A COMPARITIVE STUDY OF THE INTERNAL CONFIGURATION OF FLUID CATALYTIC CRACKING STRIPPERS

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Summary

Fluid Catalytic Cracking (FCC) Strippers act as a bottleneck in the FCC process by controlling the heat balance. The efficiency of the stripper is dictated by the internal configuration and the gas–solid flow within. In this work 3D Computational Fluid Dynamics (CFD) simulations were performed for two industrial scale strippers fitted with different internal arrangements; the conventional disk and donut baffles and the new structured packing. The CFD comparative study revealed that strippers fitted with baffles showed high degree of segregation, channeling and bypassing, while strippers with internal packing showed uniform mixing and catalyst distribution. The results indicate superior performance of the packing compared to the baffles in terms of pressure drop and stability of the unit.

Keywords

FCC stripper, CFD, Hydrodynamics, Baffles, Structured Packing.

Introduction

Fluid catalytic cracking (FCC) is the main heavy oil conversion process in most petroleum refineries (Avidan et al., 1990). Circulating fluidized bed technology is used in modern FCC units where cracking reactions take place as the vaporized gas oil feed and catalyst flow up the riser. After disengagement of the product gas and catalyst, the catalyst must be regenerated because of the deactivation due to coke deposition. In addition to coking valuable hydrocarbons also get adsorbed on the catalyst surface. It is important to strip these hydrocarbons quickly and efficiently prior to the regeneration. Incomplete stripping leads to loss of valuable hydrocarbon to the regenerator. This increases the regenerator temperature leading to faster catalyst deactivation and affecting the stability of FCC unit. This issue makes stripping an important bottle neck in the FCC unit operation.

Performance of a stripper is governed by the level of gas-particle contact and can be improved by incorporating baffles (Pugsley, 2003). The common flow problems encountered in stripping operations are flooding, bridging and large scale mal-distribution. All these problems can be minimized by using better internal configurations for distribution of phases. In the past the gas–solid flow behaviors in three different FCC strippers (empty-cylinder, V-baffled and disk-donut stripper) were investigated. The strippers with disk and donut baffles give uniform distribution of gas and particulate phases in both axial and radial directions when compared with V-baffled strippers. (Gao et al., 2007). However the presence of dead zones and channeling still continue to haunt the performance of FCC Strippers. Therefore an alternate internal arrangement has to be considered. In recent years structured packing has been offered as internals for FCC strippers. It is important to access the performance of these new internals *vis a vis* the conventional internals.

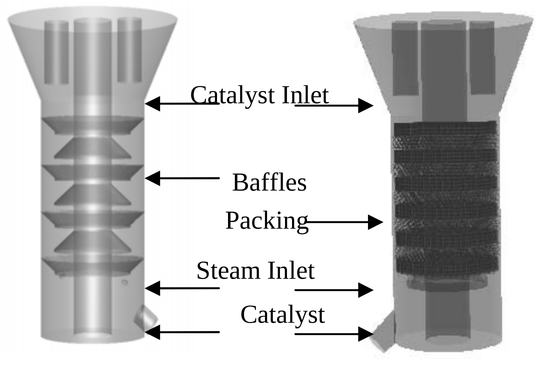

Figure (1): A 3D view of stripper geometry ; a) Stripper with baffles ; b)Stripper with Packings

In this study 3D cold flow Computational Fluid Dynamics (CFD) simulations were conducted for industrial scale FCC stripper fitted with disk and donut baffles and with structured packing. Figure 1 shows a 3D view of the strippers modeled in this work. The simulations were conducted for industrial operating conditions to access the effect of geometry on the

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pressure drop and segregation inside the stripper. Some of the results are discussed below.

Results and Discussion

Figure 2 shows comparison of mean catalyst volume fraction for the strippers fitted with baffles and with structured packing. Presence of dead zones under the baffle regions is observed in Figure 2a affecting the contacting of the phases. Also channeling is seen in some areas leading to high local catalyst velocities and this may contribute to some catalyst defluidazation. These factors will be reflected in the decreased stripper efficiency. While in stripper fitted with packing a uniform catalyst distribution is observed all along the height of stripper Figure 2b. The overall solid holdup is around 30 % all across the stripper. The packing allow 95 % of the vessel area to be available for the flow process. The packing eliminate the dead zones and zones of catalyst de-aeration providing slow and uniform catalyst velocity through the stripper. Due to low catalyst velocities higher residence time is expected and provides higher catalyst stripping efficiency.

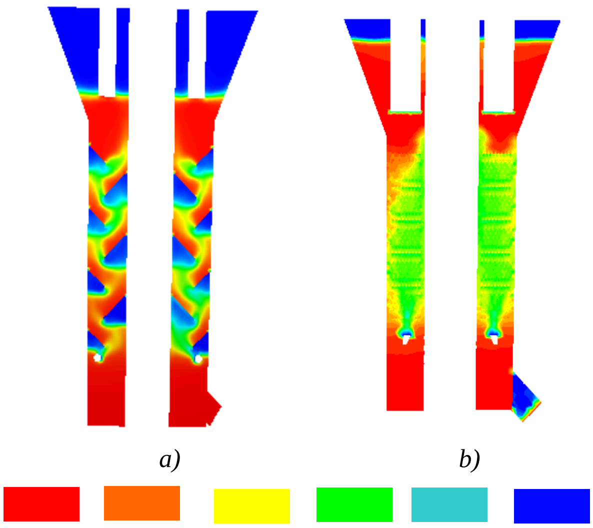

Figure 2:Comparison of catalyst mean volume fraction contour profiles: a) Stripper with baffles; b)Stripper with structured packing

Figure 3 shows the comparison of steam mean volume fraction at a cross sectional plane. High level of segregation is observed in stripper with internal baffles. The inner red zone in Figure 3a represents the voidage under the baffle region; indicating poor utilization of the steam passed in to the stripper system. For the stripper fitted with structured packing (Figure 3b), no segregation is observed. The shape of the packing structure ensures no steam pockets are formed inside the stripper allowing maximum utilization of steam for stripping. This leads to less steam consumption when compared with strippers operating with baffles and hence a lower operating costs.

Conclusions

Simulations of a cold flow industrial scale FCC stripper fitted with disk and donut baffles and with structured packing were performed. The CFD model predicted channeling and presence of dead zones in stripper with baffles and a high degree of segregation in the mixing of phases. Stripper fitted with internal packing's exhibited uniform distribution of catalyst and steams phases and showed absence of dead zones and reduced back mixing. Overall, the structured packing internals offer better contact of the two phases and improve stripper operations.

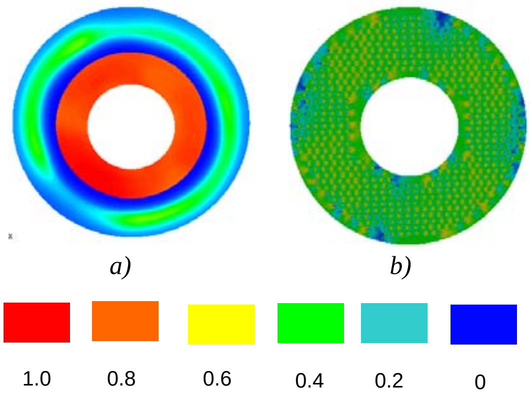

Figure 3:Comparison of steam mean volume fraction profiles at a cross section: a) Stripper with baffles; b)Stripper with structured packing

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