Closed loop antiscalant recovery and usage optimization

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Motivation

Water production and treatment plants suffer from scale formation, leading to equipment deterioration, lower yields and the need for intensified maintenance schedules, all implying higher overall production costs.

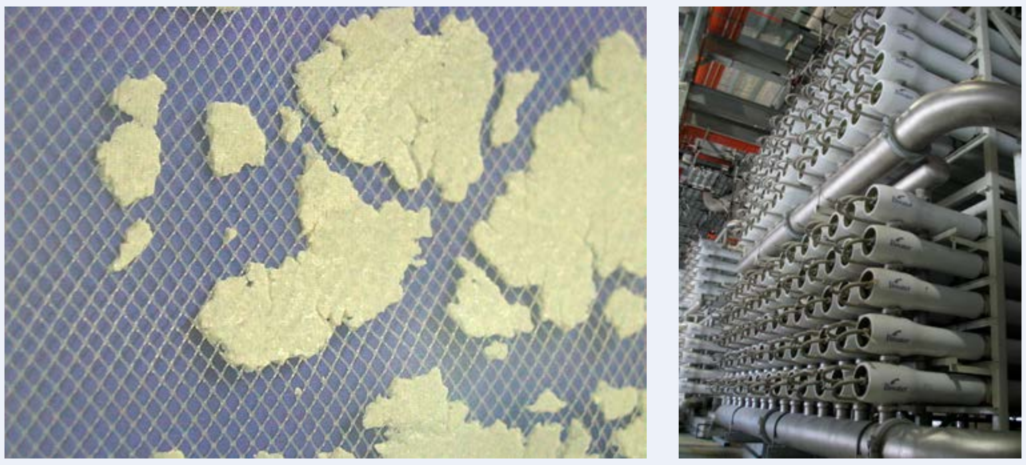


Figure 1: Scale formation on the spacers (A) as used in Reverse Osmosis (RO) membrane modules (B).

Phosphonates (see Figure 2) belong, next to phosphates and polycarboxylates, to the most widely used antiscalants in RO desalination processes. This is due to their high activity as complexing agents and their great stability and resistance to degradation.

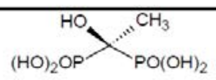
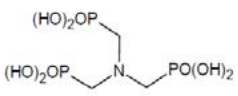
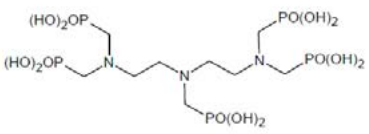
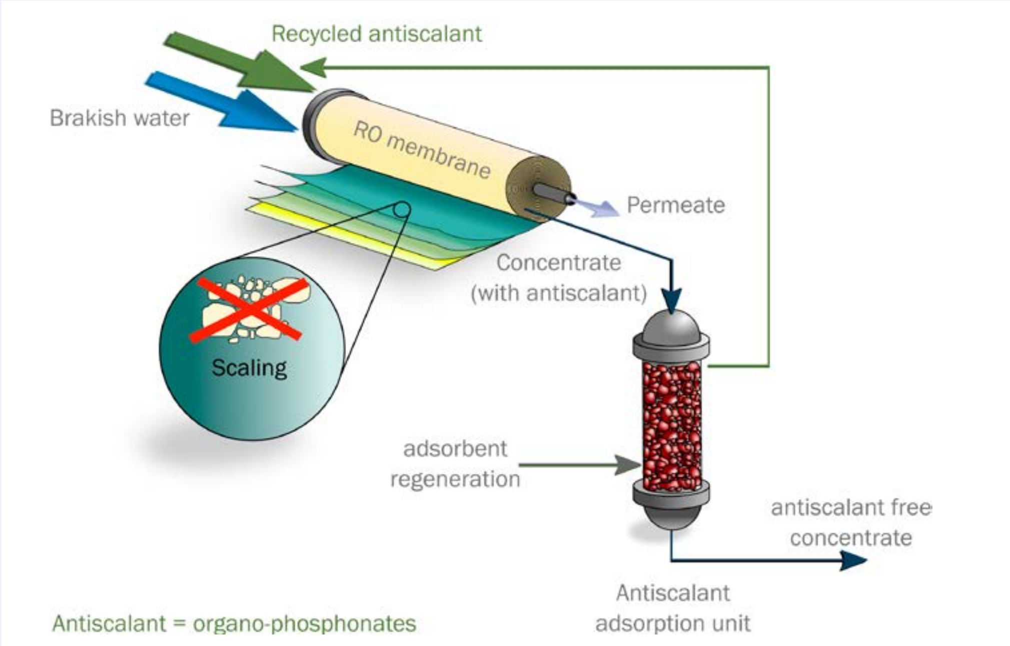
Abbreviation	Name	Structure
HEDP	1-hydroxy(ethane-diphosphonic acid)	
NTMP	Nitrilotris(methylene-phosphonic acid)	
DTPMP	Diethylenetriamine penta(methylenephosphonic acid)	

Figure 2: Widely used phosphonates as antiscalants.

The discharge of phosphonates-containing RO concentrates however, contributes to the eutrophication of surface waters. In addition, phosphonates can act as a vehicle to transport traces of heavy metals also in aquatic media.

Figure 3: Example of eutrophication of surface water.

To ensure an effect, water treatment plants usually overdose the use of antiscalants. Given the production cost of antiscalants, there is also a strong economical incentive to optimize the dose. Therefore, further knowledge of their way of acting is needed for a more efficient use of antiscalants in industry.



The aims of this project are: (1) to design and model an integrated closed loop in order to recover and recycle antiscalants. (2) To study the crystallization process of scaling salts under the influence of (recycled) antiscalants, in order to optimize their usage.

Technological challenge

Closed loop antiscalant recovery

Adsorption of phosphonates onto iron oxide-hydroxide particles seems to be a promising technique since it results in high yields and is economically feasible. In order to design and model the antiscalant recovery closed loop the adsorption/desorption kinetics will be studied under following conditions:

- Changes in pH
- Higher than room temperatures (298K)
- Presence of impurities, both organic and inorganic, e.g., Mn^{2+}, Mg^{2+}, SO_4^{2-}
- Possible saturation in the inhibition activity of the antiscalants

Crystallization research

To test the functionality of the recycled antiscalants and to optimize antiscalants use a special crystallizer design (Figure 4) will be used. Its (bottom) design will help to minimize crystal attrition and will allow the study of crystal growth and agglomeration rates of different scaling salts at fundamental level. This can be either on-line or offline, by using high speed imaging, Raman spectroscopy and other advanced optical techniques. The study of the complex Ca-phosphonate formation and the effect of the presence of antiscalants and other impurities will be also included in this research.

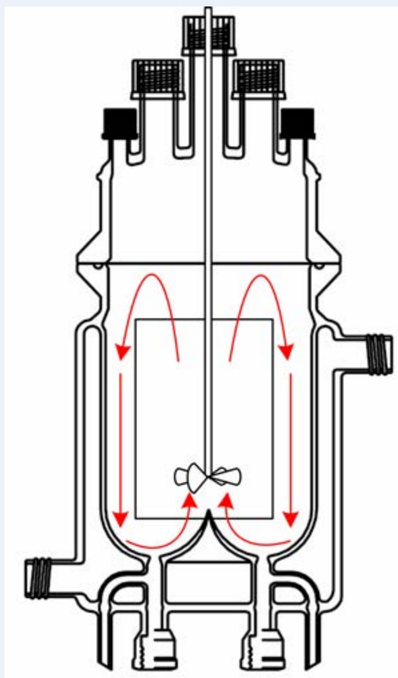


Figure 4: New crystallizer design.

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