Designation: ~~D4516 – 19~~ D4516 – 19a

Standard Practice for Standardizing Reverse Osmosis Performance Data[1]

This standard is issued under the fixed designation D4516; 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 standardization of permeate ~~flow and salt passage~~ flow, salt passage, and coefficient of performance 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 The values stated in SI units are to be regarded as standard. No other units of measurement are included in this standard.

1.4 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 *ASTM Standards:*[2]

D1129 Terminology Relating to Water

D4194 Test Methods for Operating Characteristics of Reverse Osmosis and Nanofiltration Devices

D6161 Terminology Used for Microfiltration, Ultrafiltration, Nanofiltration, and Reverse Osmosis Membrane Processes

[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] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

3. Terminology

3.1 *Definitions:*

3.1.1 For definitions of terms used in this standard, refer to Terminologies D1129 and D6161.

3.1.2 For description of terms relating to RO, refer to Test Methods D4194 and Terminology D6161.

4. Summary of Practice

4.1 This practice consists of calculating the permeate ~~flow and~~ flow, salt passage of RO ~~systems~~ systems, and coefficient of performance of RO 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 RO 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:

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

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,~~
$\frac{\Delta P_{fbs}}{2}$ = 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,~~
$\frac{\Delta P_{fba}}{2}$ = one-half device pressure drop at actual conditions, kPa,
P_{pa} = permeate pressure at actual conditions, kPa,
π_{fba} = feed-brine osmotic pressure at actual conditions, kPa,
π_{pa} = permeate osmotic pressure at actual conditions, kPa, and
TCF_a = temperature correction factor at actual conditions.

6.2 *Standardization of Salt Passage:*

6.2.1 Calculate the salt passage at standard conditions using Eq 2:

~~$$\%\,SP_s = [EPF_a/EPF_s] \times [STCF_a/STCF_s] \times (C_{fbs}/C_{fba}) \times (C_{fa}/C_{fs}) \times \%SP_a \quad (2)$$~~

$$\%\,SP_s = (EPF_a/EPF_s) \times (STCF_s/STCF_a) \times (C_{fbs}/C_{fba}) \times (C_{fa}/C_{fs}) \times \%\,SP_a \quad (2)$$

where:

$\%\,SP_s$ = percent salt passage normalized to standard (reference) conditions,
$\%\,SP_a$ = percent salt passage at actual conditions,