Computational fluid dynamic modeling and simulation of bubble column with hydrocracking reaction

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A pilot-scale H_2-vacuum residue slurry bubble column reactor (SBCR) with catalytic hydrocracking reactions was operated at 425 ºC and 160 bar in the homogeneous regime. The hydrodynamics in terms of specific pressure drop ($\Delta P/L$) and gas holdup (aG) were experimentally measured in the SBCR with 2.0 m height and 0.05 m inner diameter, which was operated at a superficial gas and liquid velocities of 6.4 and 0.271 mm/s, respectively. Based on the normal boiling point, the composition of the product classified into five pseudo-components was measured in the reactor. A two-phase computational fluid dynamics (CFD) model coupled with a reaction kinetics was developed for the SBCR at the same operating condition as the experiment. The calculated $\Delta P/L$, aG, and composition of five pseudo-component were compared with experimental data. The CFD model is applicable to predict hydrodynamics and species concentrations of homogeneous bubble columns for gas–organic liquid under elevated pressure.