

## Nanofiltration as pretreatment for scale prevention in seawater reverse osmosis desalination

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### ABSTRACT

Seawater contains high concentrations of sparingly soluble salts which can cause scaling of the membrane surface, which in turn can limit the productivity and water recovery potential of seawater reverse osmosis (SWRO). Nanofiltration (NF) pre-treatment of seawater can prevent scaling via preferential removal of scale-forming ions. Several studies have shown that the rejection of scale-forming ions can vary considerably depending on the membrane. The main objective of this study was to test a number of commercially available NF membranes with synthetic seawater in order to compare their performance and identify optimum membranes and operational conditions for the removal of compounds that are known to cause scaling ( $\text{CaSO}_4$  (s),  $\text{Mg}(\text{OH})_2$ ,  $\text{CaCO}_3$  (s), etc.) in SWRO. Six membranes, supplied by several manufacturers, were tested in a laboratory-scale plant at various trans-membrane pressure differences. For the majority of membranes, the sulphate rejection was superior at 90%, which is very important for the prevention of scaling. Following on from the obtained results, a selection of the most suitable membranes for scaling prevention in seawater desalination can be done.

**Keywords:** Nanofiltration; Scale prevention; Desalination; Atomic force microscopy

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### 1. Introduction

Seawater desalination is a separation process in which fresh water is extracted from saline water. Thus, the salts and hardness ions are retained in the concentrate stream, causing an increase in hardness and total dissolved solids (TDS). Due to the low solubility of hardness ions in seawater and depending on the conditions used, the hardness ions can precipitate on the

desalination equipment resulting in scaling, which is a serious problem in desalination plants. For scale prevention in seawater reverse osmosis (SWRO) plants certain anti-scalants, such as polyphosphates or polycarboxylic acids, are added to the feed water, but even with this precaution, the product water recovery remains low and inorganic fouling is always present.

Nanofiltration (NF) is a pressure-driven membrane process which has a molecular weight cut-off between reverse osmosis and ultrafiltration. The rejection ability of NF membranes depends not only

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