Giuliano
Calendo

Graduate Candidate	Giuliano Calendo
Examiner	Prof. Dr. Michael Burkhardt
Co-Examiner	Prof. Dr. Wolfgang Uhl, Systems Engineering and Technology, Norwegian Institute for Water Research (NIVA), Oslo
Subject Area	Water treatment

Impact of Operational Conditions on Fouling over the Length of RO Membranes

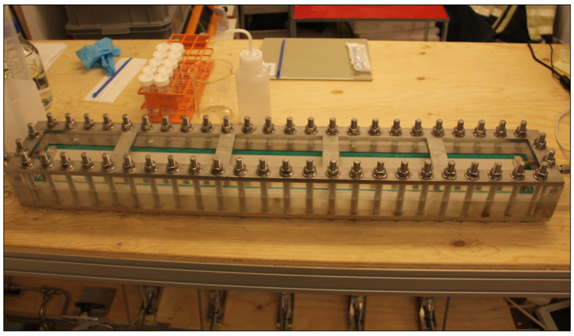

Fig. 1: Long channel membrane test cell (LCMTC) at NIVA for fouling studies on spiral-wound modules

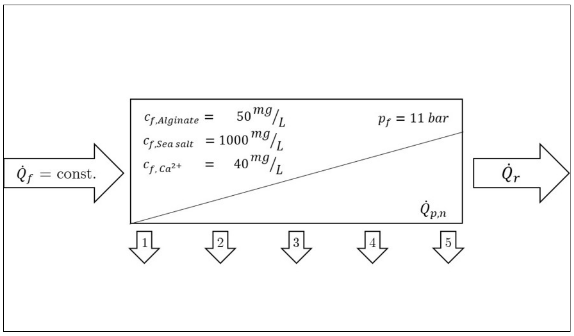

Fig. 2: Scheme of the fouling experiments with certain settings of the tested matrix

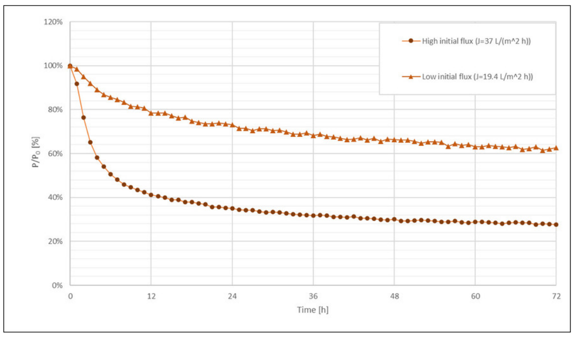

Fig. 3: Impact of initial flux on normalized permeability. Higher flux results in a faster decline of permeability

Introduction: Access to clean water is one of the most pervasive problems afflicting societies all over the world. This lead to global efforts to increase the freshwater supply via desalination of sea and brackish water. Reverse osmosis (RO) is a membrane separation process commonly used for this purpose. A major draw back of this technology is fouling, a disadvantageous deposition of e.g. particles and macro-molecules on the membrane surface. Fouling results in a decline in permeability and even damages the membrane.

Objective: The objective of this thesis was to study the impact of operational parameters, such as flux and crossflow velocity, on the fouling process. As part of a collaborative research project between UMTEC and NIVA, various desalination experiments with brackish water were performed at both institutes. The test rigs used for these experiments were equipped with a "long channel membrane test cell" (LCMTC) with five permeate segments to get an insight on operation over the length of an industrial membrane module. At UMTEC, the experiments were conducted to proof the hydraulic conditions and reproducibility of the developed LCMTC. The LCMTC performance was monitored for different configurations and at pressure levels from 3 to 11 bar. The fouling studies were conducted at NIVA. The experiments were performed at an operational pressure of 11 bar with three different crossflow velocities (0.137 m/s; 0.085 m/s; 0.064 m/s). For all experiments artificial brackish water was prepared as feed solution. Alginate (50 mg/L) was added as a model fouling substance.

Result: The tests at UMTEC showed, that feed water is still leaking into the permeate channel. Consequently, mixing between the permeate channels occurs at higher pressure conditions. It was recommended to improve the sealings. The new Labview programme make the operation extremly user friendly.
For all fouling experiments performed at NIVA, a rapid decline in permeability was observed. The fouling layer was removed, dissolved and analysed for DOC and TOC to measure the amount of foulant accumulated on the membrane. It was obvious that the fouling rate changed for the different operational conditions. High initial flux resulted in high rates of fouling, whereas high crossflow velocities reduced the fouling rates.
Overall, the LCMTC are promising tools to rapidly test new and or study existing membrane performance with different water matrices.