CO_2 methanation reactor design via mathematical modeling approaches

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The methanation of carbon dioxide has gained renewed interest in the last recent years as a potential technology for synthesizing a suitable chemical energy carrier. This modeling study aims at various designs of fixed- and fluidized-beds for the methanation of CO2 under different reaction kinetics. A process-scale one-dimensional kinetics model (1D-KM) is integrated with a particle-scale dusty-gas model (DGM) to evaluate the intraparticle transport limitation by diffusion inside a catalyst particle. Several scenarios of each reactor type are compared for a wide range of operating conditions. The bubbling fluidized-bed (BFB) with an internal heat exchanger is found as a more effective design than the fixed-bed reactors in terms of the reactor size and process operability. A computational fluid dynamics (CFD) model is used to identify hydrodynamics of the BFB reactor.