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Preparation of Novel Fe-ZSM-5 Zeolite Membrane Catalysts for Catalytic Wet Peroxide Oxidation of Phenol in a Membrane Reactor

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Abstract

Novel Fe-ZSM-5 zeolite membrane catalysts were prepared for catalytic wet peroxide oxidation (CWPO) of phenol in a membrane reactor. Firstly, the ZSM-5 zeolite membrane with a Si/Al ratio of 80 was fabricated by using secondary growth process on the surfaces of paper-like sintered stainless steel fibers (PSSFs) which was prepared by wet lay-up papermaking process and sintering process. Then, Fe-ZSM-5 zeolite membrane catalysts with Fe loading of 15%, 25% and 35% were prepared and systematically characterized by using X-ray diffraction (XRD), N₂ adsorption-desorption, field emission scanning electron microscopy (FE-SEM), energy-dispersive X-ray spectroscopy (EDS), H₂-temperature programmed reduction (H₂-TPR) and X-ray photoelectron spectra (XPS), respectively. Finally, catalytic activity of Fe-ZSM-5 zeolite membrane catalysts was evaluated by investigating the conversion of phenol, H₂O₂ and TOC as well as the Fe leaching concentration in the treated effluent based on the CWPO processes in a membrane reactor. The characterization results showed that ZSM-5 zeolite membrane with a thickness of 6 μm was fabricated on the surface of PSSFs and Fe element with a form of Fe₂O₃ was uniformly dispersed on the surface of ZSM-5 zeolite membrane support. The results of CWPO of phenol showed that the catalyst with Fe loading around 25% achieved the highest activity (phenol conversion about 95% and TOC conversion about 45%, respectively) after continuously ran for 7 hours. Meanwhile, low loss of Fe species was observed on all of the catalysts (Fe leaching concentration lower than 7 mg/L).

Key words: Fe-ZSM-5 zeolite membrane catalyst; catalytic wet peroxide oxidation; phenol; membrane reactor

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