NEW APPLICATION OF OOIDS AS PRETREATMENT MEDIA-FILTRATION FOR SEAWATER DESALINATION PLANTS

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ABSTRACT

Naturally, ooids were obtained by sieving from an open-intake in the Mediterranean Sea in Marsa Matrouh city in Egypt and other coasts and they are varying in its size from less than 0.1 up to 0.8mm compared to conventional sand-media of seawater desalination plants as a new pretreatment media-filtration. Ooids media-filtration system demonstrated a performance in removing particulates from the feed water and producing permeate of acceptable quality for feeding the RO membranes at different temperatures 20, 30 and 40°C and different flow rates 20, 40 and 60l/min. At lower flow rate 20l/min and higher 40°C, the ooids grains-filter produced water with better quality compared to that obtained from the sand-filter. The silt density index (SDI), turbidity and total organic carbon (TOC) are the filtrate quality parameters relevant to feeding desalination plants. The addition of coagulant at a concentration 1.6mg Al/l of polyaluminum chloride (PAC), produced a filtrate from ooids filter of better SDI (less than 3), lower turbidity (0.21 NTU) and higher TOC% reduction (66.1%). This study is based on a semi-pilot desalination unit, which located in the Egyptian Petroleum Research Institute (EPRI).

Keywords: Desalination, Reverse osmosis, Seawater, Ooids, Water treatment

1. Introduction

The pretreatment system is the main purpose to remove foulants contained in the source seawater and to prevent their accumulation on the RO membrane surface of seawater desalination plant. Many of the pretreatment conditioning processes followed by a conventional single- or double-stage sand filtration to remove seawater foulants such as break-point chlorination, acid addition, in-line coagulation and addition of a flocculation aid [1].

The original mineralogy of calcium carbonate components in marine settings is almost exclusively either calcite or aragonite. Because aragonite is unstable with respect to low-magnesium calcite, aragonite components transform to calcite via dissolution-precipitation processes early in the diagenetic history of most sequences. Ooids are spherical or ellipsoid coated sedimentary grains of calcium carbonate, there have been examples of ooids that are 16mm in diameter, but usually less than 2mm in diameter [2].

Calcite ooids grains were formed by Bakr *et al*. inside an assembled semi-pilot softening unit through a continuous chemical process involving reaction between bicarbonate ions and added lime using natural seawater samples. The feed seawater samples to our semi-pilot unit in the Egyptian Petroleum Research Institue (EPRI) were natural samples obtained from three locations of open-intakes; Marsa Matrouh City, Damietta City and Ain Sukhna City in Egypt [3].
Bakr and Makled were investigated the applicability of Amphistegina tests instead of sand media filtration as new pretreatment media to seawater desalination plants [4].

Therefore, the major objective of this study is to investigate the applicability of the Ooids grains instead of sand media filtration as a new pretreatment of seawater desalination plants. The comparison between them takes place in a single media filter to enhance the required filtrate quality which is the most required criteria in seawater desalination technique.

2. Materials and methods

The composition of calcite ooids is mainly $CaCO_3$ (with traces of $MgCO_3$) and the grain size between 0.1 and 0.8mm (n=1000 tests) with effective size range 0.4-0.6mm. The filter media used in our semi-pilot unit for the pretreatment of seawater are depicted in Figure1. The schematic diagram of a semi-pilot RO desalination unit located in EPRI was designed in Figure2 to meet the objectives of this study. The same unit was used and characterized by Bakr and Makled [4], with two exceptions for that unit were illustrated in Figure2. The single-media vessel has filtration media (sand or ooids) – typical design includes sand, with effective size: 0.45-0.55mm and calcite ooids, 0.4-0.6mm and the bed capacity in liters required for each vessel (6.6 sand and 7.92 ooids).

Figure1: Sand media and formed calcite ooids

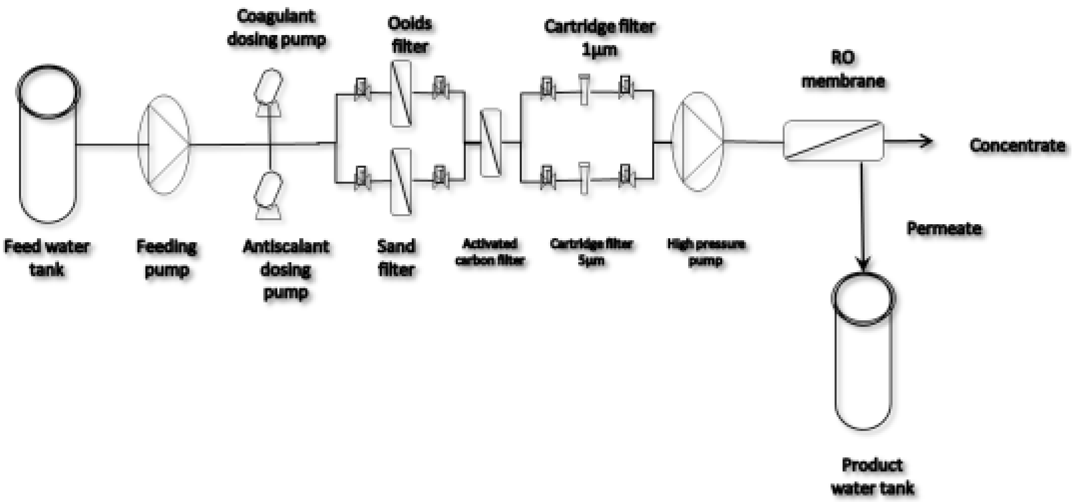

Figure2: Schematic diagram of a semi-pilot unit of desalination pretreatment

3. Conclusions

The results that obtained from this study are:

1) When operating at flow rate 20l/min and temperature 40°C with addition of coagulant at a concentration of 1.6mg Al/l produced filtrates of better SDI for ooids filter (less than 3) compared to sand media (3.8 SDI).
2) It is observed that higher removal of turbidity (89.4%) resulted in case of ooids filter and which is 69.7% in case of sand filter.

3) At lower flow rate 20l/min, the ooids filter achieved a TOC reduction (66.1%), while TOC reduction for sand filter is 58.2%. and the total reduction of residual TOC after passing through activated carbon filter for sand and ooids filtrates exceeded 90.3 and 95.7%, respectively.
4) At higher temperature, the service flow rate of ooids filter is higher compared to sand filter by 35.5%, while in case of lower temperature the filtrate flow from ooids filter is still higher by 31% only.
5) The consumption of seawater to clean the calcite ooids filter in backwash process is lower than that of sand filter by 18% at 40^{o}C. But in case of lower temperature, the difference is reduced to 7.25%.
6) The bed expansions at higher temperature were 20% and 37% for sand and ooids filters, respectively.

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