MODERNWATER | Membrane Processes

Forward Osmosis: Desalination

Modern Water owns, installs and operates world-leading membrane technologies and we are the world-leader in Forward Osmosis (FO) technology. We have successfully implemented and operated our patented desalination process internationally and produce fresh water in some of the most demanding seawater conditions in the world.

Our FO process consistently delivers significant reductions in operational costs, reduced lifetime costs and it reliably produces high quality product water, even in the most challenging conditions.

We use our world-leading FO technology platform in a number of membrane process applications other than for seawater or brackish water desalination. These include: evaporative cooling systems, secondary oil recovery and the development of renewable energy using hydro osmotic power (HOP).

FO desalination benefits

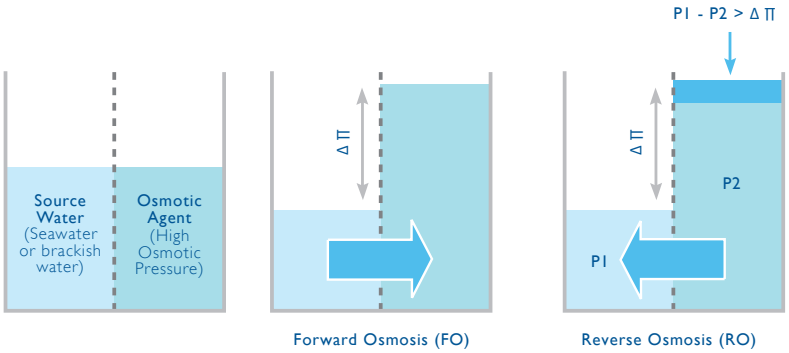
- A proven, reliable and robust membrane process
- Energy consumption typically up to 30% lower than conventional Reverse Osmosis (RO)
- Inherently low fouling characteristics (both particulate and biological fouling)
- Significantly reduced product boron levels without post-treatment when compared to conventional RO
- Higher availability than a conventional RO plant due to low fouling, simple cleaning and ease of operation

MODERNWATER

Forward Osmosis Vs Reverse Osmosis

	1 Technology Status	3 Membrane Fouling	4 Energy Consumption
Forward Osmosis (FO)	Innovative process solution now fully operational & commercially available *(Al Khaluf, Oman - the world's first commercial FO plant began operation in 2010).* [2] Competitive advantages over RO. Significant further process improvements to come. ✓	Extremely low inherent fouling - low pressure, diffusion driven process. Possibility to consider reduced pre-treatment. * *site dependent* FO Membranes are chlorine tolerant allowing effective treatment for bio-fouling. ✓	Typically up to 30% less than RO. The more difficult the feedwater the higher the energy saving. ✓
Reverse Osmosis (RO)	Mature, well established technology *(Coalinga, California - the world's first commercial RO plant began operation in1965).* Little further improvement likely.	High pressure - prone to fouling, hydraulic forces increase fouling - a key issue. RO Membranes are not chlorine tolerant.	Typically up to 30% more than FO. Any degree of fouling, higher than FO.

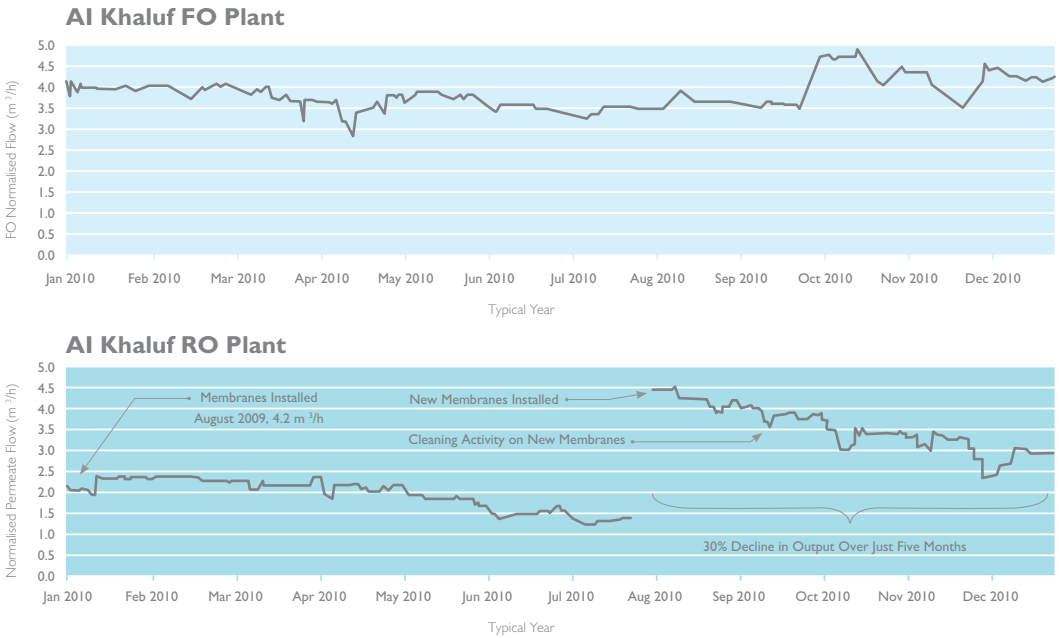
1



2

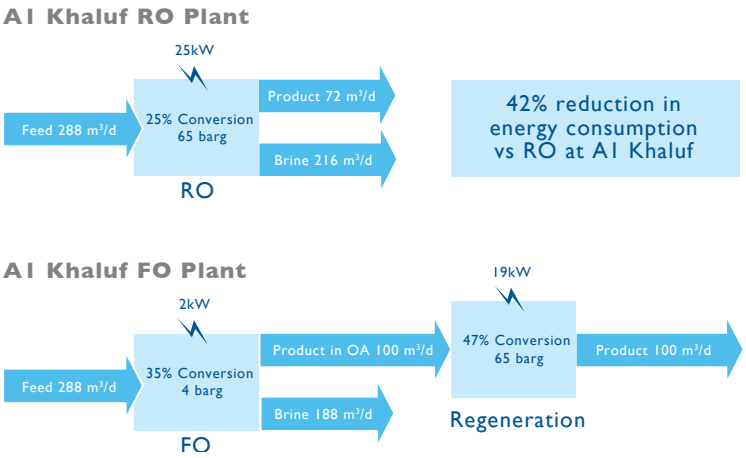
Al Khaluf, Oman

3

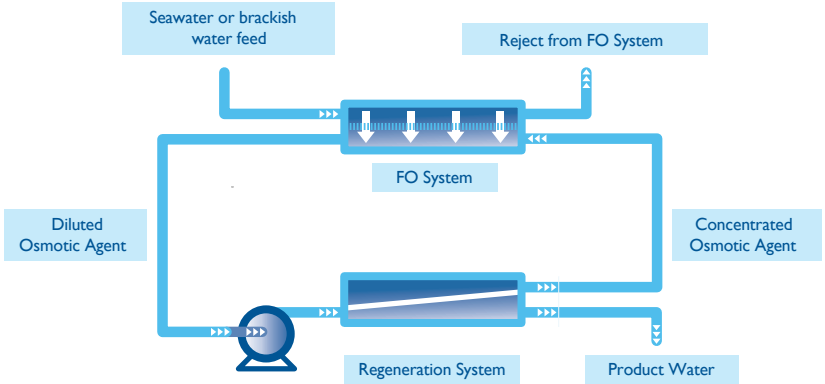


Operational Costs	Boron Removal	⑤ Ease of Operation	Capital Cost
Less than RO due to higher availability, less chemical cleaning and fewer membrane replacements. Extended membrane life - FO membrane life typically twice that of the equivalent RO membrane. ✓	Inherently high removal, without the need for post treatment (less than 1 ppm). ✓	Very similar to RO, but with less frequent cleaning and increased membrane life. ✓	Similar capital cost on a like-for-like basis. =
More than FO due to lower availability, higher energy costs, more chemical cleaning and membrane replacements.	Poor removal and may require additional costly post treatment system.	Similar to FO but more frequent cleaning and reduced membrane life.	Similar capital cost on a like-for-like basis

4



5



Process explained

At the heart of the Modern Water process is a recirculating "osmotic agent" system that transfers pure water from the feedwater (eg seawater) to the regeneration (permeate extraction) system.

By linking two highly optimised systems, the FO system and the regeneration system, significant benefits are achieved.

In the first stage, feedwater is fed under low pressure to the forward osmosis membranes, which are highly resistant to fouling and are resistant to oxidising agents. The osmotic agent, on the other side of the membrane, draws fresh water from the seawater due to a difference in osmotic pressure. This fresh water dilutes the osmotic agent.

In the second stage, permeate is extracted from the system. The pure water is removed from the dilute osmotic agent which is regenerated (or concentrated) for reuse in the first stage. This can be achieved in a number of ways depending on the proprietary osmotic agent selected.

To find out how we can help you please contact us on:
+ 44 (0)1483 696 000

Modern Water plc
Bramley House, The Guildway
Old Portsmouth Road
Guildford
Surrey GU3 1LR
United Kingdom

Other offices:

Modern Water
Villa 10593
Way No 4494
Azaibah
Muscat
Sultanate of Oman

+ 968 244 918 33

Modern Water
Unit 1701-2
Westgate Tower
1038 Nanjing Road W
Shanghai 200041
China

+ 86 21 6218 5183 Ext.140

www.modernwater.com

MODERNWATER