Abstract

Over the last few decades, polymeric membrane-based gas separation technology has drawn much consideration into essential research areas in material design and development because of their great variety, ease of processing, tunable design, cost economy, potential energy-saving capability, the environmentally benign path to access these processes. The critical parameters for the membrane-based separation process is gas permeability coefficient and ideal selectivity; however, this separation technique structure-property optimization study of polymers suggests an undesirable and an unavoidable so-called trade-off relation between gas permeability and selectivity. Therefore, extensive research has been conducted in many industries and academia to fabricate new polymer membrane for gas separation applications with high gas permeability and selectivity endowed with good-film forming ability, sufficiently good mechanical, chemical, and thermal stability. Regarding this, aromatic polyimide is considered the most attractive primary material for gas separation membranes. But aromatic polyimides have certain drawbacks, such as high softening or melting temperatures and insolubilities in many common organic solvents.

The principal aim of our research work was to develop organosoluble poly(ether imide)s (PEIs) polymers and study their gas transport properties. In this regard, four series of PEIs [PEI A-D, PEI E-G, PEI H-J, and PEI K-N] were synthesized by using four structurally different, bulky group-containing fluorinated diamine monomers with different fluorinated and non-fluorinated aromatic dianhydrides. All the polymers (except PEI N) were soluble in various organic solvents. The polymers were well-characterized by different instrumental techniques and membranes were fabricated from the polymer solutions. The solution cast membranes exhibited excellent thermal and mechanical properties and withstand the mechanical stresses imposed in the permeation cells. Their gas transport properties were investigated mainly towards four different gases CO_2, O_2, N_2, and CH_4. The highest permeability for CO_2 (175 Barrer) and O_2 (64 Barrer) was exhibited by PEI K with bulky pendant phosphaphenanthrene moiety; where as highest ideal permselectivity of CO_2/CH_4 (73.57) and O_2/N_2 (13.39) was found in PEI J with cardo fluorene moiety. PEI H-J and PEI K exhibited promising results regarding the present upper bound limit drawn by L. M. Robeson in 2008. An attempt has been made to draw a structure-property co-relationship between the chemical structure of PEIs and their gas transport properties and through MD simulation studies.

Keywords: *Poly(ether imide)s, Membranes, Gas permeability, Bulky pendant groups, Thermal properties, Mechanical properties, Robeson's upper-bound, MD simulation.*