



Hydrophilicity modification of polypropylene microfiltration membrane by ozonation

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ABSTRACT

To improve surface hydrophilicity and to reduce fouling, commercial polypropylene microfiltration membranes were ozonated to generate peroxides as grafting sites for hydrophilic monomers. Ozonation was conducted in aqueous and gaseous phases, respectively. In both phases, the amount of peroxides increased with the ozonation time. A novel way to enhance the generation of peroxides was tested, i.e., adding homogeneous catalyst, CuSO₄, to aqueous ozonation. Results showed that with an optimum dose of 0.05 g/L of CuSO₄, the peroxides generated were 18.2% more than that by the non-catalyzed ozonation in aqueous phase. It was also confirmed by scavenger tests that during the aqueous ozonation both molecular ozone and free radicals contributed to the oxidation of the membranes, the latter was formed from the self-decomposition of ozone in water. Graft polymerization was also conducted after the generation of peroxides. A hydrophilic monomer, acrylic amide, was graft polymerized onto the membrane surface. The successful grafting of acrylic amide was confirmed by the formation of new peaks corresponding to amide groups in FTIR spectra. Results of contact angle measurements and filtration tests indicated that aqueous ozonation was more effective than its gaseous counterpart in terms of hydrophilicity improvement. In addition, the XRD analysis revealed that the ratio of the membrane surface crystallinity to amorphousity was changed by both ozonation and graft polymerization. Results of SEM scanning also showed changes in membrane surfaces after modification.

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1. Introduction

Membrane filtration is a separation process and has been used extensively in various applications such as wastewater treatment, chemical industry and pharmaceutical industry. However, the filtration flux decline caused by membrane fouling constitutes a major obstacle to the wide-scale applications (Escobar and Hock, 2005). Research results indicated that increasing membrane surface hydrophilicity could effectively inhibit membrane fouling (Belfer et al., 1998; Boutevin et al., 2002; Chang et al., 2008; Gullinkala and Escobar, 2008; Hua et al., 2008). To extend the lifetime of the membranes, modifying surfaces of the membranes to increase their hydrophilicity is thus very important.

Membranes are polymer films. Various techniques can be used to increase their surface hydrophilicity. Comparing with

other surface modification techniques such as plasma treatment, irradiation with gamma-rays, corona discharge, ion beam treatment, and UV radiation (Wang et al., 2000), ozonation is inexpensive and the operation is simple. Moreover, ozonation modifies surfaces uniformly even with complicated shapes (Yuan et al., 2002).

When polymers are exposed to ozone, active peroxide groups are introduced onto the surface. These active peroxide groups are capable of initiating graft polymerization of vinyl monomers with hydrophilic groups. The hydrophilicity of the polymer surfaces is thus improved (Gatenholm et al., 1997).

Ozonation can be conducted in either gaseous phase or aqueous phase. In fact, aqueous ozonation facilitates the rapid decomposition of molecular ozone to form free radicals which are stronger oxidants than ozone itself. In addition, aqueous ozonation enables the easy addition of catalysts/additives to

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