

研究论文

PSF/TiO₂杂化超滤膜形成过程的热力学和动力学研究

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摘要 采用溶胶-凝胶法制备了不同纳米TiO₂含量的聚砜(PSF)/TiO₂杂化超滤膜,研究了TiO₂浓度对聚砜铸膜液流变学及热力学性质的影响,构建了计算成膜过程中表观扩散系数(D_a)的新方法,求出不同TiO₂浓度及温度下的 D_a 值,进而剖析了铸膜液流变学和热力学性质的变化对成膜动力学的影响.并通过扫描电镜观察、杂化膜孔隙率和超滤性能的测试考察了表观扩散系数与膜结构和性能的关系.结果表明,加入TiO₂溶胶的PSF铸膜液由牛顿流体转变为非牛顿流体,其粘度随TiO₂浓度增大而增大. TiO₂的加入减小了铸膜液对非溶剂的容纳能力,加速铸膜液的液-液相分离,同时TiO₂引起的热力学促进作用和流变学阻碍作用相互竞争,共同影响 D_a 的变化.实验得出, D_a 随温度升高而增大,随TiO₂浓度的增大有先增大后减小的趋势.

表观扩散系数 D_a 与膜的结构和性能具有很好的相关性并能直观地描述整个成膜过程.

关键词 [聚砜](#) [二氧化钛](#) [有机-无机杂化膜](#) [流变学和热力学性质](#) [表观扩散系数](#)

分类号

Kinetic and Thermodynamic Research of Polysulfone/TiO₂ Hybrid Ultrafiltration Membrane

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Abstract Polysulfone (PSF)/TiO₂ hybrid ultrafiltration (UF) membranes with different nano-sized TiO₂ content were prepared by sol-gel method. The effects of TiO₂ concentration on the rheological and thermodynamic properties of PSF casting solution were studied firstly. A new method used to calculate apparent diffusion coefficient (D_a) in membrane formation process was founded subsequently. After calculating D_a under different conditions, the effects of the rheological and thermodynamic properties on the kinetics of membrane formation were examined and the relationships of D_a , membrane structure and UF performance were evaluated through the methods of SEM observation, porosity test and UF experiments finally. The results showed that the rheological properties of casting solution were changed from Newtonian viscous behavior to non-Newtonian viscous behavior, and the viscosities of casting solution were increased by the addition of TiO₂. The addition of TiO₂ also reduced the miscibility of PSF solution with non-solvent, leading to thermodynamic enhancement for phase inversion. The diffusion behavior of solvent and non-solvent in membrane formation was strongly influenced by the complex correlation between thermodynamic enhancement and rheological hindrance due to TiO₂ addition. D_a increased with the increase of temperature. However, it increased firstly and then decreased with the increase of TiO₂ concentration. Moreover D_a had an accordant pertinence with membrane structure and properties, and could describe the entire membrane formation intuitively.

Key words [polysulphone](#) [TiO₂](#) [organic-inorganic hybrid membrane](#) [rheological and thermodynamic properties](#) [apparent diffusion coefficient](#)

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