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Absorption of coal combustion flue gases in ionic liquids using different membrane contactors

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ABSTRACT

Carbon dioxide (CO_2) and sulfur dioxide (SO_2) are typical gases produced during coal combustion and their emissions have to be controlled and minimized in order to reduce environmental risks. Organic solvents are commonly used as absorption liquids for the chemical absorption of CO_2 and SO_2, and their use in combination with a membrane device is being studied recently. The volatile character of common solvents produces solvent losses due to their evaporation into the gas stream. Thus, the use of solvents with lower vapor pressure such as ionic liquids as absorption liquids may contribute to the performance of a zero solvent emission process. In the present study, mass transfer of CO_2 is studied in a polypropylene hollow fiber membrane contactor when the ionic liquid 1-ethyl-3-methylimidazolium ethylsulfate is used as the absorption liquid. Mass transfer coefficients are compared with those obtained with a ceramic hollow fiber contactor for SO_2 absorption. The overall mass transfer coefficient takes a value of $K_{overall} = (3.69 \pm 0.18) \times 10^{-7}$ m s^{-1} and $K_{overall} = (3.38 \pm 0.09) \times 10^{-6}$ m s^{-1} in CO_2 and SO_2 systems, respectively. Main resistance to mass transfer has been found to be the membrane itself. In CO_2 absorption a theoretical effective diffusivity was estimated as $D_{eff} = 4.94 \times 10^{-7}$ m^2 s^{-1} which differs from diffusivity obtained from experimental results ($D_{eff} = (1.717 \pm 0.18) \times 10^{-11}$ m^2 s^{-1}).

Keywords: Carbon dioxide; Sulfur dioxide; Non-dispersive absorption; Gas-liquid membrane contactors; Ionic liquids; Process intensification

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