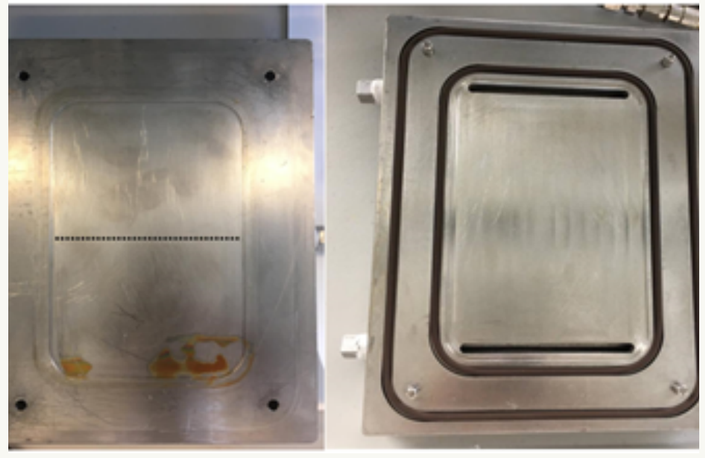
Impact of Test Cell-Induced Damage on Membrane Selectivity



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INTRODUCTION

An intact RO membrane is expected to achieve an LRV > 6 for pathogenic surrogates. But prior research indicates that defects in the active layer and, mechanical failure in the membrane module can compromise the performance of full-scale RO systems, leading to breakthroughs. However, there have been no studies on microbial passage in coupon-scale testing systems for highly selective RO membrane characterization on a laboratory scale.

OBJECTIVE

This study is based on the failures of test cell operations housing coupon-scale RO membranes, for research where membrane integrity is a key parameter.

We describe the probable zones responsible for defect creation, thus facilitating the non-selective transport of solutes expressed as log removal value (LRV).

$$LRV = \log_{10}\left(\frac{c_f}{c_p}\right)$$

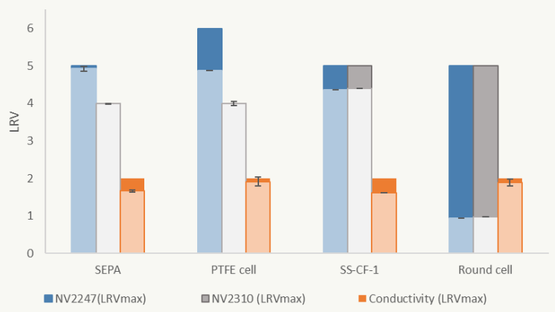
METHODOLOGY

EPSA2 (Hydranautics, U.S) coupons were studied in four different test cells:
a) commercially available SEPA crossflow cell;
b) stainless steel round cell;
c) polytetrafluoroethylene crossflow cell (PTFE CF cell), and
d) stainless steel crossflow cell (SS CF-1 cell).

Membrane integrity is assessed by the passage of
a) natural viruses (NV2247 & NV2310): novel qPCR technique,
b) fluorescent markers (Pyranine & Rhodamine WT): Tecan Infinite 200Pro plate reader,
c) salt (NaCl): electrical conductivity.

RESULTS

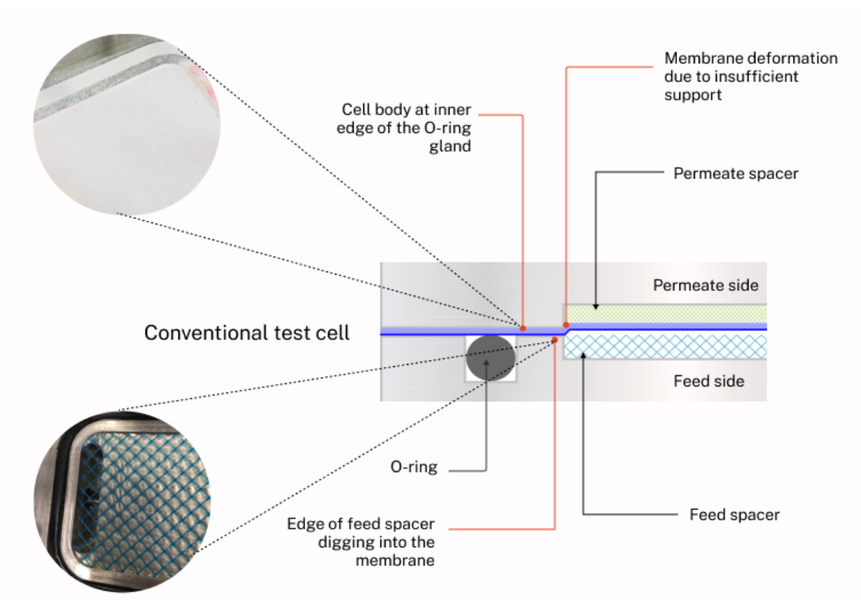
- Fluorescent marker rejection: passage occurred to the same extent as the NaCl, despite their large size difference.
- NV markers: detected in the permeate from all test cells.

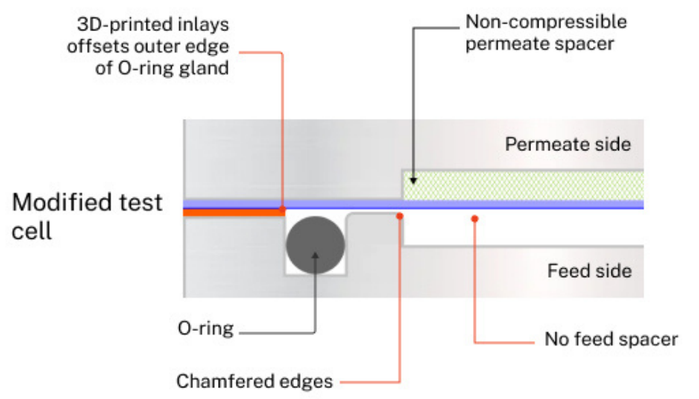


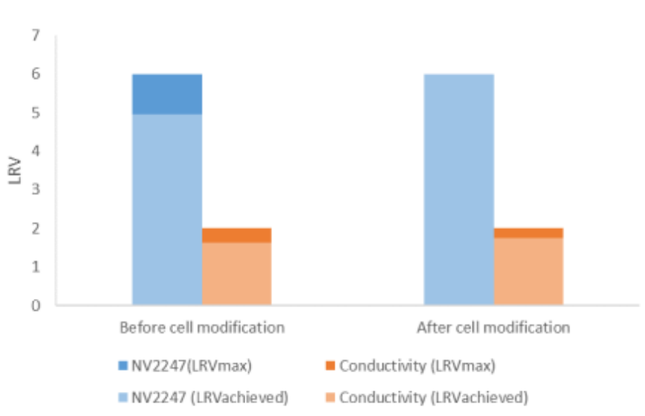
ANALYSIS

Damage to the surface was visible from the lodging of the fluorescent markers, confirming the hypothesis of mechanical damage induced by the test cell. All sharp edges in the test cells become weak points irrespective of the type of test cell, in-house built SS-CF-1, or commercial SEPA cell.

Thus, modification were carried out to minimize the contact zones for the inbuilt crossflow cell.







CONCLUSION

- Transport of different solutes reflects the decline in membrane selectivity, caused predominantly by one factor: the test cell sealing mechanism at the inner corners of the feed flow channel.
- Notably, such breaches on the membrane have no impact on the passage of NaCl.
- Upon the elimination of contact zones via cell design modification, the membrane selectivity is retained.

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