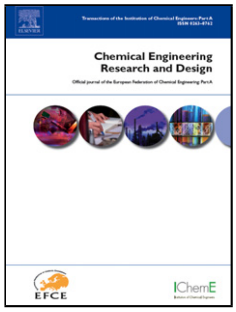

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Methodical design and operation of membrane distillation plants for desalination

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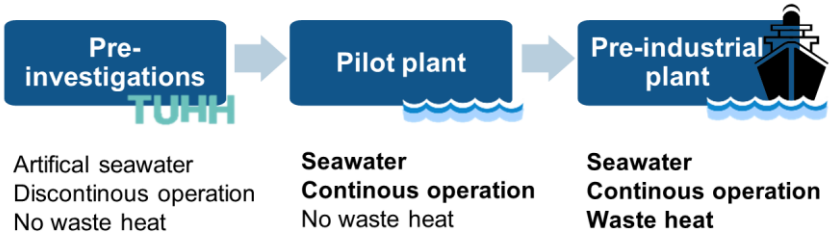
Highlights

Graphical abstract



Highlights

- A seawater desalination plant based on PGMD was operated without any flux decline
- A heat recovery concept was implemented in a pre-industrial DCMD plant
- The yield of a DCMD plant was significantly increased due to a recycle concept
- A pre-industrial DCMD plant was successfully operated on board using seawater

Abstract
The operation of pre-industrial membrane distillation (MD) units is of great importance in order to implement this new technology. The systematic development from module to plant design for MD is conducted in an industrial research-cooperation. The consequent up-scaling from a lab plant at Hamburg University of Technology (TUHH) for MD module evaluation to a pre-industrial plant is presented. Permeate gap MD (PGMD) and Direct Contact MD (DCMD) spiral wound modules with different channel lengths have been used in this study to evaluate the most suitable module configuration and design. It has been decided to go along with DCMD modules with a relatively short channel length.N A pilot plant for on land testing has been built and operated for 9 months before constructing the pre-industrial unit. In the pre-industrial plant waste heat was used and a heat recovery and recycle concept was implemented and tested successfully. It has been proven that long-term operation with real seawater is possible without significant performance decline. Besides operational data also MD plant design specifics will be discussed. The importance of ambient pressure conditionNs for the MD modules was determined. In addition, the possibility of piping system deaeration is discussed.

Keywords — membrane distillation, desalination, energy efficiency, plant design

1. Introduction

INTRODUCING new technologies into the market is always a challenging process requiring various reference test trials with long-term operation under real conditions. In this particular case the industrial feasibility of membrane distillation is evaluated choosing an application of industrial relevance for the development of a pre-industrial unit. In a structured investigation the gap between laboratory investigations and material contemplations to full-scale module and plant design is carried out.

In general, membrane distillation is a thermal separation technology which is capable of serving various separation needs. First described in the 1960s by Bodell and Weyl [1,2], since then there have been plenty of applications described for MD in literature. The most promising amongst them are the desalination of seawater, process water or the further concentration of brine from reverse osmosis units and the recovery of highly pure valuable compounds from liquid mixtures [3].

In this work the focus is on the application of MD for the desalination of seawater in order to demonstrate its industrial feasibility. Seawater is available on earth in large quantities. 96.5 % of total water is contained in World's Oceans [4]. Only few water resources can be called freshwater. But freshwater is necessary and extensively used for industrial processes and