THE USE OF ULTRAFILTRATION IN BIOLOGICALLY TREATED COKE OVEN WASTEWATER POLISHING

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Introduction One of the intensively developed concept to treat highly-loaded coke oven wastewaters is the application of membrane technologies, which become more frequently used and can successfully compete with traditional treatment schemes. In the water reclamation by NF or RO technology, which are used to remove dissolved molecules from effluent to be reused, the membrane unit feed is often the effluent from biological treatment process, and beside of undecomposed refractory compounds, it can contain also high level of biological active sludge, which can cause membrane fouling. Thus, a pretreatment process prior to the NF or RO system is required to alleviate this phenomenon. Presented researches aimed to recognize the efficiency of low-pressure membrane filtration pre-treatment of real effluents from biological loop of coke oven wastewater treatment plants. In the current research, the efficiency was evaluated in terms of removal of COD. Volumetric flux stability and the resistance to fouling phenomenon of polymeric and ceramic membranes differed in molecular weight cut-off was investigated.

Filtration experiments were conducted using laboratory scale set-up KMS Cell CF1 by Koch Membrane Systems (Fig. 1), operated in a cross-flow mode. Four types of polyethersulphone (PES) ultrafiltration membranes (by Synder Filtration), i.e. ST, MT, VT and XT with corresponding molecular weight cut-off (MWCO) equal to 10 kDa, 5 kDa, 3 kDa and 1kDa, respectively, and two DisRAM ceramic disk membranes (TAMI Industries), i.e. Fine UF-5kDa and Fine UF-8kDa with zirconia active layer were used. To evaluate the performance of ultrafiltration process as a the pretreatment method, wastewaters after biological loop were filtered at a transmembrane pressure of 0.1 to 0.3 MPa until 80% of initial feed volume was recovered in the form of permeate. After wastewater filtration, the deionized water flux was established for membranes neither chemically nor hydraulically cleaned in order to evaluate the impact of membrane fouling on the process capacity. In order to determine the overall efficiency of biological effluents ultrafiltration as a pre-treatment method, the removal rate of contaminants indicated as COD was evaluated.

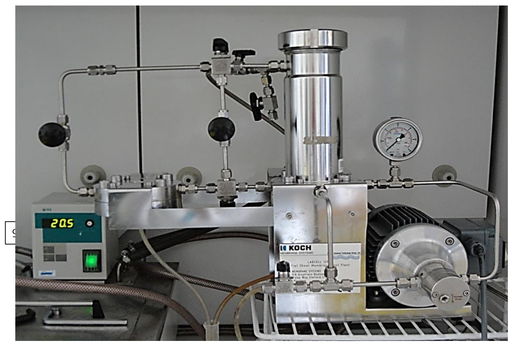

Fig. 1. KMS Cell CF1 lab-scale membrane filtration unit

RESULTS

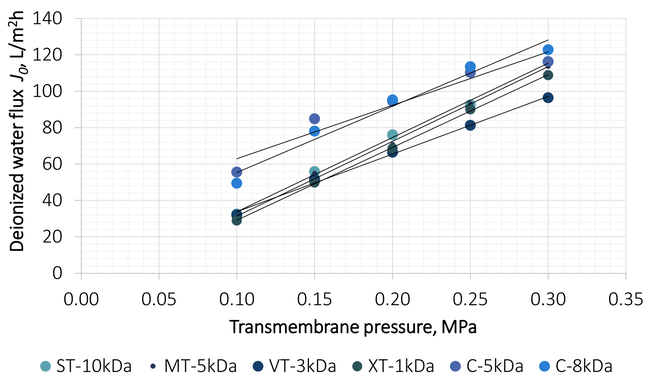

Fig. 2. Deionized water flux determined for tested PES and ceramic membranes as a function of transmembrane pressure in the range of 0.1-0.3 MPa

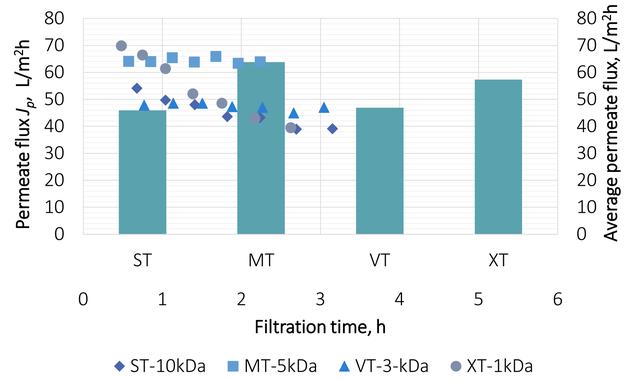

Fig. 3. The change of permeate flux with filtration time and its average value for biological effluent ultrafiltration (TMP of 0.3MPa) for tested PES membranes

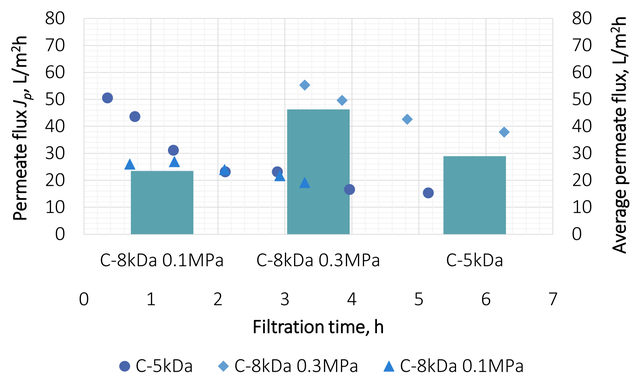

Fig. 4. The change of permeate flux with filtration time and its average value for biological effluent ultrafiltration (TMP of 0.3MPa) for tested ceramic ZrO_2 membranes

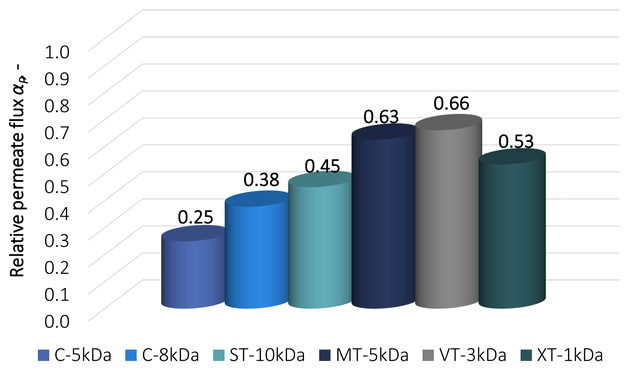

Fig. 4. Relative permeate fluxes through polymeric and ceramic membranes applied in treatment of biological effluents (TMP of 0.3MPa)

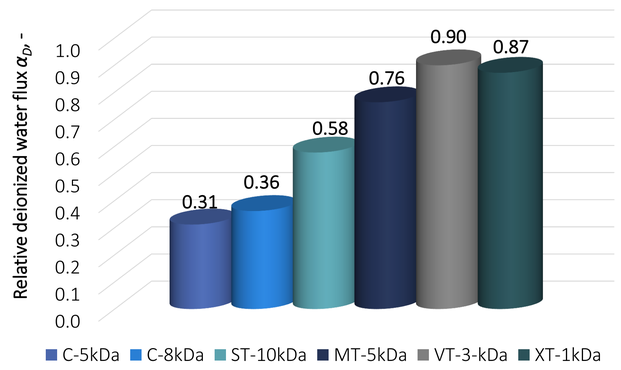

Fig. 5. Relative deionized water flux through polymeric and ceramic membranes applied in treatment of biological effluents

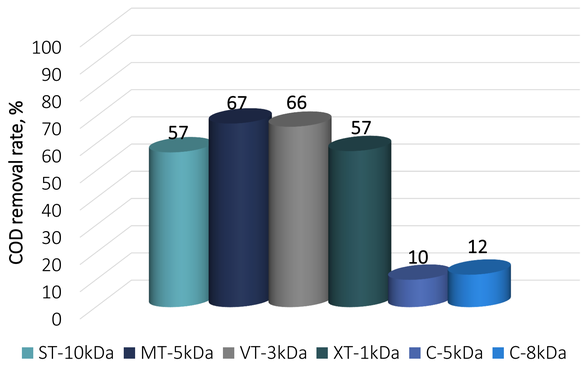

Fig. 6. COD removal by UF process with PES and ceramic membranes

CONLUSIONS

- Four types of polyethersulphone membranes of MWCO of 20 kDa, 10 kDa, 5 kDa, 3 kDa and 1kDa, as well as two ZrO_2 ceramic membranes with MWCO equal to 5kDa and 8kDa were applied in ultrafiltration of biological treatment effluents.
- Comparing membrane capacities observed during wastewater filtration it was found, that ceramic membranes were more susceptible to fouling phenomena (Fig. 3 and 4).
- Less open polymeric membranes exhibited the best permeate capacity and were the least vulnerable to fouling resulting of pore blocking.
- In case of more open membrane, fouling was mainly a result of the deposition of contaminants inside membrane pores making the capacity recovery process less effective.
- Application of ultrafiltration as method for biological effluent polishing, intending its further purification in nanofiltration and reverse osmosis units showed, that separation with tested UF membranes allowed for reduction of COD for more than 57%, 66% and 67% in case of XT/ST, VT and MT polymeric PES membranes, respectively, which was stated to be suitable level while considering NF/RO membrane fouling prevention.
- Ceramic membranes exhibited worse performance in the case of COD removal, and the rejection degree was not higher than 12% obtained for C-8kDa membrane (Fig. 6).

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