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Radiotracer Investigation in an Industrial-Scale Fluid Catalytic Cracking Unit

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Fluid catalytic cracking (FCC) is one of the main processes used for processing the crude oil in refineries. The efficiency of the cracking process depends upon process parameters such as residence time, residence time distribution, radial distribution and axial mixing of catalyst and gas phases in various sub-units such as riser, disengager, stripper and regenerator of the FCCU. Radiotracer techniques are widely used for measuring for process parameters in industrial process systems. The measured parameters are often used for troubleshooting, performance evaluation, design improvements, and process visualization, optimization and intensification. This paper describes a series of radiotracer experiments carried out in an industrial-scale FCCU in India for measurement of the flow parameters of catalyst and gas phase in various sub-systems of the FCCU. The objective of the experiments was to measure the process parameters to evaluate performance of the FCCU and process intensification.

A series of radiotracer experiments was carried out in four sub-units of the FCCU for tracing catalyst and gas phases. Lanthanum-140 (La-140) as catalyst itself and Krypton-79 (Kr-79) gas were used as radiotracers for tracing catalyst and gas phase cracked, respectively. The amount of activities used for tracing catalyst and gas phase in different sub-systems ranged 0.5-2GBq and 4-8 GBq, respectively. The radiotracer was instantaneously injected at the inlet of each sub-system and monitored at different strategically selected locations using scintillation detectors.

The data recorded in different radiotracer tests were treated and analyzed. From the treated curves mean residence time, velocity, slip factor were obtained. In order to investigate radial mixing of the phases across the cross-sections of the different sub-systems, multiple detectors mounted at each axial location were plotted and analyzed. In case of a good radial distribution, all the detectors mounted at an axial position will provide identical responses provided the wall and insulation thicknesses at the monitoring conditions were identical. However, different intensities of the monitored curves will indicate poor radial distribution of the phases. To investigate axial mixing, axial dispersion model was used values of model parameter i.e. Peclet number (Pe) was obtained.

The parameters were successfully measured and flow anomalies were identified. Homogeneous radial distribution of the two phases was observed in the riser section of the FCCU, whereas in other sub-systems, the radial distribution of the phases was poor. The velocity of gas and solid phase were measured to be 9.9 and 6.4 m/s, respectively. The slip factor was estimated to be 1.5, which was as per design criteria for efficient cracking reactions in the riser section. The flow of gas phase in the riser was observed to be as plug flow, however moderate degree of axial backmixing was observed in case of catalyst flow. The results obtained helped to plan the necessary modifications in the FCCU, scale up the capacity and optimize the performance of the system.

Country/Organization invited to participate

India

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