WaterVal: development of national guidelines to monitor reverse osmosis membrane

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Potential risk of Water Recycling

<table>
<thead>
<tr>
<th>Pathogen size</th>
<th>Pathogen risks</th>
<th>Chemical risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.01 – 0.3 µm</td>
<td>Viruses</td>
<td>Hormones</td>
</tr>
<tr>
<td>0.3 – 7 µm</td>
<td>Bacteria</td>
<td>Disinfection by-products</td>
</tr>
<tr>
<td>5 – 10 µm</td>
<td>Protozoa</td>
<td>Pharmaceuticals</td>
</tr>
</tbody>
</table>

According to the Australian Guidelines for Water Recycling, the system should be validated for **9.5 LRV of viruses** to be used for indirect potable reuse.

Log removal value = LRV = log \(C_{in}\) – log \(C_{out}\)

1 LRV = 90% rejection
2 LRV = 99% rejection

National Validation Framework

Pathogen testing methods

Biological system

Multiple barriers

RO

MBR
Research team

• The university of Queensland: Wolfgang Gernjak and Jurg Keller

• The University of New South Wales: Alice Antony, Pierre Le-Clech and Greg Leslie

• Curtin University: Damien Arrigan, Eva Alvarez De Eulate and Francesco Busetti

• Victoria University: Marlene Cran and Stephen Gray
Research question

This project was to develop validation and verification protocols for the rejection of pathogens (in particulars viruses) using online monitoring and challenge testing techniques for RO spiral wound membranes. Specific objectives were to:

- Develop validation guidelines that summarise technical protocols and plant management strategies for a range of log removal values (LRV), taking into account existing references and guidelines as well as operational experience and stakeholders.

- Understand the failure mechanisms of RO membranes and the time scales over which these occur to develop a monitoring protocol with adequate sampling frequencies.

- Evaluate the impact of compromised membranes and the additional benefits of multiples parameter testing.

- Incorporate research outcomes into a preliminary draft validation protocol.
How I explored the research question...

• Literature review:
  • Mechanism virus rejection?
  • Membrane integrity monitoring?
  • Compromised membrane?

• Operating condition: impact on monitoring technique

Feed pressure
Permeate flux
Cross-flow velocity
Permeate recovery
Temperature
pH

\[
\text{Correlation?}
\]

\[
\text{LRV}_{\text{virus}}
\]

\[
\text{LRV}_{\text{monitoring technique}}
\]
What I found...

<table>
<thead>
<tr>
<th>Operating conditions</th>
<th>Rejection</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MS2 phage</td>
</tr>
<tr>
<td>Permeate flux</td>
<td>(\uparrow)</td>
</tr>
<tr>
<td>Cross-flow velocity</td>
<td>(\uparrow)</td>
</tr>
<tr>
<td>Recovery</td>
<td>(\uparrow)</td>
</tr>
<tr>
<td>pH from 3 to 5</td>
<td>(\uparrow)</td>
</tr>
<tr>
<td>pH from 5 to 8</td>
<td>(\uparrow)</td>
</tr>
<tr>
<td>pH from 8 to 10</td>
<td>N/A</td>
</tr>
<tr>
<td>Temperature</td>
<td>(\uparrow)</td>
</tr>
</tbody>
</table>

\(\uparrow\): increase.  
\(\downarrow\): decrease.  
\(\rightarrow\): no impact.  
N/A: not applicable.
What I found...

R = 0.81

R = 0.54
The ‘global change’ aspect of my water research

Benefits of a national validation framework:

• Provide nationally consistent validation requirements for water recyclers, regulators and technology providers.

• Provide a national process for consideration of overseas validation.

• Reduce the cost of validation for specific treatment technologies – once certified, validation would not need to be repeated unless significantly changes.

• Bring together validation data for in situ treatment technologies and provide data to support the updating of the Australian Guidelines for Water Recycling.

• Streamline the scheme design process – water recyclers could choose a pre-validated treatment technology and know that the performance targets would met.

• In time, the framework could be applied to drinking water technologies. It could also be extended to environmental treatment technologies.
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References:

