

How many ppm? The unresolved problem of acid dosing in the reverse osmosis plant design

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Abstract

Different membrane manufacturer software are available for the designers of RO plants. Software releases are reissued periodically and distributed to the designers to make simulation of membrane behaviour. If you are familiar with these software you know that, a part the different products characteristics, depending on the membrane specification, the acid dosage requests to modify the pH of the feed water are very different for each supplier and often also for each software release. In the paper, using a data input a typical sea water Mediterranean Sea analysis, the membrane software are used to simulate different design conditions and the acid dosage figures are compared with those obtained from an original model developed by the authors, based on the carbonate salts equilibrium.

Keywords: Reverse osmosis; pH adjustment; Acid dosing; Sea water salinity; Carbonate system; Carbonic acid equilibrium

1. Introduction

One of the main problem with that the reverse osmosis plant process engineer has to deal, when he has to design a new plant, is the chemical pre-treatment sizing.

In particular he has to define the pH of the feed to avoid the salts precipitation phenomenon and as consequence the acid flow rate to reach

the desired value of this parameter: in other words he has to define “how many ppm”

The scale control involves the carbonic species equilibrium calculation that is directly correlated to the pH trough the well known equilibrium reactions.

The software releases normally available by the membrane or chemical products manufacturer make the calculation starting from the feed pH value and the carbonates or bicarbonates content.

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In the following sections an overview of the different releases approaches is reported and compared with the classic equilibrium model to identify the correct acid dosing rate.

2. Software different approaches

Software of three membrane manufacturers is used for the comparison.

To compare the results the following standard analysis has been assumed as reference:

	Reference analysis
Sodium (ppm)	11,093
Potassium (ppm)	507
Calcium (ppm)	426
Magnesium (ppm)	1531
Bicarbonates (ppm)	188
Sulphates (ppm)	3698
Chlorides (ppm)	19,957
pH	8.1
Total dissolved solids (l) (ppm)	37,400

The following approaches are used by different manufacturers:

Manufacturer/chemical producer	Input	Parameter calculated
1	Sea water analysis Element age Bicarbonate content Carbonate content pH	CO ₂ dissolved
2	Sea water analysis Fouling factor (year) Bicarbonate or carbonate content pH	Carbonate content or Bicarbonate content CO ₂ dissolved
3	Sea water analysis Fouling factor (%) Bicarbonate or carbonate content pH	The pH is recalculated to match bicarbonate and carbonate content

2.1. Temperature influence

The reference acid used for pH adjustment is sulphuric acid at normalized concentration of 100% and the calculations have been made in the sea water temperature range 20–35°C.

In the following diagrams (Figs. 1–3) the acid dosing rate versus temperature to modify the feed pH from the raw water value of 8.1 to feed water value of 7.5 is reported for the different manufactures.

The curves for manufacturers number 2 and 3 have the same profile, but the manufacture 2 curve slope is greater than the slope of manufacturer 3 curve.

The dosing rate is decreasing with temperature increasing.

The manufacturer 1 dosing rate is from 2 to 2.2 times greater than the others and is increasing with temperature.

2.2. Final pH influence

The acid dosing rates vs. final pH starting from initial pH value of 8.1 are reported at two different temperatures 20 and 35°C in Figs. 4, 5 and 6.

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