

Pretreatment Aluminum

The following are general recommendations for controlling high levels of aluminum in systems using reverse osmosis (RO) and nanofiltration (NF) elements. For additional information on pretreatment methods, please see MANN+HUMMEL Water & Fluid Solutions' Pretreatment Guides or contact MANN+HUMMEL Water & Fluid Solutions Technical Service.

INTRODUCTION

Natural water sources typically do not contain high concentrations of dissolved aluminum. Due to its high charge characteristics (valence of +3 charge) and small size (molecular weight of 27 Da), aluminum metal ions have a particularly high charge density making aluminum very reactive. In fact, aluminum tends to react similarly to iron. Like iron, aluminum will combine with oxygen to form an insoluble oxide. It also tends to complex with negatively charged organic colloids and will readily precipitate when silicates are present. Once these complexes have settled onto the membrane surface, it is very difficult to remove. Because of this, it is highly recommended to remove aluminum from the feed water to keep concentrations below 0.05 mg/L.

Due to aluminum's high charge characteristics, many municipalities and systems use alum (aluminum sulfate, $Al_2(SO_4)_3$) or sodium aluminate ($NaAlO_2$) chemical addition in surface water treatment. The aluminum acts as a coagulant which neutralizes the negative charged characteristics of organic suspended solids in the water and allows the suspended solids to group together and fall out of suspension. It is recommended that if a system utilizes both alum or sodium aluminate and acid injection, that the acid is injected upstream of any media filters to prevent potential aluminum fouling.

CAUSES & RECOMMENDATIONS TO PREVENT ALUMINUM FOULING

Aluminum fouling is typically found in the first and last stage of RO and NF systems. Even concentrations as small as 50 ppb of aluminum may result in a decline in membrane or system performance. Aluminum fouling may occur due to the following:

- Residual flocs that remain in the system from a pretreatment process using aluminum-based coagulants. Because aluminum is very reactive, it reacts with silica to form aluminum silicates. Silica concentrations of even 10 mg/L may result in aluminum silicate fouling. The use of aluminum-based products (i.e. coagulants in the pretreatment regime) may increase the risk of aluminum fouling due to the added aluminum ions. It is highly recommended to use other products if this is a concern.
- Precipitation of aluminum coagulants due to poor pH control. Aluminum is more soluble at low or high pH, and is less soluble at a pH range of 5.3 to 8.0. Because of this, it is recommended to operate the system at a pH in the 7 - 9 range (this depends on the feed water as other means of scaling should be avoided) to keep aluminum in solution. If the system utilizes both a coagulant and acid injection, it is recommended that the acid is injected upstream to prevent aluminum fouling.
- Antiscalants containing polymers are sensitive to the presence of metals such as aluminum. The antiscalant may deactivate in the presence of aluminum and may lead to scaling and antiscalant fouling. It is very important to select the right antiscalant for the system.
- Mineral silt, fine clay and sand particles. It is recommended to remove these through pretreatment either by multimedia filtration, ultrafiltration or microfiltration. Coagulants may be used to help form larger particles for easier removal.

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