Incident Title	**Electrostatic Precipitator Explosion**	
Incident Type	Explosion	
Date	18th February 2015	
Country	USA	
Location	Torrance, CA	
Fatalities	**Injuries**	**Cost**
0	4	Unknown

Incident Description

Credit: US Chemical Safety Board

On 16-Feb-15, the Fluid Catalytic Cracker (FCC) unit's regenerator flue gas expander tripped, initiating the automatic safeguarding system which placed the FCC unit in "safe park" (standby) mode. This automatically stops feed and starts steam injection to the FCC reactor riser, closes the safety-critical spent and regenerated catalyst slide valves (RCSV and SCSV, respectively) and trips the main air blower. The FCC main fractionator pumparound (heat removal) circuits continue circulating oil. Reverse flow of hydrocarbon vapour from the FCC main fractionator to the air-containing atmosphere of the FCC regenerator in safe park mode is prevented by injecting sufficient riser and stripping steam to maintain FCC reactor pressure > FCC main fractionator pressure and by maintaining catalyst seals above the RCSV and SCSV.

On 18-Feb-15, the FCC unit was in "safe park" mode pending cleaning of the expander (which was not positively isolated). Steam was escaping from the open outlet flange, so FCC reactor steam flow was reduced to stop it. Around 2 hrs later, an explosion occurred in the FCC electrostatic precipitator (ESP), severely damaging it and nearby equipment. Shrapnel projectiles came close to puncturing 2 vessels on the adjacent Modified Hydrofluoric Acid Alkylation (MHFA) unit which contained a large inventory of extremely toxic hydrofluoric (HF) acid. Fortunately, there were no fatalities, but 4 contractors suffered minor injuries while fleeing the explosion area and required first aid treatment.

Incident Analysis

Basic cause was ignition of a flammable mixture of hydrocarbon vapours (backflowing from the FCC fractionator and reactor) and combustion air (from the CO Boiler auxiliary air blowers) due to presence of sparks within the ESP.

Critical factors included: 1) The ESP remained energised in safe park mode (potential ignition source), 2) Significant erosion of SCSV internals (loss of catalyst seal), 3) FCC riser steam flow reduced to manage steam release at expander (FCC reactor pressure < FCC main fractionator pressure), 4) Slurry pumparound exchanger tube failure (light hydrocarbon leakage caused abnormally high FCC main fractionator pressure in safe park mode), 5) Low FCC regenerator temperature in safe park mode (hydrocarbons not burned).

Root causes included: 1) Inadequate process hazard analysis (possibility of hydrocarbons entering ESP was not considered when designing safe park safeguard system), 2) Inadequate inspection frequency (excessive RCSV and SCSV internal erosion), 3) Inadequate process monitoring (RCSV and SCSV differential pressures), 4) Inadequate risk assessment (re-validation of 2012 variance of expander isolation procedure), 5) Inadequate leadership (failure to enforce refinery isolation standards).

Lessons Learned

1) Safety-critical equipment must be properly maintained, 2) All modes of operation (including "safe park") should be considered during process hazard analysis studies, 3) Electrical power to FCC electrostatic precipitators should be isolated if there is a risk of a combustible/explosive mixture entering.

More Information

1) "Electrostatic Precipitator Explosion; Torrance, California", US Chemical Safety and Hazard Investigation Board, Report No. 2015-02-I-CA (2017).
2) "Managing Risk in Major Maintenance – A Case Study on Fire and Explosion Incidents in the Process Industry", A. Musthafa, IChemE Loss Prevention Bulletin 268 (August 2019).

Industry Sector	Process Type	Incident Type
Oil & Gas	Fluid Catalytic Cracking	Explosion
Equipment Category	**Equipment Class**	**Equipment Type**
Mechanical	Vessel	Electrostatic Precipitator

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