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Abstract
The aim of this work is to study the ageing state of a used reverse osmosis (RO) membrane taken in Algeria from the Benisaf Water Company seawater desalination unit. The study consists of an autopsy procedure used to perform a chain of analyses on a membrane sheet. Wear of the membrane is characterized by a degradation of its performance due to a significant increase in hydraulic permeability (25%) and pressure drop as well as a decrease in salt retention (10% to 30%).

A used RO (reverse osmosis) membrane was selected at the site to perform the membrane autopsy tests. These tests make it possible to analyze and identify the cause as well as to understand the links between performance degradation observed at the macroscopic scale and at the scale at which ageing takes place.

External and internal visual observations allow seeing the state of degradation. Microscopic analysis of the used membranes surface shows the importance of fouling. In addition, quantification and identification analyses determine a high fouling rate in the used membrane whose foulants is of inorganic and organic nature. Moreover the analyses proved the presence of a biofilm composed of proteins.

Keywords: **desalination, reverse-osmosis, membrane, seawater, fouling**

1. Introduction

In recent years, there has been an increased use of RO membrane desalination process. Many countries in the world suffer from a shortage of natural fresh water. Salt is the main contaminant in seawater with an average of 35 grams of salt in every liter of seawater. The safe limit for salt in drinking water is around 1 gram per liter. The desalination process removes salt from water. Membrane-based desalination technologies such as, pressure driven nano-filtration (NF) and reverse osmosis (RO), osmotically driven membrane processes as represented by forward osmosis (FO) and pressure retarded osmosis. Membrane fouling is caused by the deposition of suspended particles or colloids, organic macromolecules, sparingly soluble inorganic compounds, microorganisms, or their mixtures on (or even inside) the membrane [1].

2. Material and Methods

The fouled RO membrane element (HYDRANAUTICS SWC 5) serial number: A1497030 selected for the autopsy study had been in service for nearly 2 years in a water treatment facility operated by Benisaf Water Company of Ain Temouchent in the Ouest of Algeria. The RO desalination plant was integrated into the water treatment facility in response to the increased salinity of sea water in the region. The Fouled membrane as inspected with;
Atomic absorption spectrometry (AAS), ATR/FTIR Analyses,Optical and electron microscopic analyses.

3. Results and Discussion

Table 1. Results of SAA analyses of deposits scraped from the fouled membrane surface.

Elements	Concentration (ppm)
Al	580
Ca	450.9
Cu	0.0340
Fe	0.2577
K	434.1
Mg	551.7
Si	392.5

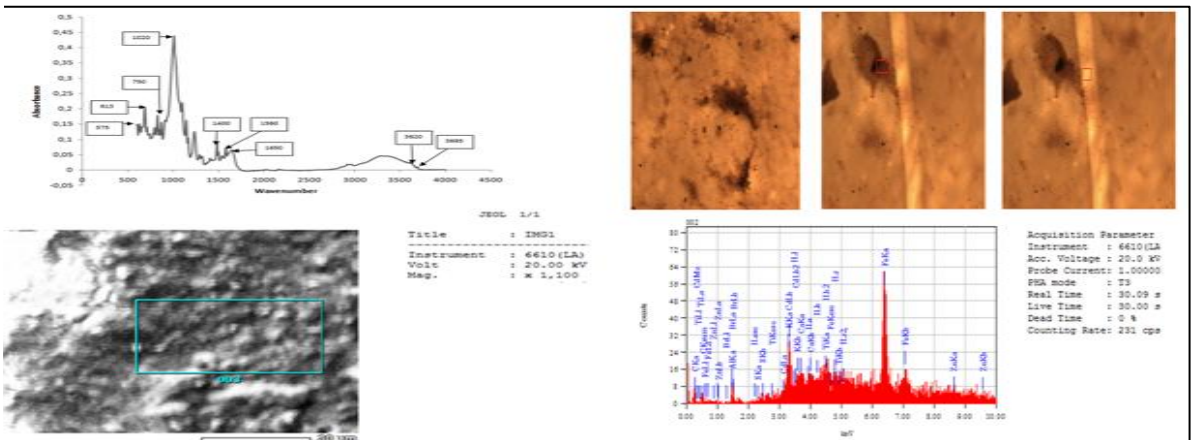

Figure 1. SEM image, micrograph and Chemical composition of the membrane surface.

Microscopic observation of samples reveals the importance of fouling deposition in the membrane surface. The SEM images show the morphological aspect of the fouling as well as the importance of the thickness of the layers as shown in Figure 1.
The main absorption bands were in the vicinity of 1020 cm-1(Si-O and Al-O) of silicate.
The results from SAA analysis are shown in Table 1. The majority of detected elements included Al (580 ppm), Mg (551.7 ppm),Ca (450.9 ppm), K (434.1 ppm) and Si(392.5).
Lesser amounts of Fe (257 ppm), and Na (186.7 ppm) were also present. Low levels of B, Cu, Zn and Mn were also identified in the deposits[2].

4. Conclusion

Inspection by SEM EDS confirms the diversity of the fouling composition layer across the surface of the membrane [2], and The main absorption bands were in the vicinity of 1020 cm-1 (Si-O and Al-O) of silicate [1].
The results obtained are consistent and complementary to each other. From the results of the study the following conclusions can be drawn:

- The extent of fouling was uneven on the membrane surface with the areas below or near the feed spacer being most affected. The fouling in areas further away from the strands was generally less loaded.
- Inorganic elements found with a high percentage are Fe, Al. The use of iron chlorides as coagulant and A maleic acid-based as antiscalant can contribute to the increase in the percentage of these elements in the fouling.
- The adhesive complex is composed of a particulate colloidal matter (Al, Fe, Si) and organic substance. It can accelerate the formation of fouling. Adsorption of organic and colloidal matter can also play a crucial role in the development of fouling layers.

References

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