# CHEMICAL DOSING STATIONS

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## Contents



## Summary

The dosage of chemicals and, in particular, of antiscale is essential for the safe and efficient operation of any evaporative desalination plant. The missing or incorrect dosage of antiscale for even a few hours of operation can cause the complete clogging of the tube bundle because of the precipitation of calcium carbonate and magnesium hydroxide.

To restore the operation of the evaporator after such an accident, acid cleaning of the unit is required. In the worst case, if the formation of magnesium hydroxide or calcium sulfate occurred in the high temperature stages and the clogging cannot be removed, even with acid cleaning, stringent mechanical cleaning has to be carried out.

It is, therefore, essential that the operation of the antiscale dosing system is monitored in order to ensure that the correct antiscale flow rate is dosed in the plant.

The above considerations mean that in a seawater evaporator there is a great tendency for scale to form in the high-temperature parts of the unit and, in practice, the brine heater is usually the first part on the unit to show signs of scale formation.

## 1. Introduction

Several chemicals are dosed in the desalination plant and are extremely important for the process. Among these chemicals the following can be summarized:

- Antiscale (MSF (Multi-stage flash) and MED (Multiple effect distillation) processes)
- Antifoam (MSF and MED processes)
- Sodium sulfite (MSF and MED processes)
- Hydrochloric acid (for acid cleaning)
- Sulfuric acid (MSF and MED processes decarbonation)
- Ferric chloride (Reverse osmosis processes)
- Polielectrolite (Reverse osmosis processes)
- Sulfite (Reverse osmosis processes)

Their dosage is, in some cases, directly affecting the plant performances, and therefore reliability and precision are factors which are of utmost importance in order to achieve the desired performances.

Despite the fact that similar chemical dosing stations are commonly used in petrochemical and power generation processes, the needs which are peculiar to a desalination plant sometimes require a different approach and more stringent specifications with respect to the standards.

Nevertheless, the fact that these stations are basically composed of tanks, small bore piping, pumps in general of a metering type, agitators and instrumentation, the specification for the chemical dosing station must consider the state of the art, and the standards which are available for the single components.

Furthermore, the trend of the design of chemical dosing stations is towards "package type", skid mounted and complete in every respect with base plate, interconnecting piping, instrumentation, structural steel, access platform and ladders charging hoppers, etc.

These stations are, in general, completely assembled, or pre-assembled, to a degree related to the possibility of lifting and transportation of the station itself from the workshop of a manufacturer where the detailed design and the assembly of the equipment has been developed.

Painting and precommissioning of the station can also be developed at the manufacturer's workshop.

This system allows the work to be carried out on site to be reduced to the simple installation of the unit upon the foundation slab on the anchor boxes, connection of the skid mounted unit to the pipework, connection of the electrics, and painting touch-up.

Besides simplifying and reducing site erection and civil work, the system gives a better quality of construction of the units, since much of the job is carried out in a closed workshop.

Of particular importance are the accessibility and the easy and rapid maintenance aspects, therefore the unit equipment and piping layout is one of the basic considerations that must be reviewed with the manufacturer and the client in order to achieve the optimal results.

## 2. Generalities on Chemical Dosage

### 2.1. Generalities on the Scale Formation

To obtain the maximum performance from the desalination plant it is necessary to minimize the scale formation which reduces the heat transfer coefficient.
The details on how the scale is formed and can be prevented are dealt with elsewhere, the present chapter describes only the equipment which is used in desalination plants in order to avoid scale.

"Scale" means deposit of calcium carbonate ($CaCO_3$), magnesium hydroxide ($Mg(OH)_2$) and calcium sulfate ($CaSO_4$); the last one being defined as "non alkaline" scale.

Alkaline scale formation can be described by the following equation:

$$2HCO_3 \xleftrightarrow{\text{heat}} CO_3^{2-} + CO^2 + H_2O$$

$$CO_3^{2-} + H_2O \xleftrightarrow{\text{heat}} 2OH^- + CO_2$$

As these reactions are in equilibrium they can proceed in either direction; and the rate at which they proceed is governed mainly by the concentrations of the various ions in solution and by the partial pressure of the carbon dioxide above the solution, which influences its solubility in the aqueous phase.

If the carbon dioxide gas cannot escape, the reactions cannot proceed.

Calcium carbonate and magnesium hydroxide are formed when calcium and magnesium ions present in the sea water combine with the carbonate and hydroxyl formed by the decomposition of the bicarbonate ions.

The following reaction represents the phenomena:

$$2OH^- + Mg^{2+} \rightarrow Mg(OH)_2$$

It follows that the rate of formation of these two components depends on the concentration of $HCO_3$, the temperature, the partial pressure of carbon dioxide, and the time of resistance.

With sufficient temperature, time and $CO_2$ release, $CO_3^{2-}$ will hydrolyze to produce $OH^-$ which will precipitate as $Mg(OH)_2$. At low temperatures, up to about 100°C, because the rate of formation of $CO_3$ is higher than that of production of $OH^-$, and because $CaCO_3$ is less soluble than $MgCO_3$, the former will precipitate in preference.

Moreover $CaCO_3$ and $Mg(OH)_2$ scales have inverse solubility characteristics, that is their solubility decreases with increasing temperature.

### 2.2. Generalities on the Antifoam Dosage

The foaming tendency of seawater in distillation plants is unpredictable. It is generally thought that foam is formed when organic compounds are concentrated in the brine and give rise to the surface-active effects, which increase the liquid film strength at phase interfaces, for example, between water and vapor.

The effect of foaming tends to be more severe in those plants where the demisters are close to the brine stream, and where only a small disengagement volume is available for complete separation of vapor and water phases. It can also be a problem in plants with high vapor velocities. If foaming is not controlled, brine is carried over into the distillate, resulting in contamination of the product water and reducing the overall evaporator efficiency.

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