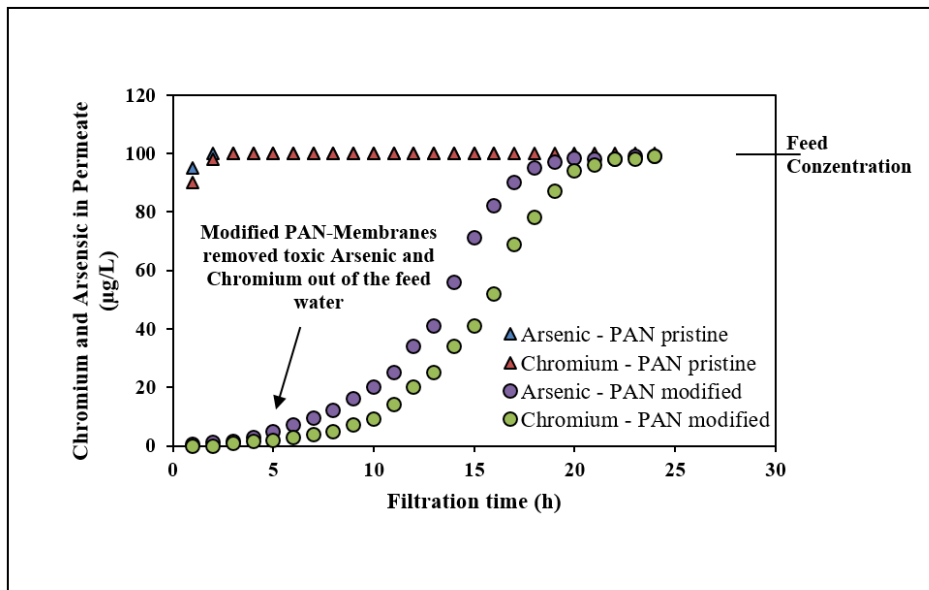


2.5 SELMO-HF: Selective Oxyanion Removal from Drinking Waters by modified Hollow Fibre Membranes



Project Duration

01.07.2020 – 30.06.2022

Funding

i³ Project of the Hamburg University of Technology

TUHH
Technische Universität Hamburg

Introduction

In 2020, 30% of the world population had no access to safe and clean drinking water supply. Some of the reasons for this are microbiological pollution and the presence of arsenate and other heavy metals in raw water sources. High concentration of arsenate in ground water is a health problem for more than 300 million people in 100 countries in the world. Related to arsenate, chromate is another geogenic pollutant that causes problems for the water supply of millions of people worldwide. Both substances belong to the chemical group of the oxyanions (HAsO_4^{2-} , CrO_4^{2-}) and are highly carcinogenic and listed as most hazardous health issues by the World Health Organization. Due the negative charge of these substances, ion exchange is a possible technology for the treatment of this raw water. However, this technology is technically complicated as well as cost and energy intensive.

Research Goals

Goal of this project is the development of a new ultrafiltration membrane, which is capable of rejecting microbiological pollutants as well as remove oxyanions by adsorption onto the membrane material. For this, the Institute for Water Resources and Water Supply (TUHH) and the Institute for Polymer Research (HZG) will collaborate interdisciplinary to develop a functionalized polymer membrane. The novel membrane should be able to remove particular substances due its small pore size (10-30 nm) and operate at moderate pressures of max. 0.3 bar.

Approach

Pristine PAN membranes were modified with different anion exchange groups such as primary and quaternary ammonium groups to create an adsorption capacity for arsenate and chromate ions. Due to a periodic backwash, particular fouling were removed and anion exchange groups were regenerated. By this technology, only a single filtration was necessary to produce microbiologically safe and oxyanion-free drinking water. The modification methods used in this project are described in Fig. 1.

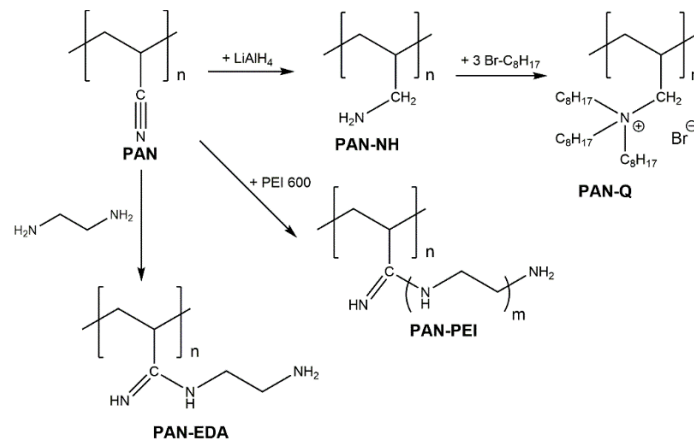


Figure 1: Preparation of PAN-Modifications; Nitrile group of PAN is functionalized with different methods

Recent Results

The functionalization of the virgin PAN membrane was successful conducted with the different methods, which can be seen by the increased surface charge of the modified membranes (Fig. 2) and the FTIR-data (Fig. 3).

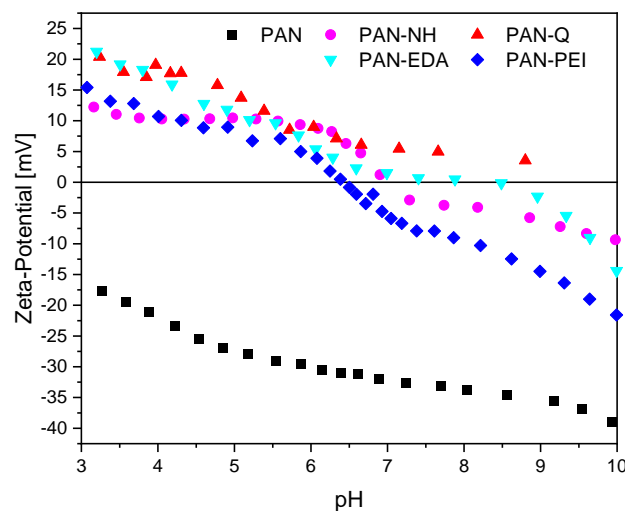


Figure 2: Zeta potential of functionalization of PAN membranes, streaming potential method, 1 mmol/L KCl

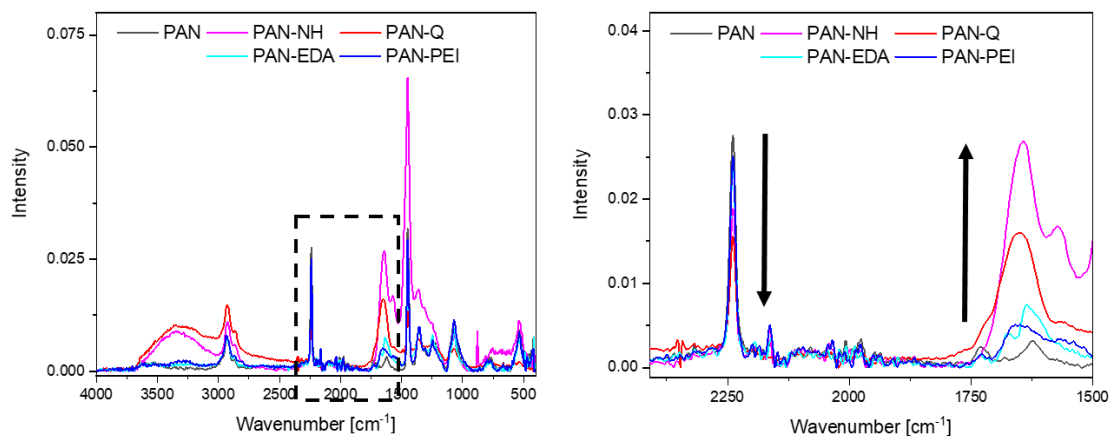


Figure 3: FTIR Data of different PAN membranes

Filtration experiments with pure water and chromium spiked water showed that the pure water permeability of the modified membranes were only affected to a small extent (Fig. 4A). However, the adsorption capacity for the removal of hexavalent chromium increased significantly (Fig. 4B). The data showed that the highest removal performance was reached with the PAN-NH membrane and the PAN-EDA membranes, which both are modified with primary amine functional groups. Furthermore, the quaternized PAN membranes (PAN-Q) also showed an increased adsorption capacity.

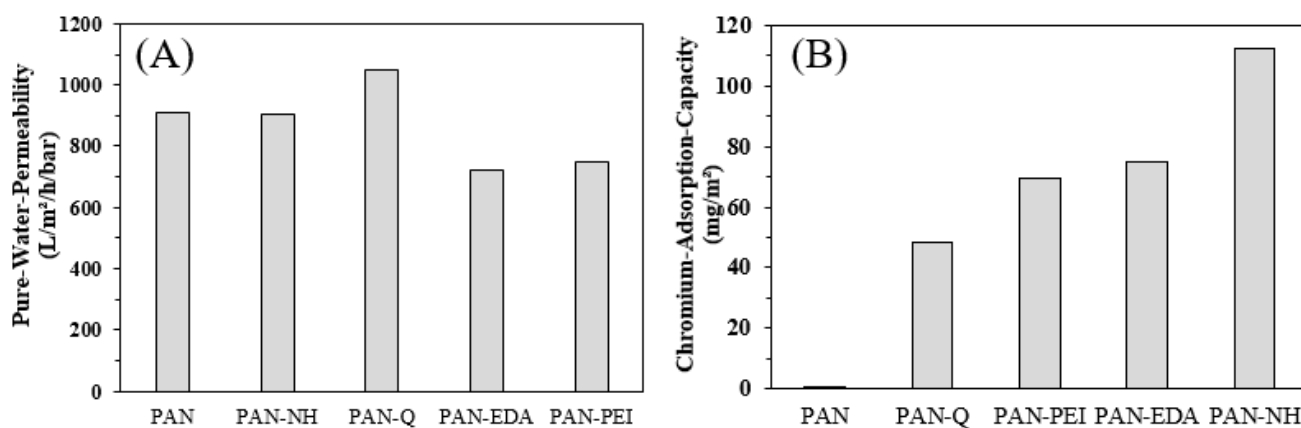


Figure 4: A) Permeability data of different PAN membranes; B) Chromium-Adsorption-Capacity of PAN membranes

Conclusion and Outlook

The first results of the PAN modification showed promising results for the adsorption of negatively charged oxyanions. Further experiments should show whether desorption of chromate and arsenate is possible during backwash and if the adsorption capacity can be restored.

Project Partners

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