ABSTRACT

Fluid catalytic cracking (FCC) has been in commercial use for the last five decades. True, major developments, both in hardware modifications and operational features, have taken place during this period but very few publications have appeared in the literature. Most of the innovations are not easily accessible as those are covered through patents. Developments of indigenous technology and generation of data commensurate with the need of the country are, therefore, vital for India, particularly in view of the selective operation of Indian FCC units to maximise middle distillate production (in contrast to International practice). In this context, the cold model studies reported in this work assume significance, having incorporated hydrodynamic studies relating to a model for the prediction of pressure profiles in the riser, loop pressure data indicating different flow regimes in the stripper and evaluation of flow parameters like the dispersion and interphase transfer coefficient.

Investigations have been carried out in an experimental set-up consisting of various sub-systems of a FCC unit, namely riser (0.1016m ID), stripper (0.4572m ID), slow bed (0.2032m ID), downcomer and transfer lines, all fabricated out of perspex sheets and tubes so as to enable visual observation. Equilibrium FCC catalyst has been used as the bed material. Comprehensive pressure drop data on the riser, stripper, downcomer and the entire loop have been obtained. Studies on gas mixing have been made using CO_2 as the tracer. Four different types of stripper internal, as practised in the Indian refineries, have been tested and their performances evaluated.

While Chapter-I deals with the literature review on the subject, Chapter-II discusses the apparatus used and procedure adopted for the experimental work. Chapter-III presents the riser pressure and voidage profiles. A theoretical analysis, based on the continuity equation and gas-solid mixture momentum balance, is presented to predict and also compare the riser pressure profile along its height (Chapter-III). Detailed analysis of loop pressure in the FCC unit (Chapter-IV) indicates that the riser pressure profile is mainly dependent on the pressure recovery in the downcomer and extent of pressure drop in the inclined transfer line. Pressure profiles within the stripper indicate

the coexistence of two different regimes : bubbling fluidised bed above the stripper air entry point and a non-fluidised packed bed below it.

Detailed studies on gas-mixing using CO_2 as the tracer have been carried out and the results reported in Chapter-V. Based on CO_2 balance within the stripper, a new definition of baffle efficiency under cold condition has been suggested. The effects of the type of stripper internal and G_a/G_s ratio on the baffle efficiency have been found out. Single phase homogeneous dispersion model as well as the two-phase model have been used to obtain the Peclet number (single phase model), N_D and N_k (two-phase parameters). These two parameters give significant indication of the nature of gas-solid contacting process within the stripper and can be used for modelling studies of FCC stripper and design of commercial plants. In the concluding section (Chapter-VI), the scope of future work has been highlighted giving suitable recommendations.

KEY WORDS

Hydrodynamics; Fluid catalytic cracking (FCC); Riser; Stripper; Downcomer; Inclined transfer line; Dense phase; Dilute phase; Voidage; Bubbling bed; Non-fluidised bed; Packed bed; Annular flow model; Relative velocity model; Baffle efficiency; Peclet number; Dense phase dispersion number (N_D); Interphase transfer number (N_k).