THE USE OF ULTRAFILTRATION IN ENHANCEMENT OF CHEMICAL COKE OVEN WASTEWATER TREATMENT

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Introduction: Coke oven wastewater is one of the most contaminated and toxic aqueous stream generated by thermal coal processing. It contains a significant amount of organic and inorganic pollutants, among which substances well recognized as environmental and living organisms toxicants can be found, i.e. cyanides and sulphides. In the conventional coke oven treatment system, these contaminants should be eliminated from the stream at chemical wastewater treatment site. However, due to operational limitations, part of the compounds remains in the stream, which is introduced to further biological treatment, what may lead to inhibition of biological processes.

The main goal of the presented research was to test different ultrafiltration membranes toward enhancement of chemical coke oven wastewater treatment and to evaluate the efficiency of the process in regard to capacity, fouling affinity and selected contaminants (complex cyanides, COD) removal rates.

Filtration experiments The laboratory scale installation for membrane filtration, KMS Cell CF 1 (produced by Koch Membrane Systems) (fig.1), operated in a cross-flow mode was used for chemically treated coke oven wastewater polishing. The installation was equipped with the feed tank of a volume of 0.5 dm^3 and a flat-sheet membrane with an effective separation area of 28 cm^2. 3 types of polyethersulphone (PES) ultrafiltration membranes (by Synder Filtration), i.e. SM, ST, MT with corresponding molecular weight cut-off (MWCO) equal to 20, 10 kDa, and 5 kDa were used. The characterization of membrane's transport properties by determining a dependence of deionized water volumetric flux on a transmembrane pressure (TMP) in the range of 0.1 to 0.3 MPa was made. Real coke oven wastewater after chemical loop was 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. The deionized water flux after process was established to evaluate the impact of membrane fouling on the process capacity.

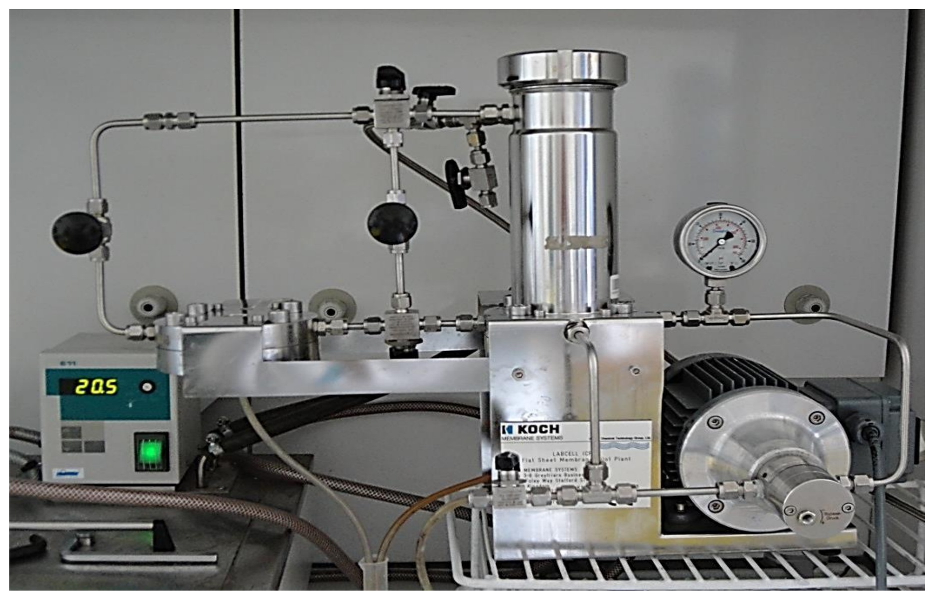

Fig. 1. KMS Cell CF1 lab-scale membrane filtration unit

RESULTS

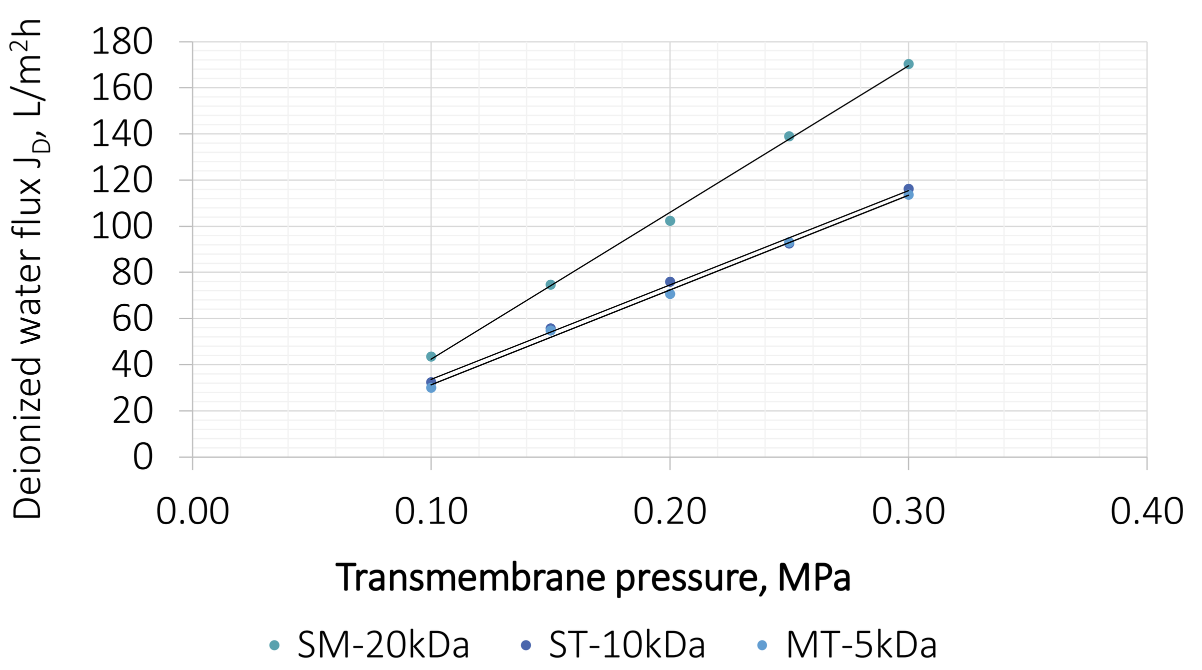

Fig. 2. Deionized water flux determined for tested PES membranes as a function of transmembrane pressure in the range of 0.1-0.3 MPa

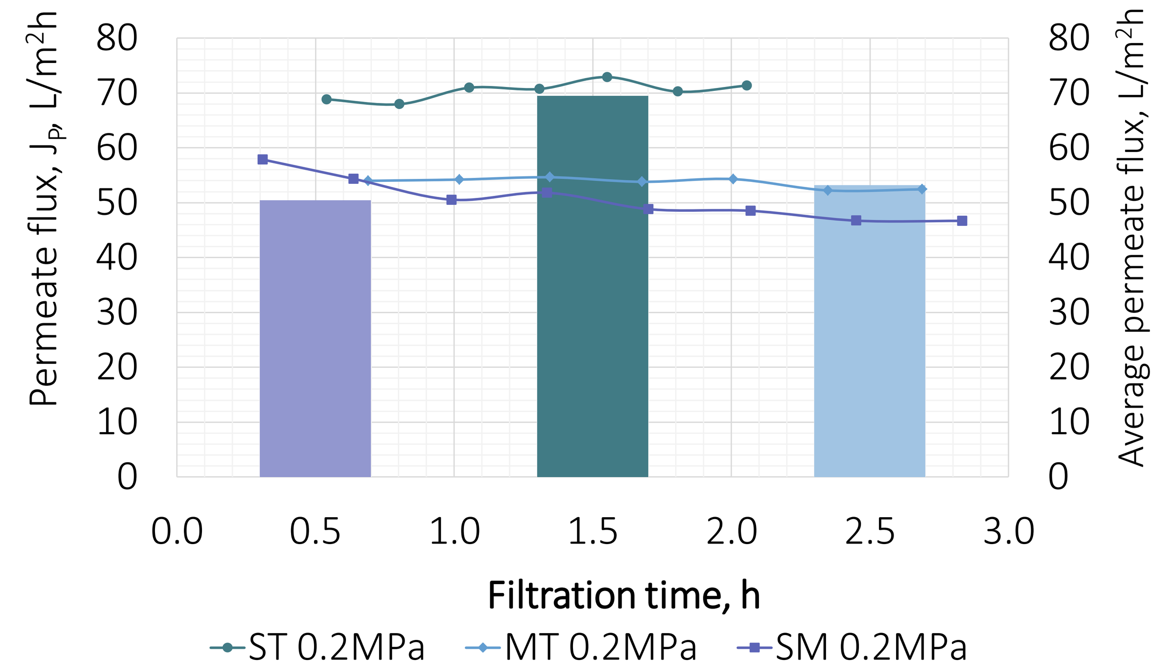

Fig. 3. The change of permeate flux with filtration time and its average value for chemical loop effluent ultrafiltration (TMP of 0.2MPa) for tested PES membranes

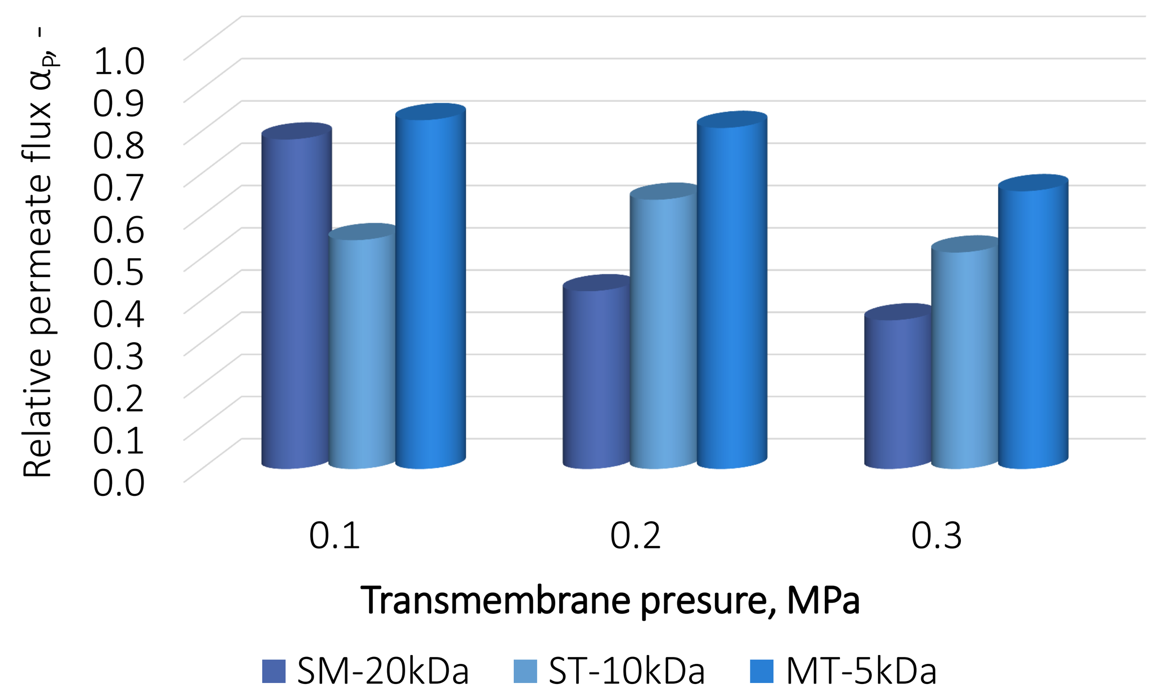

Fig. 4. Relative permeate fluxes through polymeric PES membranes aaplied in treatment of chemical loop effluent (0.1-0.3 MPa)

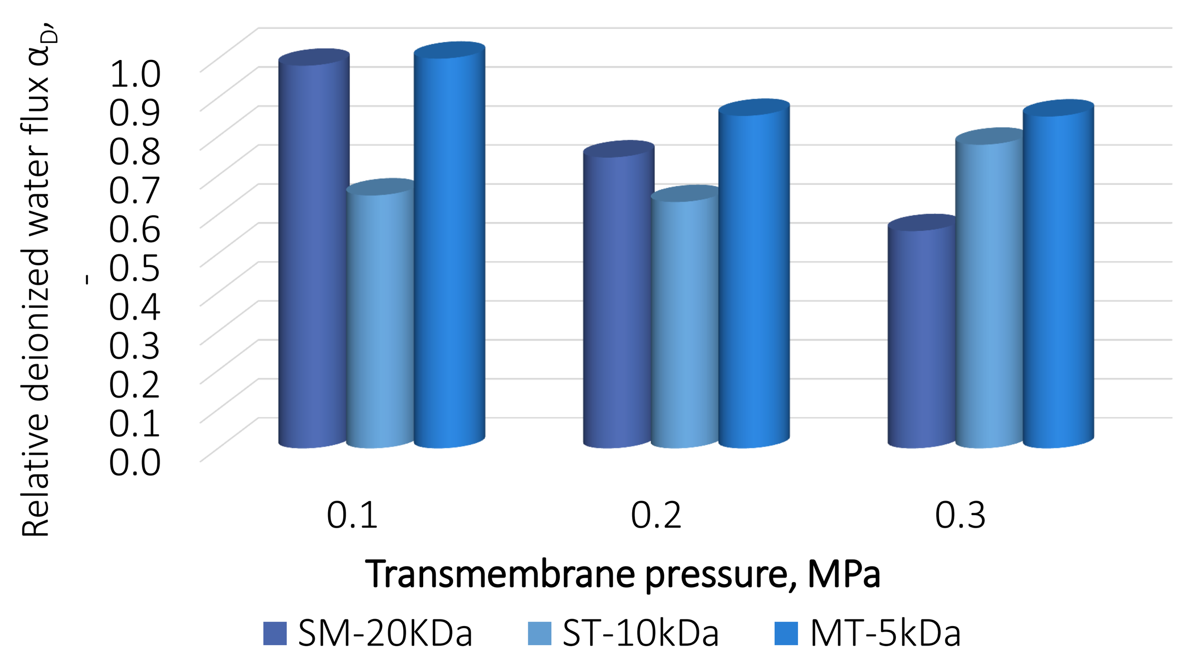

Fig. 4. Relative deionized watewr fluxes through polymeric PES membranes after ultrafiltration of chemical loop effluent (0.1-0.3 MPa)

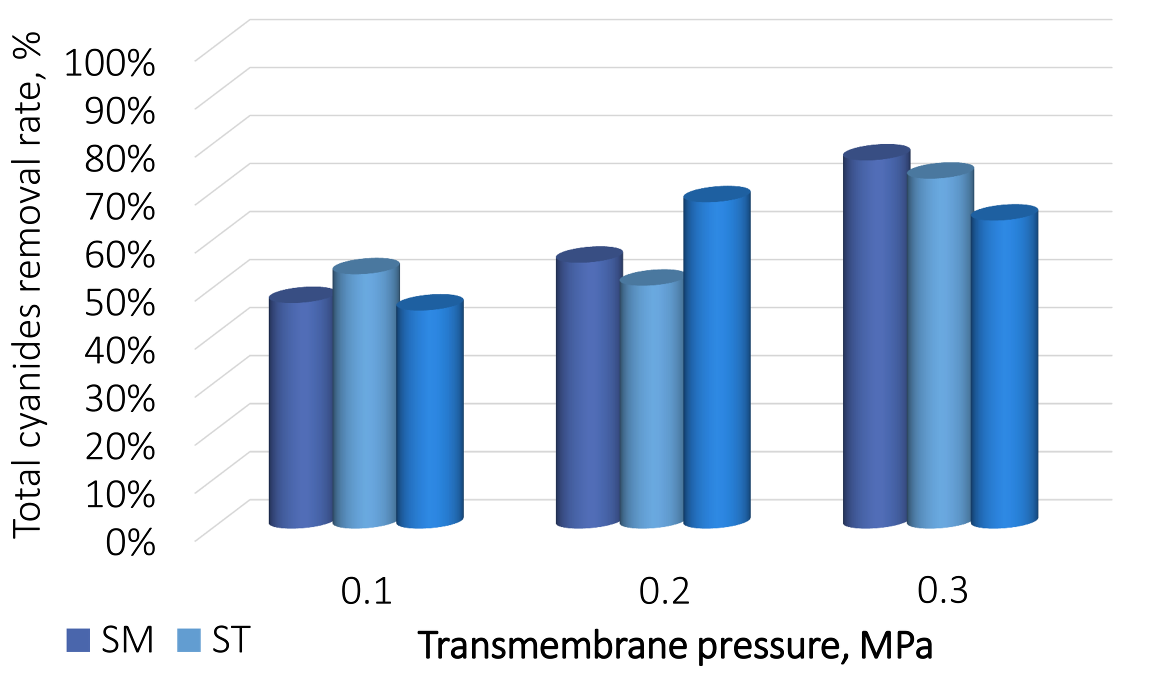

Fig. 5. Total cyanides removal by UF process with PES membranes

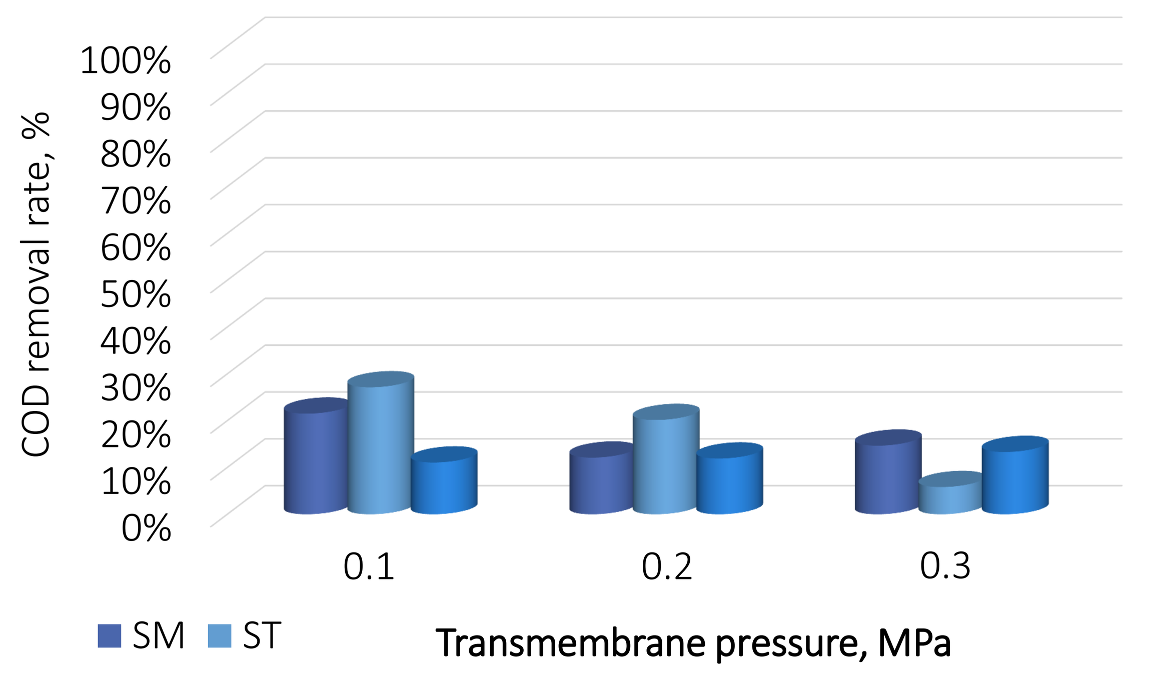

Fig. 6. COD removal by UF process with PES membranes

CONLUSIONS

- Three types of polyethersulphone membranes of MWCO of 20 kDa, 10 kDa, 5 kDa were applied in ultrafiltration of chemical treatment effluents.
- Membranes characterized with the smallest molecular weight cut off (5 kDa), exhibited the best permeate capacity and were the least vulnerable to fouling phenomenon resulting of pore blocking (fig. 2, 3 and 4).
- In case of more open membranes (10 and 20 kDa), fouling was caused by deposition of contaminants inside membrane pores making the capacity recovery process less effective (fig. 3 and 4).
- Evaluation of contaminants removal efficiencies indicated, that ultrafiltration process could be successfully combined with chemical treatment not only to prevent membrane from adverse fouling, but also to remove iron-cyanide complexes (fig. 5). The obtained reduction rate of total cyanides varied from 46 to 75%.
- Removal of organic contaminants expressed as COD was less efficient (27%) indicating, that most of contaminants were below MWCO that the ones of tested membranes (fig. 6).
- Among all tested membranes, the treatment of chemical effluents at MT membrane of cut off 5 kDa would be preferable due to its capacity, lowest fouling affinity and contaminants removal efficiency.

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