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纳米颗粒原位植入法制备改性超滤膜及其抗生物污染性能研究

Preparation of nanoparticle-embedded polysulfone ultrafiltration membranes and evaluation of the anti-biofouling property

关键词：超滤膜 纳米颗粒 原位植入 抗生物污染

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摘要：选取氧化铝分散体(Al_2O_3)、Linde A型沸石(LTA)、Linde L型沸石(LTL)和X型八面沸石(FAU-X)4种纳米颗粒,采用原位植入的方法对超滤膜进行表面改性,以提高聚砜超滤膜的抗生物污染性能.通过扫描电子显微镜、接触角测定、抗生物污染性能测试等方法来表征改性前后膜结构和性能的变化.结果表明,纳米颗粒在膜表面的原位植入具有其可行性,该方法只改变超滤膜的表面形貌,对断面和底面的结构没有影响;纳米颗粒原位植入法改性后,超滤膜的亲水性有显著提高.就抗生物污染性能而言,纳米颗粒的植入提高了膜的抗粘附性能,在纳米颗粒覆盖的区域没有大肠杆菌粘附生长;在这4种膜中,UF-LTA和UF-LTL膜的抗粘附性能优于UF-Al_2O_3和UF-FAU-X膜.相较而言,LTA型沸石在膜表面分散效果良好,原位植入后显著改善了膜的亲水性并且表现出较好的抗粘附性能,可作为理想的材料用于下一步研究.但LTA型沸石的抗水流剪切的能力较弱,要想提高该种纳米颗粒在膜表面的结合牢固性,应考虑减小颗粒的粒径.

Abstract: In order to enhance the anti-biofouling ability, surface modification of polysulfone ultrafiltration membrane was performed by in-situ embedment of four types of nanoparticles—aluminum oxide (Al_2O_3), Linde type A zeolite (LTA), Linde type L zeolite (LTL) and Faujasite type X zeolite (FAU-X). The bare and the modified membranes were tested for the changes of structures and properties by conducting scanning electron microscope (SEM) observation, contact angle measurement and anti-biofouling test. SEM observation showed that in-situ embedment of the four different nanoparticles was feasible, which only changed the surface morphology but not the cross section of the membranes. Nanoparticles embedded on the surface increased the hydrophilicity of the membranes, resulting in the improvement of anti-fouling ability to organic matters. Anti-biofouling ability was also observed as the modified membranes were more resistant to the adhesion of *E.coli* on the membranes. There was no growth of *E.coli* on the areas covered by nanoparticles. Membrane UF-LTA and UF-LTL showed greater anti-adhesive ability than membrane UF-Al_2O_3 and UF-FAU-X. In general, zeolite LTA was an ideal material because they could better disperse on the membrane surface and remarkably improved the hydrophilicity and anti-adhesive ability of the membrane. However, zeolite LTA could not withstand the force of shear flow. In order to enhance the firmness stability of the incorporated zeolite LTA on the membrane surface, smaller particles would be preferred.

Key words: ultrafiltration nanoparticles in-situ embedment anti-biofouling

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