine the concentration of all major ions using the appropriate methods given in Guide D 4195. At a minimum, the concentrations of Mg⁺⁺, Na⁺, HCO₃⁼, and Cl⁼ must be determined.

7. Calculation

7.1 Calculate the calcium concentration in the concentrate stream from the calcium concentration in the feed solution, from the recovery of the reverse osmosis system, and from the calcium ion passage as follows:

$$Ca_c = Ca_f \times \frac{1 - Y(SP_{Ca})}{1 - Y}$$

where:

Ca_c = calcium ion concentration in concentrate, mg/L,

Ca_f = calcium ion concentration in feed, mg/L,

Y = recovery of the reverse osmosis system, expressed as a decimal, and

¹ This practice is under the jurisdiction of ASTM Committee D-19 on Water and is the direct responsibility of Subcommittee D 19.08 on Membranes and Ion Exchange Materials.

Current edition approved May 29, 1987. Published July 1987.

² Annual Book of ASTM Standards, Vol 11.01.

³ Annual Book of ASTM Standards, Vol 11.02.