



Safety Impact			Environmental Impact		Production Impact		Damage
Fatalities	Injuries	First Aid	Leak Volume	Reportable	Days	Cost	Cost
0	0	0	Large	Yes	?	\$\$\$\$	\$\$\$

The Incident

During restart of the fluid catalytic cracker (FCC) after an electrical power failure, an operator noticed a hydrocarbon vapour leak in the unsaturated gas plant (USGP) section of the unit shortly after liquid transfer from the debutaniser column to the downstream rerun column had been initiated. The control board operator was notified and feed to the FCC was stopped. A few minutes later, while a team of operators was investigating and attempting to isolate the source of the leak, the vapour ignited and a major fire erupted. Fortunately, the operators escaped safely and a fire detector in the nearby hot oil pumphouse alerted the control board operator who immediately stopped feed to the USGP. The incident was attended by the on-site emergency services and the external fire brigade. The fire was brought under control within 90 minutes and the remaining hydrocarbon inventory was allowed to burn off. It was finally extinguished after a total duration of approximately 6½ hours. The FCC remained shut down for several weeks.

Background

The FCC had undergone a major revamp of the converter section two years prior to the incident and had suffered numerous operational problems and multiple shutdowns and startups ever since. The FCC startup procedure involves heating and circulating catalyst in the converter section, cutting in feed to the reactor riser, lining out the main fractionator, starting the wet gas compressor and then progressively introducing hydrocarbons to the columns of the unsaturated gas plant (USGP). In order to dewater the debutaniser, a drain point on the bottoms outlet pipework is opened and water is allowed to escape to the local ground drains until hydrocarbons are observed coming out (the hydrocarbons are subsequently recovered in the wastewater treatment plant).

The debutaniser drain and pumpout systems share a section of DN 80 (3" NS) pipe suspended vertically from a branch on the underside of a DN 150 x 80 (6" x 3" NS) reducing tee located on the vessel side of the debutaniser bottoms isolation valve on the transfer line between the debutaniser and rerun columns. The vertical pipe connects to the branch of an equal tee. This tee originally had valves on both sides leading to the oily water sewer and pumpout systems, respectively, but the pumpout system had been disconnected from process some years earlier by removing and replacing the valve with blind flanges at the open ends. The failed reducing tee was later found to be a set-on type rather than the forged type called up in the original project piping specification (not visible as covered by insulation).

Causes

The immediate cause of the fire was a loss of primary containment (LOPC) from a DN 150 x 80 (6" x 3" NS) reducing tee branch on the transfer line between the debutaniser and rerun columns due to fatigue cracking and subsequent mechanical overload. The LOPC resulted in a release of highly flammable liquid/vapour at elevated temperature and pressure which ignited on contact with an uninsulated section of slurry pipe at the debutaniser reboiler. Critical factors included 1) high levels of cyclic stresses on the pipework (multiple FCC shutdowns and startups), 2) incorrect tee piece design (set-on instead of forged), 3) inadequate pipework support (tee piece provided only support after valve removed) and 4) inadequate inventory isolation within the USGP (extended duration of fire). Root causes included inadequate management of change (MoC), inadequate pipework inspection (dead legs and redundant pipe/fittings) and inadequate design (FCC converter revamp and lack of remote-operated shutoff valves between USGP columns).

Lessons

Process hazard analyses should take account of abnormal conditions created by operational instability resulting from process/equipment unreliability. Remotely operated shutoff valves can minimise the impact of an uncontrolled leak.