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CO₂ absorption enhancement by water-based nanofluids of CNT and SiO₂ using hollow-fiber membrane contactor

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Abstract

In this study, CO₂ absorption enhancement using nanofluid in a gas-liquid hollow fiber membrane contactor (HFMC) was conducted through a 2D mathematical model. The model was developed by considering molecular diffusion in radial and axial directions as well as non-wetting condition. CO₂ absorption was conducted from a gas mixture, containing CO₂ and air, which flows in the shell. Also, absorbents which are containing CNT and SiO₂ nanoparticles flow in tube side counter-currently. The effect of nanoparticles was considered by taking two prominent mechanisms for mass transfer enhancement in nanofluids; i.e., Brownian motion and Grazing effect. Model predictions compared with experimental results and excellent agreement was found. The simulation results indicated that introducing 0.05 wt.% SiO₂ nanoparticles enhanced absorption rate up to 16%. CNT because of high adsorption capacity and hydrophobicity showed much better performance than the SiO₂ nanoparticles, so that introducing 0.05 wt.% CNT enhanced the absorption rate up to 34%. For better performance of nanoparticle in the absorbent, there is an optimal loading which is 0.03 and 0.04 wt.% for SiO₂ and CNT, respectively.

Keywords: CFD; Nanofluid; CO₂ absorption enhancement; Hollow fiber; Membrane contactor; Mass transfer

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