European Site #42 - Saturated Gas Plant (SGP) Deethaniser Overhead Line Rupture

Safety Impact			Environmental Impact		Production Impact		Damage
Fatalities	Injuries	First Aid	Leak Volume	Reportable	Days	Cost	Cost
0	1	5	Large	Yes	?	$$$$	$$$$

The Incident

The Deethaniser overhead line of a Saturated Gas Plant (SGP) suffered a catastrophic failure at an elbow immediately downstream of a washwater injection point. The release caused a huge vapour cloud which ignited after 20 – 30 seconds, resulting in a massive explosion and fire. The pressure wave from the blast caused widespread damage to houses and businesses within a 1 km radius of the site. Debris from the explosion was spread over a wide area including on an adjacent public highway. Some 10 – 15 minutes later, a second release occurred which also ignited and caused the fire to increase in size and intensity. Several other pressurised piping systems in the fire zone overheated and ruptured. The fire was brought under control within 70 minutes and was extinguished 5 hours and 40 minutes later. The damage to the SGP caused the refinery to be shut down for several weeks, followed by a phased startup.

Background

The SGP was commissioned around 20 years before this incident. The original design included continuous washwater injection at the combined feed inlet to the SGP feed surge drum to combat salt and hydrate formation. However, soon after commissioning, this was found to be only partially effective so an additional injection point was created on the Deethaniser overhead line by utilising an existing vent point. The pipe section that failed was a DN 150 (6" NS) forged carbon steel elbow. Inspection revealed the wall thickness had reduced from 7.1 mm (nominal) to 0.3 mm (minimum). The thinning was found to be localised to the elbow and, to a lesser extent, adjacent pipe sections. The uncorroded pipe sections were found internally coated with black iron sulphide scale which "passivates" the carbon steel pipe.

It is estimated that approximately 180 tonnes of flammable liquids and gases and 0.5 tonnes of toxic hydrogen sulphide (H_2S) were released during the incident. Fortunately, the incident occurred on a public holiday when there were only 185 people on site rather than the normal weekday workforce of around 800 staff and contractors. Few were outside when the explosion occurred because most were inside buildings, preparing for shift handover.

Causes

The immediate cause of the explosion and fire was loss of primary containment (LOPC) due to erosion/corrosion of the Deethaniser overhead line at a point downstream and in close proximity to a water injection point that was not part of the original design. Critical factors were continuous rather than intermittent injection of washwater and absence of an injection quill or other atomising device (leading to erosion of the protective iron sulphide scale layer) and absence of an in-service pipework inspection plan. Root causes included 1) inadequate design (absence of atomising device), 2) inadequate communications (Operations personnel failed to alert other groups when washwater injection was switched from occasional to continuous mode), 3) failure to conduct a Management of Change (MoC) review (continuous versus intermittent operation) and 4) inadequate corrosion management system (insufficient resources and failure to meet industry recommended best practices for inspection and maintenance of piping at injection points).

Lessons

Erosion-corrosion of carbon steel piping in sour service tends to be most pronounced in areas of high turbulence such as elbows and tees because the protective internal iron sulphide scale layer may be removed by erosion. Washwater injection into process piping should be introduced via a quill or other atomising device in order to minimise erosion of the sulphide scale layer. API 570 ("In-service Inspection, Repair, and Alteration of Piping Systems") and NACE Publication 34101 ("Refinery Injection and Process Mixing Points") provide guidance on best practice for in-service inspection of injection points.

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