# European Site #2 - Fluid Catalytic Cracker (FCC) Regenerator Combustor Cone Failure

| Safety Impact | | | Environmental Impact | | Production Impact | | Damage |
|---|---|---|---|---|---|---|---|
| Fatalities | Injuries | First Aid | Leak Volume | Reportable | Days | Cost | Cost |
| 0 | 0 | 0 | 0 | 0 | 37 | $$$$ | $$$ |

## The Incident

A UOP High Efficiency Regenerator FCC unit operated at reduced throughput for an extended period due to various operational problems at the Regenerator and Main Fractionator. The Regenerator problems presented as poor pressure build in the regenerated catalyst standpipe (RCSP) and a significant increase in combustor density and temperature despite the recirculation catalyst slide valve operating at reduced opening. The Main Fractionator problems presented as heavy cycle oil (HCO) wash section flooding and poor base level control stability. The combined economic impact of these problems triggered a decision to undertake a planned surgical shutdown ("swoopdown") of the unit commencing around 4 weeks after the above operational problems began. Repairs to the Regenerator were on the critical path for determining the duration of the shutdown. The Crude Distillation Unit (CDU) was slowed down for atmospheric residue (atres) containment during the FCC outage.

## Background

Two hot spots had been present on the Regenerator for more than 2 years. One was on the upper side of the regenerated catalyst standpipe (RCSP) nozzle; the other was adjacent to and below the recirculation catalyst standpipe nozzle. The hot spots were being cooled by means of a large array of external air movers which prevented overheating of the shell. However, the air movers created a noise problem which had resulted in periodic complaints from the local community.

A pressure survey prior to the swoopdown revealed a low apparent density in the RCSP. A review of the regenerated catalyst slide valve (RCSV) opening against catalyst flow and differential pressures showed no problems with the slide valve. A gamma scan confirmed that flooding was occurring below the HCO draw pan and suggested that flooding was likely to have built up to the point where several trays above the HCO pumparound and below the LCO draw had become very heavily loaded. Inspection of the Regenerator combustor cone at the swoopdown revealed 5 splits including one approximately 4 m (13 ft) long that had opened up creating a hot spot on the vessel wall. Inspection of the RCSP nozzle confirmed that refractory failure had occurred creating the hot spot on the upper side of the nozzle.

## Causes

The immediate cause of the poor pressure build in the RCSP was refractory failure (refractory debris fell into the RCSP preventing proper venting of entrained aeration gas and impeding downward movement of catalyst). The immediate cause of the damage to the combustor cone and its support skirt was failure of the sealing mechanism to exclude catalyst from the annular space between the cone skirt and the vessel wall (prevents cone skirt expansion during warmup and causes inward bulge of skirt and overheating of bimetallic weld between the carbon steel and inconel sections of the cone skirt). The splits in the combustor cone allowed a massive internal recirculation of hot catalyst from the upper regenerator to flow through the annular space behind the cone skirt to the combustor, causing the external recirculation catalyst slide valve to operate only 20% open (usually 70% open). A critical factor for the refractory failures was thermal cycling triggered by multiple electrical power failures and unplanned shutdowns of the FCC unit (roughly one per month over a 12-month period). The immediate cause of the Main Fractionator HCO wash section flooding was severe coking and tray panel blowout at one of the wash trays. A critical factor was operation of the Main Fractionator with excessive HCO drawoff rates which caused the trays below to run dry.

## Lessons

Careful inspection of the sealing mechanism between the combustor cone support skirt and the vessel wall is essential at each turnaround. An external pumpdown is best practice for assuring adequate wetting of the HCO wash trays.


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