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Green Organic Photocatalytic Membrane for Wastewater Treatment

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ABSTRACT

This study describes preparation by phase inversion technique and characterization of efficient Photocatalytic blend PMMA/PVDF membranes using green solvent. The prepared membranes used for applications in environmental friendly advanced oxidation processes and fine chemical synthesis. The properties relating to the applications of photocatalytic membranes such as antifouling, separation performance, and photocatalytic effectiveness of photocatalytic performance are studied.

Keywords: Green Solvent, Photocatalytic Organic Membranes, phase inversion, Wastewater treatment.

1 Introduction

Photocatalytic membrane is a promising solution for wastewater treatment since they combine the physical separation of membrane filtration, the organic degradation and anti-bacterial property achieved by photocatalysis in a single unit. Titanium dioxide (TiO2) is the most commonly used material for fabrication of photocatalytic membranes due to its low cost, non-toxicity and high chemical stability. The present work describes the preparation of MF/UF membranes based on the use of poly (methylmethacrylate) (PMMA) polymer, which is compatible with PVDF and TiO_2 particles in casting solutions, using triethyl phosphate TEP safer and more compatible solvent. TiO_2 embedded poly (vinylidene fluoride) (PVDF)/PMMA photocatalytic membranes were prepared by phase inversion method. A non-solvent induced phase separation (NIPS) coupled with vapor induced phase separation (VIPS) was used to fabricate flat-sheet membranes using a dope solution consisting of PMMA, PVDF, TiO_2, and triethyl phosphate (TEP) as an alternative non-toxic solvent.

2 Experimental

Two membranes are prepared according to the formula proposed by Benhabiles et al. [1] via the phase inversion NIPS technique where a thermodynamic temperature-induced change and a non-solvent causing the precipitation of polymer and thus forming a membrane. The ingredients are weighed and put in a clean and dry container and tightly closed to prevent loss of solvent and then without stirring at 90°C overnight to expel air bubbles. We stop the stirring before the casting a half hour. The collodion can be kept at over 50°C. Spreading is done on a glass surface using a knife whose thickness is set at 300µm. It is left for 2.5 minutes before immersion in the coagulation medium, which is water. The prepared membranes are listed in Table 1.

Table 1: *TiO_2-PVDF/PMMA photocatalytic membranes composition*.

Membrane Code	TiO_2 wt %	PVDF wt %	PMMA wt %	PVP wt %	PEG wt %	TEP wt %	T° C	H%
M1	2	6	6	5	5	76	25	51
M2	5	6	6	5	5	73	25	52

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The obtained membranes characterized by Scanning Electron Microscopy (SEM) to examine the membrane morphology. A laboratory cross-flow cell (DeltaE srl, Milan, Italy), operating at 25 °C, was used to carry out pure water permeability PWP experiments.

3 Results and Discussion

3.1. Membrane Characterization

Membrane morphology indications a fundamental role in membrane behavior and filtration performance. The morphology of the prepared membranes are investigated using a scanning electron microscope (SEM). Fig.1 show SEM images of top, bottom and cross-section of the prepared membranes M1 and M2. Top and bottom surfaces of the membranes presented a porous and sponge-like structure. However, along the cross section membranes show an asymmetric structure: a thin layer at the top surface in the form of macrovoids and a sponge-like structure across the rest of the membrane.

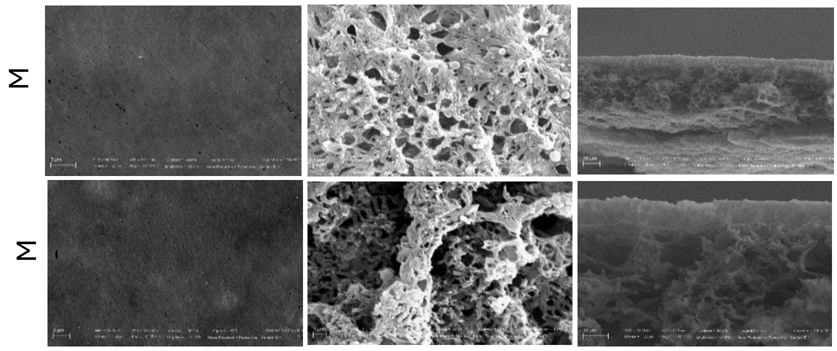

Figure1: SEM images top surface, bottom surface and cross section of membranes M1 and M2.

Membrane permeability and selectivity are both affected by membrane morphology [2]. Before starting the pure water permeability (PWP) tests, a flux stabilization period was performed and PWP is calculated by applying the following Equation (1):

$$PWP = Q/A\ t\ p \tag{1}$$

Where A is the membrane area (expressed in m²); p is the pressure (expressed in bar); Q is the permeate volume in liters; and t is the time (expressed in hours). The porosity of the membranes increased as the increase of TiO_2. The increase in porosity after increasing TiO_2 amount can be related to the formation mechanism of the membranes. As a consequence, the permeability of the membrane was enhanced. The results show that the mean PWP for M1 increase from 86.257 $L/h.m^2.bar$ to 117.53 $L/h.m^2$ for M2. So the catalyst amount have an influence on the membrane porosity. The flux of membranes decreased by decreasing the pressure. For membrane, M1 the flux decreased from 154 to 70 $L/h.m^2$ as the cross-membrane pressure increased from 0.8 to 1.8 bar.

4 Conclusions

In this study, porous photocatalytiques membranes are prepared using an alternative solvent. Furthermore, the effect of the TiO_2 amount in the PVDF/PMMA membranes was evaluated. The results revealed that the increasing of TiO_2 quantity enhance the properties of the membranes by enhancing their porosity and consequently there permeability.

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