Preliminary design of internally cooled bubbling fluidized-bed reactor for CO_2 methanation process using computational fluid dynamics

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A computational fluid dynamics (CFD) model for internally-cooled bubbling fluidized-bed (ICBFB) reactor was proposed for CO_2 methanation with H_2. The helically coiled heat exchanger was employed to utilize the reaction heat for steam production. A rigorous gas-solid-wall heat transfer model and heterogeneous reactions with kinetics obtained from the literature were developed for CO_2 methanation using Ni-based catalyst. The CFD model results for ICBFB were compared with literature experiments and modeling data in terms of the temperature profile and producer gas compositions. Pressure, temperature, solid volume fraction, bubble characteristics, producer gas compositions, reaction rates, and heat of heterogeneous reaction were then analyzed. The present ICBFB reactor showed an excellent capability for controlling reactor temperature in the presence of exothermic reactions in CO_2 methanation process.