Coupling horseradish peroxidase based bioreactor with membrane distillation: elucidating antibiotics degradation and membrane fouling mitigation

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Abstract

The frequent detection of antibiotics in the surface water bodies increases concerns due to their harmful effect on the biota. In this study, the potential of standalone membrane distillation (MD) and horseradish peroxidase (HRP) enzyme assisted MD treatment (MD_{HRP}) was explored for the removal of 13 antibiotics. A standalone MD system achieved 95 to >99% removal of the antibiotics from feed solution in ultra-pure water. The enzymatic membrane bioreactor, *i.e.*, MD_{HRP} completely retained both the HRP enzyme and antibiotics (>99%) in the feed tank, and HRP achieved biocatalytic degradation of antibiotics, thus reducing antibiotics concentration in the feed solution. Overall, 16 to >99% degradation of the antibiotics retained within MD_{HRP} system was achieved by HRP. Antibiotics degradation was greatly affected by the chemical structure and physicochemical properties of the antibiotics. MD_{HRP} treatment resulted in high removal (>70%) of antibiotics containing either electron-donating groups (*e.g.,* phenolic group) or both electron-donating group/electron-withdrawing groups (*e.g.,* phenolic and amide groups/carboxylic group) in their structures. When secondary-treated effluent (*i.e.,* effluent from a conventional membrane bioreactor) was spiked with antibiotics and used as a feed in MD_{HRP} system, in addition to the antibiotics degradation, HRP reduced the concentration of bulk organic carbon (30%) and nitrogen (62%) from feed during continuous operation. This in turn assisted in reducing membrane fouling and improving the membrane flux.

Keywords: Horseradish peroxidase enzyme; Membrane distillation; Antibiotics; Enzymatic membrane bioreactor; Secondary wastewater effluent