Table 3 Recommended Crossflow Rates

	Crossflow	ΔP*
"HP" Screen	5-8 L/min/m^2	15 psi (1 bar)
"LP" Screen	5-8 L/min/m^2	10 psi (0.7 bar)
"S" Channel	9-15 L/min/m^2	1.5 psi (0.1 bar)
* Typical ΔP measured with water and permeate closed		

Table 4 Maximum Recommended Operating Pressures

Maximum Operating Pressures at 30°C	
Forward	100 psi (7 bar)
Reverse	7 psi (0.48 bar)

Table 5 Air Integrity Test Specification

Air Diffusion Rates	
Ultrafiltration 1kD thru 5kD	≤ 323 sccm/m^2 @ 15 psi (1 bar)
Ultrafiltration 10kD thru 300kD	≤ 323 sccm/m^2 @ 7.3 psi (0.5 bar)
Microfiltration ≥ 0.1 um	≤ 323 sccm/m^2 @ 3 psi (0.2 bar)

Maximum Operating Temperature 50°C

CHEMICAL COMPATIBILITY

TangenX membrane cassettes are compatible with the following:

- ACN (<15%)
- DMF, DMSO (<40%)
- DMAC (<15%)
- Phosphoric acid (<1M)
- Sodium Hypochlorite (<400ppm)
- Sodium Hydroxide (<0.5M)

TangenX membrane cassettes are NOT compatible with the following:

- Pure aromatic and chlorinated hydrocarbons
- Ketones
- Polar aromatics
- Aliphatic esters

A more comprehensive list is available in the cassette validation guide.

CAUTION

In the event that the cassette is subjected to any of the conditions listed below, it is recommended that you perform both cassette integrity and water flux tests to ensure your cassette is not damaged. Damage may occur as a result of the following:

- Dropping on hard surfaces, or other mechanical shock.
- Poking with sharp objects on screened surfaces
- Excessive feed pressure.
- Excessive permeate backpressure, or pressurizing the filtrate port.
- Exposure to harsh chemicals.
- Freezing.
- Excessive heat.
- Drying out – ultrafiltration or microfiltration membrane that is allowed to dry out can permanently damage the pore structure.

MEMBRANE CASSETTES MUST REMAIN WET AT ALL TIMES TO MAINTAIN PRODUCT INTEGRITY AND PERFORMANCE.

FOR TECHNICAL SUPPORT OR ORDER ASSISTANCE PLEASE CALL YOUR LOCAL SALES REPRESENTATIVE.

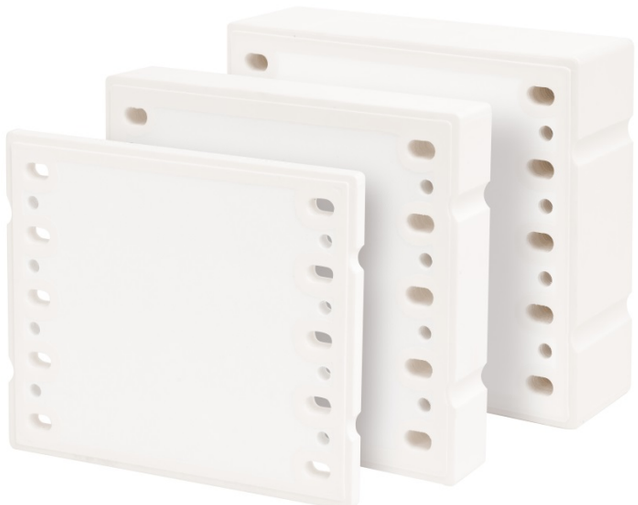
REPLIGEN TANGENX™ STANDARD WARRANTY

Repligen Corporation warrants its TangenX™ products will meet their applicable published specifications when used in accordance with their applicable instructions for a period of one year from shipment of the products. **REPLIGEN MAKES NO OTHER WARRANTY, EXPRESSED OR IMPLIED. THERE IS NO WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE.** The warranty provided herein and the data, specifications and descriptions of Repligen TangenX™ products appearing in published catalogues and product literature may not be altered except by express written agreement signed by an officer of Repligen. Representations, oral or written, which are inconsistent with this warranty or such publications are not authorized and if given, should not be relied upon.

In the event of a breach of the foregoing warranty, Repligen's sole obligation shall be to repair or replace, at its option, the applicable product or part thereof, provided the customer notifies Repligen promptly of any such breach. If after exercising reasonable efforts, Repligen is unable to repair or replace the product or part, then Repligen shall refund to the customer all monies paid for such applicable product or part. **REPLIGEN SHALL NOT BE LIABLE FOR CONSEQUENTIAL, INCIDENTAL, SPECIAL OR ANY OTHER DAMAGES RESULTING FROM ECONOMIC LOSS OR PROPERTY DAMAGE SUSTAINED.**

TangenX™ PRO Cassette

USER GUIDE



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PRODUCT CONTENTS

Package includes the following:

1. TangenX™ PRO membrane filtration cassette: product consists of either a 0.5 m^2 (5 ft^2) cassette, 1.5m^2 (15ft^2), or a 2.5 m^2 (25 ft^2) block cassette
2. Silicone gaskets

IMPORTANT INFORMATION BEFORE YOU BEGIN

CASSETTES

- Cassettes may be stacked to increase filtration surface area; however, use only one type of membrane molecular weight cutoff at one time. *Do not install a mixture of cassettes with different pore sizes in the hardware.*
- Cassettes must be flushed with deionized (DI) water or water for injection (WFI) to ensure removal of storage agents and preservatives from the membrane filter. It is critical to use the highest quality water possible to avoid fouling the membrane or introducing contaminants into the system that could affect membrane performance and product recovery.

GASKETS

- Gaskets lose their resiliency over time. Repligen recommends that you replace gaskets a minimum of every six months. Repligen supplies two gaskets per cassette. Installation of the first cassette requires two gaskets; stacking additional cassettes requires only one gasket. Extra gaskets should be saved to replace worn or damaged gaskets.

PUMP

- When using TangenX™ cassettes, select a pump with adequate capacity. Crossflow rate ranges (see Table 3) are feed channel type and process fluid dependent.

MEMBRANE CASSETTE INSTALLATION

1. Lift the end plate off the manifold.
2. Rinse the silicone gaskets with deionized water or WFI. Place a rinsed gasket flat against the bottom manifold; ensure that the holes in the gasket line up with the holes in the manifold.
3. Using scissors carefully open the cassette bag to remove cassette.

   WARNING: Each cassette is stored in an aqueous solution containing 15-20% glycerin and 0.1% sodium azide, pH 7 - 10. Follow standard safety procedures for handling aqueous glycerin/ sodium azide, including the use of gloves, safety goggles, and lab coat.
4. Place the cassette into the holder flat against the gasket. Place another gasket on top of the cassette. Ensure that the holes in the manifold, gaskets, and cassette are completely aligned. If you are using multiple cassettes, continue the same gasket/cassette/gasket pattern, ending with a gasket between the last cassette and the end plate.
5. Place the end plate on top of the last gasket of the cassette or cassette stack.
6. Install the tie-rod spacers (if used) and washers on each bolt leaving a minimum of 18 mm (0.75 inch) of thread exposed on the rod. By hand, screw the nut on each bolt and hand tighten evenly by alternating from one nut to the other.
7. Bolts must be further tightened to within the recommended torque values as shown in Table 1 using a calibrated manual torque wrench.
8. Figure 1 illustrates the bolt patterns for the two holder types: TangenX™ PRO 4-bolt horizontal cassette holder is designated by letters H1 through H4.
9. TangenX™ PRO 2-bolt vertical holder is designated by letters V1 and V2.
10. **Table 1** Recommended Torque Values

Holder Type	Torque Range (in-lbs)	Torque Range (nm)
TangenX™ PRO 4-BOLT	300 – 450	35 – 50
TangenX™ PRO 2-BOLT	600 – 900	70 – 100

11. **TangenX™ PRO 4-bolt torque sequence:** Using the calibrated torque wrench with a 1-¼" deep socket, place the socket on bolt H1 and tighten the nut ¼ turn. Then move the wrench diagonally to bolt H2 and tighten the nut ¼ turn. Next move the wrench to bolt H3 and tighten the nut ¼ turn. Then move the wrench diagonally to bolt H4 and tighten the nut ¼ turn. Alternate back and forth using this crisscross pattern until the torque wrench "clicks" at each nut. Repeat this sequence until the wrench "clicks" without turning the nut. The "click" of the torque wrench indicates that the nut has reached the set point torque value.

Figure 1
Torque Sequence for TangenX™ PRO Cassettes

12. **TangenX™ PRO 2-bolt torque sequence:** Using the calibrated torque wrench with a 1-¼" deep style socket, place the socket on bolt V1 and tighten the nut ¼ turn. Next move the wrench across to bolt V2 and tighten the nut ¼ turn. Alternate back and forth until the torque wrench "clicks" at each nut. Repeat this sequence until the wrench "clicks" without turning the nut. The "click" of the torque wrench indicates that the nut has reached the set point torque value.

    CAUTION: Nuts must be tightened uniformly to avoid damaging the cassette. Leakage may result from non-parallel plate alignment or over-compression of the cassettes at one end.

    Wait 5-10 minutes and allow the gaskets to relax before re-torquing. Check each nut, per the Figure 1 sequence, using the torque wrench at its set point torque value (see step 7 above).
13. Re-torque as needed to create a liquid-tight seal, but do not exceed the maximum torque limit for the TangenX™ PRO holder type used (see Table 1).

    NOTE: Torque may change during processing as the cassettes may compress, or as the cassettes expand or contract with temperature changes. Periodically check the torque of the bolts and adjust torque as needed.

FIRST TIME USE OF MEMBRANE CASSETTE

Cassettes should be flushed with DI water or WFI to ensure removal of storage and preservative agents from the membrane filter and to minimize any possible interaction with your particular application. The recommended volume of water to flush the cassettes prior to use is 20 to 40 L/m^2. For some applications, further sanitization is required.

CASSETTE INTEGRITY TEST

The purpose of the cassette integrity testing is to provide a non-destructive method to verify the integrity of a Tangential Flow Filtration (TFF) cassette. Each cassette manufactured by Repligen undergoes strict release testing, including an air integrity test. This release test verifies the integrity of the cassette prior to shipment; however it can't guarantee the integrity of the cassette's installation in the holder at the time of use. In the rare case there is an integrity issue, it can be a result of shipping damage or improper installation. Therefore, a pre-use integrity test should be conducted on site and can easily be performed following the cassette installation and flush. Integrity test specifications are shown in Table 5 of this guide. A detailed procedure (AN1002) for the measurement of air integrity can be obtained by contacting Repligen or your local sales representative.

CLEANING OF MEMBRANE CASSETTES

Cassettes can be reused if cleaned and stored properly. To clean, flush each cassette (or cassette stack) with a recommended cleaning solution from Table 2. Use 2 liters of cleaning solution per 1 m^2 of membrane area. Upon completion of the cleaning cycle, flush each cassette (or stack) with buffer, WFI, or DI water prior to storing.

Table 2 Recommended Cleaning Solutions

Cleaning Agent	Cleaning Conditions
0.1 N to 0.5N Sodium Hydroxide	Contact Time = 30 – 60 minutes Temperature = 35°C (95°F)
1.5% Alconox® Detergent	Contact Time = 30 – 60 minutes Temperature = 40°C (104°F)

STORAGE OF MEMBRANE CASSETTES

Membrane cassettes must be stored wet to maintain their characteristics and integrity and prevent microbial growth. Below are critical factors to remember when storing include the following:

- Cassettes stored greater than 2-4 weeks should be removed from the holder.
- Cassettes left in the holder should be flushed with fresh storage agent about every 2 weeks. Contact the membrane manufacturer for a list of appropriate storage agents.
- Recommended PH ranges:
  - 2 - 13, long term (storage)
  - 1 - 14, short term (cleaning)
- Recommended storage temperature:
  - 4°C - 25°C long term (>7 Days)
  - 50°C short term (<7 Days)
  - Do not freeze cassettes

MEMBRANE OPERATING CHARACTERISTICS

Take care to use the membrane at the lowest pressure possible while still producing consistent permeate flow. Although higher operating pressures initially improve flow rate, it also promotes increased concentration polarization and membrane compaction, which ultimately limits flow. With very low NMWL membranes, lower operating pressure may also reduce the retention of salts and very low molecular weight species.

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REVISION: R7	TANGENX™ PRO CASSETTE PRODUCT USE GUIDE	

TWO-SIDED BROCHURE ONLY		COVER SHEET ONLY
PRINT 1	PRINT 50	PRINT COVER SHEET

TANGENX™ PRO CASSETTE PRODUCT USE GUIDE

REVIEW AND APPROVAL

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REVISION HISTORY

REV	DOCUMENT CHANGE #	DESCRIPTION OF CHANGE	AUTHOR	DATE
R0	N/A	Initial.	SOL	18-Feb-2008
R1	F.DMO-I09/003	Modified air integrity test specification pressure for 10 kD - 300 kD MWCO's; corrected "S" channel crossflow rate	JCO	31-Mar-2009
R2	IF.DMO-1033 12-006	Added 25 ft² cassette surface area, added water flush volume, added column to Table 3.	MPE	04-Apr-2012
R3	IF.DMO-1033 12-016	See DMO for details.	MPE	22-Oct-2012
R4	IF.DMO-1033 12-022	See DMO for details.	MPE	17-Dec-2012
R5	IF.DMO-1033 13-012	Added ACN compatibility, See DMO for details.	MPE	06-Aug-2013
R6	DMO-15034	Updated revision number from R5 to R6 on first page and changed web address from novasep to order@tangenx.com, new author is VRA, replaced laskarides with Santos.	VRA	29-Jul-2015
R7	DMO-18007	Update company name to Repligen and the product name to the Repligen branded name	JVO	31-JAN-2018

STATUS APPROVED

EFFECTIVE DATE 31 Jan 2018