Effects of feed gas dilution ratios on performance of CO_2 methanation in bubbling fluidized-bed reactor using computational fluid dynamics

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This study investigated the hydrodynamics, reaction kinetics, and heat transfer of a bench-scale bubbling fluidized bed (BFB) reactor for CO_2 methanation. A three-dimensional gas-solid Eulerian computational fluid dynamics (CFD) model coupled with a modified Syamlal–O'Brien drag model and reaction kinetics for Ni-based catalysts was developed. Two types of wall boundary conditions were compared to obtain an identical simulation result. The reactor performances on hydrodynamics, reaction kinetics, and heat transfer under four inlet N_2 contents of 77.5%, 50%, 25%, and 0% were analyzed. As the inlet N_2 content decreased from 77.5% to 0%, the mean bed temperature increased from 340 to 456 °C, the gas volume decreased owing to the reaction, the fluidizing number (u_g/u_{mf}) decreased from 4.1 to 3.5, the solid holdup increased, and the HTC increased from 327 to 386 W/m^2/K. This study identified the effects of hydrodynamics and reaction kinetics on HTC in the BFB for CO_2 methanation.