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ASSE International

Reverse Osmosis Water Efficiency – Drinking Water

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ASSE International
Mokena, Illinois

Foreword

This foreword shall not be considered a part of the standard, however it is offered to provide background information.

ASSE Standards are developed in the interest of consumer safety.

Residential Reverse Osmosis water treatment systems provide an excellent means to reduce contaminants found in drinking water. To function properly, these systems need a certain amount of rinse water that is typically sent to drain. Manufacturers of RO systems and components have been working to improve the efficiency of RO systems by reducing the amount of rinse water needed. The spirit of this standard is to aid water conservation efforts by providing manufacturers an efficiency target for their RO system designs.

Recognition is made of the time volunteered by members of the Working Group and of the support of the manufacturers who also participated in the meetings for this standard.

This standard does not imply ASSE's endorsement of a product which conforms to these requirements.

Compliance with this standard does not imply acceptance by any code body.

These products are meant for residential point-of-use locations, not point-of-entry.

It is recommended that these devices be installed consistent with local codes by qualified and trained professionals. It is recommended that these devices be replaced and serviced in accordance with the manufacturer’s instructions. Replacement of filters and RO membrane is essential for proper function of the device.

This standard was promulgated in accordance with procedures developed by the American National Standards Institute (ANSI).

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Reverse Osmosis Water Efficiency – Drinking Water

1. General

1.1 Application

Residential Reverse Osmosis (RO) systems are used to treat drinking water. RO water treatment equipment reduces total dissolved solids, heavy metals, inorganics, and organics water contaminants. RO's are typically installed under or below the kitchen sink, however counter top and free-standing models are also used in the market.

1.2 Scope

1.2.1 Description

This standard covers water efficiency, automatic shut-off valves, and flow restrictor requirements for Residential RO systems and performance testing to address the membrane life concerns of high efficiency RO membranes. This standard includes test requirements for complete systems or components (RO membrane, automatic shut off valve, flow restrictor). RO systems typically consist of the following components:

System Manifold
RO Membrane
Pre- and Post-filtration assemblies
Supply Connection
Drain Connection
Storage Tank (e.g. atmospheric tank, captive air tank)
Faucet or dispensing valve
Check valves
Push fit fittings
Tubing
Tank backpressure reduction mechanism (e.g. permeate pump) (optional)
Booster pump (optional)

A shut-off device is a required component for system compliance to this standard. Systems that incorporate a flushing mechanism are acceptable. The volume of water used for flushing during normal operation is a part of reject water. This does not include water used for pre-conditioning during system startup.

1.2.2 Flow Range

Residential RO systems use a variety of membrane sizes based on the design of the system. There is no limitation on flow rate for the system.

Note: Refer to ASSE 1087 for requirements for commercial systems.

1.2.3 Pressure Range

Systems and components shall be able to operate under static pressures of 20 - 120 psi (138 - 827 kPa).

1.2.4 Temperature Range

Systems and components shall be able to operate with water temperatures of 39 - 100 °F (3.9 - 37.8 °C)

1.3 Reference Documents

Referenced industry standards shall be to the revision stated below.

- ASSE 1087-2018, Commercial and Food Service Water Treatment Equipment Utilizing Drinking Water
- NSF/ANSI 42-2019, Drinking Water Treatment Units – Aesthetic Effects
- NSF/ANSI 53-2018, Drinking Water Treatment Units – Health Effects
- NSF/ANSI 58-2018, Reverse Osmosis Drinking Water Treatment Systems
- NSF/ANSI 61-2019, Drinking Water System Components – Health Effects
- NSF/ANSI 330-2018, Glossary of Drinking Water Treatment Unit Terminology
- Standard Methods For the Examination of Water and Wastewater, 23rd. 2510 CONDUCTIVITY (2017) https://doi.org/10.2105/SMWW.2882.027
- Standard Methods For the Examination of Water and Wastewater, 23rd. 2540 SOLIDS (2017) https://doi.org/10.2105/SMWW.2882.030

2. Test Specimens and Test Laboratory

Sample selection and scope of testing shall be as required by the laboratory or certification body.

3. Performance Requirements and Compliance Testing

3.1 Membrane Life Test for High Efficiency Membrane Systems

3.1.1 Purpose

This test determines a system's membrane's potential or resistance to hard water scaling. This section shall not be required if section 3.3 will be performed.

3.1.2 Procedure

(1) Install the system in accordance with the manufacturer's instructions.
(2) Create the influent challenge water with the characteristics in Table 1.

Table 1 - Constituents of influent challenge water.

Note: This challenge water has been created to achieve a Langelier Saturation Index (LSI) of 0.7. While preparing the challenge water, be aware that the pH may rise.

TDS	1000 mg/L ± 10%
Hardness (as $CaCO_3$)	340 mg/L ± 10%
pH	7.3 ± 0.3
Alkalinity (as $CaCO_3$)	120 mg/L ± 10%
Temperature	77 ± 2 °F
Pressure	50 ± 3 psi

Calcium chloride shall be used to increase hardness.
Sodium bicarbonate shall be to increase alkalinity.
Sodium chloride shall be used to increase TDS.
Hydrochloric acid shall be used to lower the pH, and sodium hydroxide shall be used to raise the pH.

(3) Measure and record the constituents of the influent challenge water at the beginning of each day.
(4) Flow water through the system for 4 hours of operation. For tank-type systems, after 4 hours with the storage tank empty measure and record the TDS reduction, permeate flow rate, and percent recovery. TDS may be measured per Standard Methods by Conductivity (2510) or Standard Methods by Solids (2540). Calculate the percent of recovery by collecting 100mL of permeate and the corresponding reject water volume.

$$\%\,recovery = \frac{100mL\ permeate}{reject\ volume + 100mL\ premeate} \times 100\%$$

$$reject\ volume = reject\ flow\ rate\ \times time\ to\ 100mL$$

$$time\ to\ 100mL = permeate\ flow\ rate(Lpm) \times 0.1L$$

Equation 1 – Calculation of percent recovery. Example: If 100mL permeate collected corresponds to 75 mL of reject water collected at the same time, the percent recovery = 100mL / (75mL + 100mL) x 100% = 57%

$$\%\ TDS\ Reduction = \frac{TDS\ influent}{TDS\ effluent} \times 100\%$$

Equation 2 – Calculation of percent total dissolved solids reduction.

(5) Run the system with the outlet open for an additional 12 hours. Close the outlet for an 8-hour rest period to allow the storage tank in tank-type systems to fill and shut off.
(6) At the beginning of the next day once the faucet or tap is initially turned on after the 8-hour rest period, measure and record the TDS reduction, permeate flow rate, and percent recovery
(7) Repeat sections 3.1.2(4) through 3.1.2(6) for a minimum of 20 days and produce a minimum total product volume of 1000gal (3785 L).

An example test results table is provided as reference in Annex A.

3.1.3 Criteria

(1) The percent TDS reduction shall be a minimum of 75% each day.
(2) The flow rate shall not decrease by more than 50% of the Day 1 reading throughout the test.
(3) The system recovery shall be on average a minimum of 40%. One tenth of the sample readings may be less than 40% and no less than 30%. The final recovery measurement shall be at minimum of 40%.

3.2 System Efficiency

3.2.1 Purpose

The purpose of this test is to determine the RO system's water efficiency. This section applies only to complete systems being evaluated under this standard.

3.2.2 Procedure

See "TDS reduction, recovery rating, and efficiency rating claims" section in NSF/ANSI 58.

3.2.3 Criteria

Minimum efficiency shall be 40% or the manufacturer's claimed efficiency, whichever is greater per the results of NSF/ANSI 58.

3.3 Membrane Life Test for High Efficiency Membranes

3.3.1 Purpose

This test determines the membrane's potential or resistance to hard water scaling. This is a test of the membrane separately from a system. The section shall not be required if section 3.1 has been performed.

3.3.2 Procedure

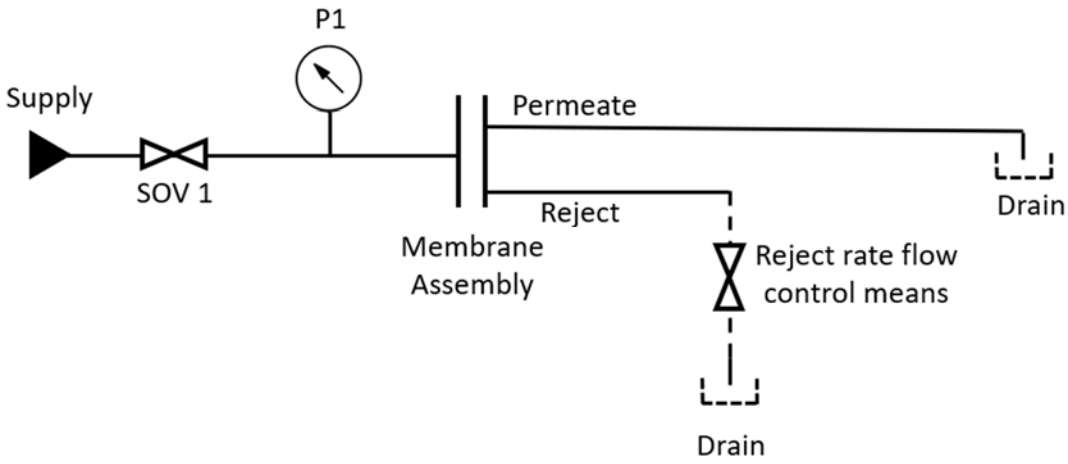

Figure 1 – Membrane Life Test Setup

The membrane supplier shall specify the recovery rate for the test.

Install two RO elements according to the manufacturer's instructions, and Figure 1. Use a method (e.g. needle valve, capillary tube, etc.) to control the reject flow rate to the drain.

Note: RO elements shall be tested in housings specified or agreed to by the element manufacturer.

Perform the test procedure defined in section 3.1.2. Periodically inspect and clean or replace the reject flow rate control means to ensure that it is not scaling.

Note: With accelerated testing with this challenge water, there may be scale deposits that dislodge and restrict the reject flow rate and change the backpressure. A strainer or other method may be used to protect the flow control means.

3.3.3 Criteria

The criteria shall be the same as in section 3.1.3.

3.4 Structural Integrity

Structural integrity testing shall be compliant with NSF/ANSI 58.

3.5 Contaminant Reduction

Contaminant reduction testing shall be compliant with NSF/ANSI 58.

4. Detailed Requirements

4.1 Materials

Materials shall comply with NSF/ANSI 42, NSF/ANSI 53, NSF/ANSI 58 or NSF/ANSI 61.

4.2 Documentation

4.2.1 Drawings

Assembly drawings, schematics and other data which is helpful to the installer and needed by the testing agency to determine compliance with this standard shall accompany the product or otherwise be provided when submitted for examination and testing under this standard.

4.2.2 Installation Instructions

Instructions for installation, maintenance and testing shall be packaged with the device. These instructions shall include:

(1) Information necessary to allow a correct installation, show the correct installation position, and filter replacements process.
(2) System recovery performance and rated water efficiency rating shall be stated on the specification sheet and installation manual per NSF/ANSI 58.
(3) Supply and drain fittings shall be installed per local plumbing codes. Directions to use a saddle valve and other device that pierces drain fittings shall not be allowed in the installation instruction.
(4) The statement: "An air gap device shall be used to connect the reject water outlet to a drain connection."
(5) The device shall be installed in an accessible location and sized per local plumbing codes.

4.2.3 Specification Sheet

System recovery performance and rated water efficiency rating shall be stated on the specification sheet.

4.2.4 Maintenance

RO systems require proper maintenance to continue functioning. Detailed instructions on how to change, and the recommended frequency of changing the pre-filter(s), post-filter(s) and membrane(s) shall be provided.

4.3 Markings

Each device shall have the following information marked on it where it shall be intended to be visible after the device has been installed:

(1) Name of manufacturer or trademark
(2) Type and model number of the device
(3) Rated water efficiency of the RO system

5. Definitions

Definitions in the standard shall take precedence over any other publication. Definitions not shown are found in the Plumbing Dictionary (applicable edition) published by ASSE or by NSF/ANSI 330.

Air Gap	A clear vertical space between the end of the water treatment device's drainline and the flood level rim of a receptacle which holds water.
Atmospheric Tank	Water storage tank that does not use compressed air to push water out of the tank.
Booster Pump	Electric water pump used to increase the water supply pressure.
Captive Air Tank	Water storage tank that includes a bladder to separate water from air. As water fills the tank air is compressed on the other side of the bladder. The compressed air is used to push water out of the tank.
Efficiency Rating	The percentage of the influent water to reverse osmosis system that is available to the user as treated water under operating conditions that approximate typical use. (From NSF/ANSI 330)
Flushing	Rinsing the membrane element without producing product water or permeate.
Permeate Pump	A pump that stores the hydro power of the brine, the reject water, and uses the energy to power the permeate under pressure into the unit's storage tank. Used with a captive air tanks to reduce backpressure.
Permeate Water	Water that has passed through the RO membrane intended for use or drinking.
Recovery Rating	In membrane filtration, the figure obtained (expressed as a percent) by dividing the volume (gallons or liters) of product water produced by the total volume (gallons or liters) of feedwater fed to the particular unit or system.
Reject Water	Water that is prevented from passing through the RO membrane not intended for use or drinking.
RO Membrane	Semipermeable membrane used in RO Systems.
RO System	A water treatment process that removes undesirable materials from water by using pressure to force the water molecules through a semipermeable membrane.
Shut-off device	This device prevents reject water when the system is not treating water.

6. Annex A (informative)

The following is an example results table for section 3.1.

Sample ___ of 2. Starting date: _____. End date: _____.

		Challenge Water Constituents							System Performance			
Day	Hour	TDS	Hardness	pH	Alkalinity	Temperature	Pressure	TDS (ppm)	% TDS Reduction	Permeate Flow Rate (L/min)	Reject Flow Rate (L/min)	% Recovery
1	0											
1	4											
2	0											
2	4											
3	0											
3	4											
4	0											
4	4											
5	0											
5	4											
6	0											
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18	0											
18	4											
19	0											
19	4											
20	0											
20	4											

7. Annex B (informative)

The following is a recommended method of evaluation for conformity assessment.

7.1 Test Plan

Membrane element test samples may be provided with an appropriate housing in order to complete section 3.3.

The number of test units needed for each of these tests is shown in Table 2. Test units may be used for multiple tests as appropriate.
The number of units required for section 3.4 and 3.5 is defined by NSF/ANSI 58.
The number of units required for section 4.1 is defined by the referenced standards in that section.

Table 2

Section	Number of test units
3.1	2
3.2	2
3.3	2
3.5	2

7.2 Documentation

Assembly drawings, installation instructions and other data which are needed to enable a testing agency to determine compliance with this standard shall be provided when submitted for examination and performance tests under this standard.

7.3 Rejection

Failure of 1 device shall result in a rejection of that type, model and size.

7.4 Product Bracketing for Systems

Testing of a representative model may be used for compliance conformation of similarly designed products that differ in membrane size, number of pre- and post-filters or tank size. The following requirements shall be used for product bracketing:

1. The system contains similar components and design pertaining to manifold design, reject flow restrictor, recovery, shut-off valve, and storage tank type and size.
2. If the membrane is available in multiple sizes, the largest membrane size shall be used for testing the bracketed family.
3. If the storage tank is available in multiple sizes, the smallest storage tank shall be used for testing.
4. The membrane elements or sheets are produced by the same manufacturer.
5. The membranes are produced using the same process, chemistry, and identical materials.
6. The membrane's specification and tolerances pertaining to nominal pore size and distribution are identical.
7. The water efficiency of the bracketed systems shall use the equivalently sized or more restrictive flow restrictor to provide an equivalent or greater water efficiency rating as the tested system.