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Roll-to-roll dip coating of three different PIMs for Organic Solvent Nanofiltration

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Abstract

PIM-1, PIM-7, and PIM-8 composite membranes have been fabricated for Organic Solvent Nanofiltration (OSN) on two different support membranes. Both support membranes, PAN and crosslinked Ultem 1000, displayed pore sizes within the range of 20 – 25 nm as characterised by gas liquid porometry. PIM layers of <500 nm thickness were formed from dip coating on a roll-to-roll pilot line. The resultant composite membranes exhibited typical MWCOs in the region of 500-800 g mol^{-1}. The quality of coating obtained on the crosslinked Ultem 1000 support membrane was consistently higher for all three PIMs than that obtained on the PAN membrane. The PIM composite membranes coated on to crosslinked Ultem 1000 were stable in a wider range of solvents than those on the PAN support. OSN testing in a model system with isomeric alkane solutes verified that manipulated changes to the molecular architecture of the polymer backbone resulted in a higher *separation factor between straight and branched alkane isomers*.

Keywords: Organic Solvent Nanofiltration; Thin film composite membrane; Dip coating; Polymer of Intrinsic Microporosity

1 Introduction

Polymers of Intrinsic Microporosity (PIMs) are an attractive class of materials for separation processes. A favorable characteristic of the PIMs is that they are solution processable polymers with highly rigid, contorted structures that frustrate the polymer packing upon drying, giving rise to a continuous network of intermolecular voids that are <2 nm in dimension [1]. PIMs may enable expansion of the current gas separation applications [2], and have potential applications in OSN [3]. More than a decade since the *invention of PIMs*, PIM-1 remains one of the most researched and most promising materials from this class of polymers. Various reports detail efforts to understand and optimise the synthesis and purification of PIM-1 to produce a higher quality polymer [4–7]. Self polymerisation of an AB-type monomer is also a promising route to obtaining high molecular weight PIM-1 [8]. Alternative PIMs are typically synthesised from monomers that require custom synthesis, and their polymerisation conditions and purification protocols are less optimised than those of PIM-1.

Bench scale dip coating of PIM-1 onto PVDF supports enabled thicknesses down to 1 µm to be achieved for pervaporation [9]. Coatings were applied to PVDF membranes of different pore sizes, and no significant change to the thicknesses of the obtained PIM-1 layer were reported. Adhesion of PIM-1 to PVDF support membranes, however, has been reported to be problematic for OSN [10]. There have also been problems reported for adhesion between PIM-1 and PAN, such that an epoxy resin based crosslinking procedure within the PIM-1 material was needed to enable filtrations in aromatic solvents [11]. Without this crosslinking, there were reports of partial