Experiment and CFD for heat management of CO_2 methanation in a bubbling fluidized-bed reactor

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In this study, the catalytic CO_2 methanation in PtG is experimentally and numerically investigated for a bubbling fluidized-bed (BFB) reactor. Due to the strong exothermic reactions, heat management is an important factor in improving reactor energy efficiency. The diluted reactant gas mixture ($CO_2/H_2/N_2$ = 0.045/0.18/0.775 in volume fraction) was fed at the bottom of BFB (ID = 0.05 m) filled by 0.15 m bed height of Ni-based commercial catalyst (d_p = 100 μm, r = 2300 kg/m^3) to maintain the inlet superficial velocity at 400 °C of 0.03 m/s (~3.5 u_{mf}). An Eulerian-Eulerian two-fluid computational fluid dynamics (EE-CFD) model incorporating with an empirical correlation of gas-solid interphase heat transfer and kinetic rate model was proposed for the BFB reactor. The EE-CFD results such as the bed expansion, temperature profile, the gas molar fraction of species, CO_2 conversion, CH_4 yield and producer gas purity along the reactor height were compared with experimental data. The effects of operating conditions on the heat management of the BFB reactor were analyzed from the EE-CFD simulation.