THE EFFECT OF BUBBLE SIZE ON THE PERFORMANCE OF EBULLATED BED HYDROPROCESSORS

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A recent cold-flow study has revealed that modifying gas distributor design in three-phased fluidized beds can have a significant effect on overall phase hold-ups and regime transition velocities, even at equivalent phase velocities. It is conjectured that this can be attributed to changes in the bubble-size distribution within the reactor. This study aims to develop a complete kinetic-hydrodynamic model of a resid hydroprocessing ebullated bed reactor with internal recycle in order to study the effects of bubble size distribution on performance metrics of industrial significance. The model consists of combined catalytic and ther-mal reaction models, phase separation efficiency correlations obtained through CFD modelling, catalyst fouling and deactivation models, boiling-point based Vapour-Liquid Equilibria (VLE) relations, and specialized phase hold-up corre-lations developed for resid hydroprocessing applications.

A preliminary hydrodynamic model comparing monodisperse bubble sizes between 0.5 mm and 4 mm has been performed. At the lowest bubble size, gas entrainment (and hence gas hold-up) were maximal, while ideal phase separation was achieved at the largest bubble size. Bed gas hold-ups ranged from 10 % to 40 %. Increased gas entrainment was also associated with a decrease in internal liquid recycle ratio required for design ebullation height. The effect of bubble size was most pronounced near a diameter of 1 mm.

Ongoing analysis into the effect of bubble recycle on bed gas phase com-position in a reactive system is being performed. The effect of bubble size on liquid residence time and hence conversion will be studied with the objective of determining the optimal bubble size for maximizing key conversion parameters.