Department of Civil, Geo and Environmental Engineering
Chair of Urban Water Systems Engineering

Evaluation of water reuse and recovery of energy and salts during treatment of domestic and industrial wastewater effluents using a combination of biological and membrane separation processes

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☒ **ongoing** ☐ **finished:**

Project relevance and motivation

The sustainable development in the world has been challenged by water scarcity due to population growth, urbanization, climate change and environmental pollution. This challenge calls for the use of developed and improved technologies that can enhance water supply through the use of alternative water sources, such as domestic and industrial wastewater effluents.

Membrane separation processes in wastewater treatment and water reclamation are widespread in developed countries and they are occupying more and more prominence in Brazil. In the water sector, membrane processes most commonly used are: reverse osmosis (RO), applied mainly for water purification in seawater desalination and brackish water; nanofiltration (NF), used in water purification, bleaches and elimination of micro-pollutants; ultrafiltration (UF) and microfiltration (MF), applied in bioreactors with membranes (MBRs) to treatment of domestic sewage and industrial effluents aiming at the reuse of treated water.

Reverse osmosis has emerged as an efficient membrane separation process in drinking water production. Despite the advances in reverse osmosis, fouling control is considered a major challenge in operating membrane systems as it leads to higher operating pressures, frequent need for chemical cleanings, membrane deterioration, and

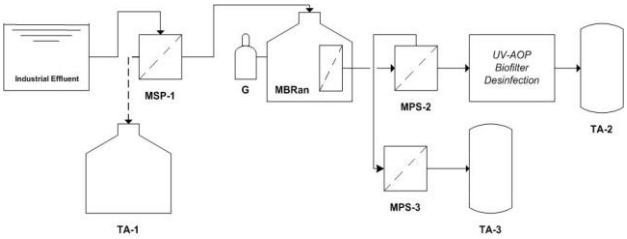
compromised water quality. Fouling of membranes in water and wastewater treatment is a complex phenomenon caused by many mechanisms such as scaling, adsorption, concentration polarization and biofouling.

Objectives

The aim of this project is to confirm the technical feasibility of an anaerobic biological process application (anaerobic membrane bioreactor - AnMBR) coupled with subsequent membrane separation processes (ultrafiltration, nanofiltration, reverse osmosis and electrodialysis) for establishing water reuse, energy recovery and salts recovery strategies from treatment of two waste streams (municipal wastewater and vinasse). Therefore, the combination of these processes may be displayed as a promising technology in transitioning domestic and industrial effluents, which are perceived of turning waste streams into valuable products.

Experimental setup

This project has been developed in partnership with the Federal University of Minas Gerais, Brazil, and it has been performed in two different stages due to evaluation of two types of effluents (municipal wastewater and vinasse) in different treatment processes. Regarding the industrial wastewater (vinasse) treatment, it has been conducted at the Federal University of Minas Gerais-UFMG and the treatment process route and the experimental setup utilized are illustrated, respectively, in Figures 1 and 2.



Legend:
MSP-1 – Ultrafiltration
MSP-2 – Nanofiltration
TA-1 – Recovery for fertirrigation
G – Biogas storage
MBRan – Anaerobic Membrane Bioreactor
MSP-3 – Electrodialysis
TA-2 – Water recovery
TA-3 – Recovery of salts

Fig. 1: Schematic illustration of the industrial effluent treatment route (vinasse)

Fig. 2: Bench-scale AnMBR with two reactors in series for vinasse treatment.

Regarding the municipal wastewater treatment, it has been conducted at the Technical University of Munich-TUM and a bench-scale membrane system (Figure 3) with a flexible configuration (flat sheet or spiral-wound module) has been used to evaluate the performance of RO membrane process in drinking water production. The bench-scale unit is equipped with a customized control and data acquisition system to monitor and register flux, pressure and selected water quality parameters (e.g., temperature and conductivity).

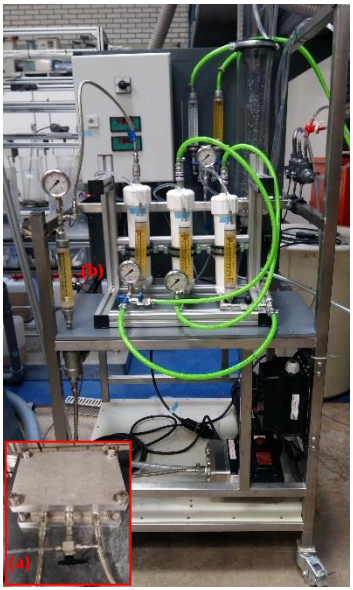


Fig. 3: Bench-scale RO membrane system with a flexible configuration: (a) flat sheet or (b) spiral-wound module), used to evaluate the performance of RO membrane process in drinking water production

The impact of the feed water quality (municipal wastewater treated by a fluidized bed UF reactor) in a RO membrane operation will be analyzed, concerning:

- biofouling characteristics and mitigation strategies, whereas a better understanding of biofouling characteristics and its mechanisms can help to control biofilm growth, develop cleaning strategies and improve sustainable operation of the membrane system;

- ammonia and TOrCs rejection;

- the permeate quality for purposes of direct potable reuse.