Brackish and Saline Groundwater Treatment: opportunities in regions with climate variability and freshwater shortages

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Desalination in inland areas
In-Situ Desalination (ISD)
Field Trials and results
Conclusion
Desalination in Inland Areas

* Large centralised plants (rare)
* Often based on small scale Reverse Osmosis (RO) technology near point-of-use, using brackish groundwater feed
Conventional Desalination drawbacks

- Power Costs (seawater quality feed particularly)
- Reject fluids require safe disposal
- Membrane fouling (colloids, biofoulants)
- Scaling
- Licensing
• RO-based, distributed system

• Downhole – treatment carried out *in situ* within a brackish aquifer, with dual screens (feed and concentrate reinjection separated by a packer)

• Whole process – groundwater feed, treatment, pumping of permeate to surface and reject reinjection in the lower aquifer powered by a single submersible pump

• International Patents for ISD
Advantages of ISD

- Distributed system - near point of use
- Low energy costs - only permeate is pumped to the surface
- Aquifer provides natural filter
- In situ operation under ambient groundwater conditions (e.g., anoxia) reduces potential for fouling
- No chemicals added to feed groundwater (antiscalents)
- Rejects contain only groundwater salts and disperse at low elevations in the aquifer (density contrast, natural stratification)
- Low operating recovery gives low salinity of rejects
- Low environmental footprint
Conceptual model of flowlines during ISD, based on modelling results

Groundwater flow

Feed

Concentrate reinjection
Trial 1  Swan Valley WA

- Background groundwater TDS: 2900mg/L
- Mean Groundwater feed TDS: 3300mg/L
- Groundwater feed flowrate: 1700 L/h

- Permeate TDS: 150mg/L
- Permeate flowrate: 500-600L/h
Swan Valley Field Trial:
variation in feed TDS
* **Tertiary palaeochannel aquifer**
  confined gravel

* **Groundwater feed TDS:**
  3200mg/L

* **Feed flowrate:** 10m$^3$/h (3.2L/s)
Trial 2 results

- ISD system produced 4 m³/h (96 m³/d) per ISD bore at 100 mg/L TDS
- Daily maintenance gave sustainable operation over 6 months
- Projected 30 ML/y assuming 10% downtime
- Power costs 1.35 KWH/m³ (A$0.20/m³)
- Wellfield of 6 units scheduled to produce 150-180 ML/y for vineyard
- Impacts on aquifer minor, minimised by significant vertical movement of reject fluids
- Aquifer beneficial use not considered to be compromised
# Performance

<table>
<thead>
<tr>
<th></th>
<th>Modelled DOW ROSA v6.1 model (DOW Filmtec 2007)</th>
<th>After 60 days of operation</th>
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</thead>
<tbody>
<tr>
<td>Feed groundwater</td>
<td>3200 mg/L</td>
<td>3200 mg/L</td>
</tr>
<tr>
<td>Feed groundwater flow</td>
<td>9.75KL/h</td>
<td>10KL/h</td>
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<tr>
<td>Permeate TDS</td>
<td>89 mg/L</td>
<td>100 mg/L</td>
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<tr>
<td>Permeate flow</td>
<td>3.6KL/h</td>
<td>3.8-4.2KL/h</td>
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<tr>
<td>Concentrate TDS</td>
<td>5000 mg/L</td>
<td>4800-5040mg/L</td>
</tr>
</tbody>
</table>
Model predictions: Salinity (TDS)
Longitudinal Cross section

Layer 1 (Clay)
Layer 2 (Sand, with clay and gravel)
Layer 3 (Confining clay)
Layer 4 (Coarse gravel with sand)
Layer 5 (Clay and silty clay)
Layer 6 (Coarse gravel with sand)
Layer 7 (Weathered clay)
Layer 8 (Basement rock (Clay))
Simulated Concentration at Reinjection Zone
Conclusion

- ISD ideally suited to provide a reliable, alternative high quality water needs of communities in regions where low quality groundwater is available.

- New ISD approach provides an alternative, scalable method for brackish and saline water desalination

- Environmental footprint and impacts are low, but impacts need to be quantified
ISD provides advantages over the more conventional RO system approach, particularly through integrated feed/treatment/permeate delivery and reject reinjection, giving cost savings.

Sustainable operation of ISD can be achieved, although care required in selection and testing of site hydrogeology and modelling of system behaviour is critical to successful operation.
Thanks

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