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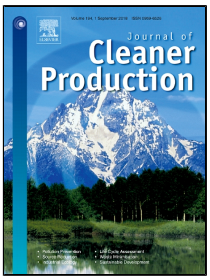

Membrane technology in wastewater treatment enhanced by functional nanomaterials

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Membrane technology in wastewater treatment enhanced by functional nanomaterials

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Abstract

Ultrafiltration polymer membranes are facing great challenges in broader applications, for their inherent limitations especially poor hydrophilicity, anti-fouling and anti-compaction properties. In order to improve and enhance the integrated properties of the membrane, $Y_xFe_yZr_{1-x-y}O_2$ coated TiO_2 solid superacid (SYFZr-Tis) functional nanomaterial was synthesized via hydrolysis, calcination and sulfation, and phosphorylated $Zr_xSi_{1-x}O_2/Al_2O_3$ (PZSA) was prepared through co-hydrolysis, silanization and phosphorylation, followed by coating of Al_2O_3. The functional nanomaterials show positive effects on membrane performances. The SYFZr-Tis nanoparticles can form micro reaction locations (MRLs) in the membrane when doping into polyvinylidene fluoride (PVDF) to prepare SYFZr-Tis/PVDF hybrid membranes, which show a tensile strength of 3.57 MPa, water contact angle of 29.1° and porosity of 73.58%. Moreover, the hybrid membrane shows a favorable oil retention ratio of 90.63% and a stable permeate flux of 345 L m^{-2} h^{-1} under operating pressure of 0.15 MPa (59.93% and 183 L m^{-2} h^{-1} for PVDF pristine membrane). In addition, the PZSA functional nanomaterials were employed as a functional layer to form PZSA self-assembled membrane on porous supports. Research shows that the self-assembled membrane performs oil and COD retention ratios of 86.84% and 85.23% respectively and a water yield of 526.32 L m^{-2} h^{-1} when treating oily wastewater (under operating pressure of 0.15 MPa). Furthermore, compared with the hybrid membrane, the PZSA self-assembled membrane performs recyclable character, which lowers membrane costs. Therefore, functional nanomaterials effectively enhance the development of membrane technology, and they are expected to achieve potential applications in wastewater treatment.

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