Effect of Advanced Oxidation Pretreatments on Membrane Filtration of Protein Containing Waste Waters

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Membrane separation processes offer several benefits over conventional methods in industrial wastewater and water treatments, however, fouling issue limits their applications. Several materials may cause fouling, depending on the chemical characteristics of the membrane material and the pollutant, or the characteristics of the water matrix. Nevertheless, proteins and protein-like substances are known to induce severe membrane fouling. These types of pollutants often can be found in food industrial waters, like dairy or meat industrial effluents. There are several methods for enhancing fouling mitigation, both physical and chemical methods. Among them, oxidation pre-treatment may open a new way in development membrane filtration processes, which meet the requirements of „circular economy", as they not only may prevent the membrane fouling, but enhance the biodegradability and make possible the utilization of the retained pollutants. In this work, the effect of ozone and Fenton-reaction as pre-treatments, and the effect of membrane modification by heterogeneous photocatalyst particles on membrane fouling were investigated and compared. During experiments different types of proteins, BSA, whey proteins, casein and model and real industrial wastewaters were treated.

In order to reveal the effect of pre-treatments and membrane modification, fouling models were fitted and membrane filtration parameters were calculated. It was found, that short time ozonation and Fenton pre-treatments enhance the flux and decrease the fouling. Examination of the effect of the oxidation capacity of ozone and Fenton reagents show that the fouling propensity does not depend on the pre-treatment method, only the applied oxidation capacity. At the same time, long-term oxidation has no positive effect on fouling mitigation, as the formed oxidation by-products may go through the membrane, or may cause fouling, decreasing the pollutant rejection and increasing filtration resistances. After membrane filtration the possibility of retained pollutants also were investigated; the biogas production yield and the methane content in the biogas also increased in the pre-treated samples.

The membrane modification affects the protein fouling in a more complex way. In this case, the membrane – protein - water matrix (e.g. pH, salinity) interactions should be taken into consideration. Our results show, that the membrane preparation method, the particle size, the pH also affect the flux and pollutant retention. In case of large molecules, which are tend to associate, the membrane modification may be advantageous, moreover, the fouled membrane can be cleaned by means of heterogeneous photocatalysis.

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