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The performance of polycarboxylates as inhibitors for $CaCO_3$ scaling in reverse osmosis plants

K. Zimmer[a], W. Hater[a], A. Icart[a], J. Jaworski[b], N. Kruse[b], G. Braun[b,*]

[a]*Kurita Europe APW GmbH, Giulinistrasse 2, D-67065 Ludwigshafen/Rh, Germany, emails: kirstin.zimmer@kurita.eu (K. Zimmer), wolfgang.hater@kurita.eu (W. Hater), anna.icart@kurita.eu (A. Icart)*
[b]*Technische Hochschule Köln, Institute of Chemical Engineering and Plant Design, Betzdorfer Strasse 2, D-50679 Cologne, Germany, emails: jolanthe.jaworski@th-koeln.de (J. Jaworski), nicolas.kruse@th-koeln.de (N. Kruse), gerd.braun@th-koeln.de (G. Braun)*

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ABSTRACT

A new membrane-based method was applied to investigate the performance of three phosphorus-free antiscalants of different chemical structures to prevent calcium carbonate scale. Apart from a polyacrylate homopolymer, two copolymers were studied, one of it also being free of nitrogen. The results show that an inhibition of $CaCO_3$ scale on reverse osmosis (RO) membranes is possible with phosphorus-free antiscalants. The individual performance strongly depends on the chemical structure of the polycarboxylate. A specially adapted copolymer clearly outperforms the polyacrylate homopolymer in case of severe scaling conditions. The average residence time of the water in the test plant is approximately 1 h, compared to around less than a minute in a full-scale RO plant. So the operating conditions in the test plant make it more difficult for an AS to inhibit scaling compared to a full-scale RO plant. By energy-dispersive X-ray fluorescence (EDXRF), the scaling layer thickness can be estimated. The SEM images and the 3D images from CLSM showed that the water quality and the applied antiscalant have a great influence on the scaling layer morphology. The effective blocking of the membrane does not only depend on the amount of precipitated $CaCO_3$ but there is also a great influence of the scaling layer structure. With a normal scaling potential of the water, the scaling layer consists of calcite, and at higher LSI values of the feed water, there was also aragonite found on the membrane. From the three antiscalants AA/AMPS shows, as it was expected, the lowest performance as calcium carbonate scale inhibitor, because it is designed predominantly as a disperser and as stabilizer for calcium phosphate. PAA proved to be an efficient inhibitor for hardness at standard applications. For the application in waters with high scaling potential, AA/EA is very suitable, because this inhibitor is able to serve as a good stabilizer for hardness and at the same time as a disperser. A combination of different polymers enables special solutions for high requirements.

Keywords: Polycarboxylates; Calcium carbonate; Scale inhibition; CLSM; SEM; Reverse osmosis

*Corresponding author.

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