Computational fluid dynamics of gas-liquid bubble column in H2-Vacuum residue oil system

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A gas-liquid Eulerian computational fluid dynamics (CFD) model coupled with a population balance equation (PBE) and a hydrocracking chemical reaction model was developed to investigate hydrodynamics of a bubble column in a H2-vacuum residue oil system (H2-VR) in terms of pressure drop, gas holdup, mean bubble size, and specific surface area. The concentrations of species including vacuum residue (VR), vacuum gas oil (VGO), distillate (DISTIL), naphtha (NAPH) after 1 h when the chemical reactions took place. The column had a height of 1.9 m and an inner diameter of 0.05 m. The column was initially filled with a VR and VGO mixture of a height of 1.9 m. The VR-VGO mixture with 80% VR and 20% VGO by weight was injected at a velocity of 0.271 mm/s in the bottom. The H2 entered through the gas distributor at a superficial gas velocity of 6.4 mm/s. The bubble column was operated at 160 bar and 430°C. After one-hour reaction, the pressure drop, the gas holdup, the mean bubble size and the specific surface area were estimated to be 4,997 Pa/m, 7.8%, 4.0 mm and 116 m2/m3, respectively. The concentrations of VR, VGO, DISTIL, NAPH and gas were 40.4, 35.4, 9.4, 6.7 and 8.1 wt.%, respectively.