Catalytic Reformer Upgrade Evaluation

Our industrial partner is evaluating the modification of one of their catalytic reformers to lower pressure operation.

Catalytic reformers are a refining process that changes the molecular structure of C6 - C9 hydrocarbons from normal paraffins and cyclo-parffins to iso-parafins and aromatics through a process called dehydro-cyclization. This significantly raises to octane number of the material fed to the catalytic reformer. Hydrogen is produced as a byproduct.

The catalytic reformer liquid product is a major component of the gasoline blending pool. The byproduct gas stream is rich in hydrogen and is used as a feed to other process units employing catalytic reactions that catalytically remove sulfur and nitrogen from various refinery streams.

Another byproduct of the process is a small amount of coke which deposits on the catalyst and blocks active sites which decreases the overall activity of the catalyst. The process design consists of four interconnected reactors. At any time three are operating in series and one is operating in regeneration mode. Higher operating pressure in the reactors has a lower rate of coking than lower pressure. Lower pressure has a greater degree of dehydro-cyclization and so the challenge is to find an operating pressure balance point which has an acceptable rate of catalyst degradation while still producing an acceptable product yield.

The reference pressure measuring point for catalytic reformers is the pressure in the product effluent separator drum. (see attached PFD) In the case of the unit to be studied this pressure is presently 300 psig. Our partner is interested in reducing the drum pressure to 35 psig which should increase product octane number and hydrogen yield. It will also change the distribution of the liquid and vapor streams leaving the drum as more of the product molecules will wind up in the vapor stream due to the lower operating pressure. Ideally, the less non-hydrogen molecules in the export hydrogen stream, the better operational performance is for the downstream hydroprocessing units. Our challenge is to come up with a vapor handling system that minimizes the ultimate amount of the potential liquid product molecules in the vapor stream and maximizes the hydrogen purity of the vapor stream exiting the plant.

A technical data package is being prepared by our partner. At the minimum it should include a process flow diagram, a mass and energy balance. This project will proceed over the course of the academic year.

Milestones include:

- Review of data provided and preparation of a design basis memorandum including product recovery alternatives to be evaluated. This will be reviewed and agreed to by the industrial partner
- ASPEN simulation of process validated against current operating conditions • Create PFD's to represent alternative processing schemes • Build ASPEN models for proposed product recovery alternatives, run models and evaluate results. Report to industrial partner and agree which alternatives to pursue
- Refine the alternative cases agreed upon. • Proposal: Evaluate whether current separation equipment on unit (e.g. compressors, pumps, and separation drums) can be repurposed for any of the alternative cases.
- Use ASPEN cost estimating function to develop relative costs of selected alternative cases and review with industrial partner
- Finalize selected case and draft report for review with partner
- Issue final report

Professor Center will be project sponsor and will be actively engaged in providing process expertise to the project team. The industrial partners will provide subject matter experts to provide technical assistance as needed.