



Designation: D 4516 – 00

Standard Practice for Standardizing Reverse Osmosis Performance Data¹

This standard is issued under the fixed designation D 4516; 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 approval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This practice covers the standardization of permeate flow and salt passage data for reverse osmosis (RO) systems.

1.2 This practice is applicable to waters including brackish waters and seawaters but is not necessarily applicable to waste waters.

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 1129 Terminology Relating to Water²

D 4194 Test Methods for Operating Characteristics of Reverse Osmosis Devices³

D 6161 Terminology Used for Crossflow Microfiltration, Ultrafiltration and Reverse Osmosis Membrane Processes³

3. Terminology

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

3.2 For description of terms relating to reverse osmosis, refer to Test Method **D 4194** and Terminology **D 6161**.

4. Summary of Practice

4.1 This practice consists of calculating the permeate flow and salt passage of RO systems at a standard set of conditions using data obtained at actual operating conditions.

5. Significance and Use

5.1 During the operation of an RO system, system conditions such as pressure, temperature, conversion, and feed concentration can vary, causing permeate flow and salt passage

to change. To effectively evaluate system performance, it is necessary to compare permeate flow and salt passage data at the same conditions. Since data may not always be obtained at the same conditions, it is necessary to convert the RO data obtained at actual conditions to a set of selected constant conditions, thereby standardizing the data. This practice gives the procedure to standardize RO data.

5.2 This practice can be used for both spiral wound and hollow fiber systems.

5.3 This practice can be used for a single element or a multi-element system. However, if the RO system is brine staged, that is, the brine from one group of RO devices is the feed to a second group of RO devices, standardize the permeate flow and salt passage for each stage separately.

5.4 This practice is applicable for reverse osmosis systems with high rejections and with no significant leaks between the feed-brine and permeate streams.

6. Procedure

6.1 *Standardization of Permeate Flow:*

6.1.1 Calculate the permeate flow at standard conditions using Eq 1:

$$Q_{ps} = \frac{\left[P_{fs} - \frac{\Delta P_{fbs}}{2} - P_{ps} - \pi_{fbs} + \pi_{ps} \right] (TCF_s)}{\left[P_{fa} - \frac{\Delta P_{fba}}{2} - P_{pa} - \pi_{fba} + \pi_{pa} \right] (TCF_a)} (Q_{pa}) \quad (1)$$

where:

- Q_{ps} = permeate flow at standard conditions,
- P_{fs} = feed pressure at standard conditions, kpa,
- $\frac{\Delta P_{fbs}}{2}$ = one half device pressure drop at standard conditions, kpa,
- P_{ps} = permeate pressure at standard conditions, kpa,
- π_{fbs} = feed-brine osmotic pressure at standard conditions, kpa,
- π_{ps} = permeate osmotic pressure at standard conditions, kpa,
- TCF_s = temperature correction factor at standard conditions,
- Q_{pa} = permeate flow at actual conditions,
- P_{fa} = feed pressure at actual conditions, kpa,
- $\frac{\Delta P_{fba}}{2}$ = one half device pressure drop at actual conditions, kpa,

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.

Current edition approved Jan. 10, 2000. Published April 2000. Originally published as D 4516 – 85. Last previous edition D 4516 – 85 (1994).

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

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