Effect of different additives on the physical and chemical CO 2 absorption in polyetherimide hollow fiber membrane contactor system

Abstract

Porous asymmetric polyetherimide (PEI) hollow fiber membranes were fabricated via a phase-inversion method using ethanol, glycerol and acetone as the additives in the spinning dope. Also, hollow fiber PEI membrane without additives was fabricated. An aqueous solution of 1-methyl-2-pyrrolidone (80 wt.%) was used as bore fluid to prevent forming of an inner dense skin layer. The precipitation rate of the polymer dopes with the different additives was studied using cloud point measurement. The effect of the additives on the resulting membrane structure, surface porosity, pore size, critical water entry pressure, collapsing pressure and physical and chemical CO2 absorption performance by distilled water and NaOH (1 M) solution in a gas–liquid membrane contactor system were investigated and compared. Cloud point diagrams indicated that the precipitation rate of the polymer dopes increased following the trend of ethanol > acetone > glycerol. Results of gas permeation tests showed that ethanol and glycerol as additives provided the membranes with the largest and smallest pore size, respectively. Moreover, all the additives resulted in an increase in the effective surface porosity. The cross-section of the membranes was examined via a scanning electron microscopy. Ethanol in the spinning dope provided the membrane structure with a sublayer with finger-like macrovoids, originating from the inner and outer surfaces of the hollow fiber and extending to the middle section of the hollow fiber wall, which resulted in a larger pore size and higher CO2 absorption rate than the other PEI hollow fiber membranes.