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 thermal 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 correlations
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 composition 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.