

Fluid catalytic cracking simulation performance study using factorial design

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Fluid catalytic cracking process (FCC) is an important refinery conversion process, it represents a multivariable, highly non linear and challenging control and optimization problem, since strong interactions occur among its variables [1]. In this kind of process, the importance of each variable must be determined. Optimization is an useful tool for better understanding of the system, verifying the effect of each variable in the process conversion. In this work, factorial design and response surface analysis were used to identify key operational process variables of a fluid catalytic cracking process.

A Kellog Orthoflow F fluid catalytic cracking process model proposed by Moro [2], was used to simulate the fluid catalytic cracking process. The deterministic dynamic model was run with the results of the factorial design aiming comparison an investigation of the prediction capabilities of simplified models. The concepts of experimental design in combination with simulations were used to determine the operational conditions that maximize conversion without infringe operational restrictions. Initially, a factorial design 2^4 was performed to determine how the input variables proposed in the model affect the responses, mainly the conversion process. From these analyses, it was found that diluted phase regenerator temperatures and riser exit temperature infringe the operational process restrictions. Then, the generated simplified models were employed for mapping the optimal and feasible region for flexible operation in conjunction with response surface analyses. Table 1 shows the pareto chart results for the riser exit temperature where the input variables that have more influence are the converter feed (RTF), when it changes from -1 to +1 level, the riser temperature decrease in 39.4% and when the regenerated catalyst stream (CTCV) changes from -1 to +1 level the riser exit temperature increase in 87.6%. In these results are exposed the importance of the catalyst oil ratio related with CTCV and the feed temperature with the oil conversion.

Table 1. Riser exit temperature 2^4 (4-0) design standardized effects.

Variable	CTCV	RTF	TFP	RAI
Standardized effect	103.0882	-46.44	13.26	13.08

TFP: feed temperature; RAI: regenerator Ar stream

Figure 1 illustrates the response surface for the riser exit temperature with both catalyst regenerated and feed flows as independent variables where high catalyst regenerated flows and low feed flows produce high riser temperatures and consequently higher process conversion.

Fitted Surface; Variable: TRX
 $2^{**}(4-0)$ design; MS Residual=14,968
 DV: TRX

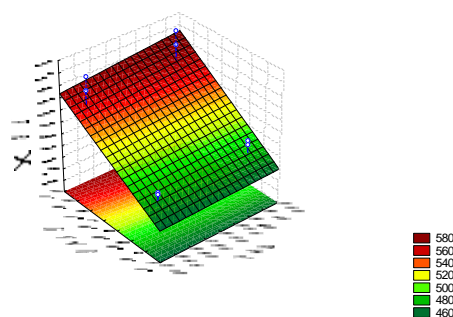


Fig. 1. Response surface for riser exit temperature

The reduced models did not show good agreement with the deterministic model of the process. The complexity of the deterministic model contributed to the inability of the reduced model to predict certain operating ranges of the process predicted by the deterministic model.

References

- [1] Tvrzka de Gouvea, M., Odloak, D. (1998) Computers chem Engng. 22, 191-198.
- [2] Moro, L.F.L., Odloak, D. (1995) J. Proc. Cont. 5, 29-39.