LEARNING FROM ACCIDENTS

Safety Alert from SEA (India)

SEA (INDIA)

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Title: Vizag Gas Leak dtd. 7th May, 2020

What Happened

On 7th May 2020, an incident of uncontrolled Styrene vapour Release occurred at LG Polymers - Visakhapatnam from one of the Styrene storage-tanks (M6 Tank). The accident took the life of 12 persons in the immediate subsequent period and 585 people had to undergo treatment in hospitals, besides causing loss of livestock and vegetation.

Some properties of Styrene,

- ✓ Colourless liquid at normal temperature
- ✓ Highly Flammable with Explosive range: 1.1 to 7%
- ✓ Flash point: 31°C, Boiling point: 145°C
- ✓ Threshold Limit Value (TLV) for 8 hours a day: 50 ppm; Short-term Exposure Limit (STEL)
- ✓ of maximum 15 minutes: 100 ppm; Immediate Danger to Life & Health (IDLH): 700 ppm
- ✓ Causes severe eye, skin and respiratory irritation, CNS depression, nausea, vomiting etc.
- ✓ on short term exposure
- ✓ Highly reactive and can polymerise (which is an exothermic reaction)
- ✓ The rate of polymerisation increases with increase in temperature and results in runaway reaction at 65°C
- ✓ Polymerisation is controlled in normal circumstances by adding low temperature inhibitor substance like p-tert-butyl catechol (TBC).
- ✓ At higher temperatures, only high temperature inhibitors like Tertiary Dodecyl Mercaptan (TDM) and n-dodecyl mercaptan (NDM) etc. can inhibit the polymerization of Styrene.

Root Cause of Incident

- ✓ The modified piping design carried out by December 2019, within the M6 Tank not only totally disturbed the Styrene recirculation system but also led to significant thermal stratification in the M6 Tank with high temperature gradient. Hence, the top level of the Styrene monomers in M6 Tank experienced much higher temperatures than the bottom layer.
- ✓ The refrigeration system was operated as a standard practice in LG Polymers between 8.00 a.m. - 5.00 p.m. only on all days manually. There was inadequate time duration for Refrigeration and cooling system to maintain the temperature of Styrene monomer below 20°C in the M6 Tank at all levels in the tank.
- ✓ The temperature measurement in M6 Tank is restricted to the bottom zone, while the top and central zones had higher temperatures. Thereby, the temperatures at the top level and the middle level were not available at all to detect the temperature rise in the upper levels. Further, the SOP followed by LG Polymers for the temperature limit of 35°C was improper. The prescribed frequency standards of polymer and TBC measurement were also not followed and the samples of Styrene monomer from the recirculation and refrigeration system viz., bottom of the M6 Tank was analyzed once in 4 days approximately by LG Polymers.

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- ✓ The high temperatures at the top levels of the tank led to Thermal Radical Polymerization. The high temperatures made the limited TBC available (due to Thermal Stratification) at the top layers ineffective.
- ✓ The M6 Tank was an old tank with old design structures. The inner side of the tank was not lined. Further, LG Polymers was complacent in cleaning the tank once in 5 years (last cleaned in 2015) resulting in the accumulation of contaminants, which acted as catalyst inside the tank, initiating polymerization of Styrene which overwhelmed the inhibition effects of TBC.
- ✓ The company management had ignored the increase of polymer content from 4th April 2020 and then the sharp rise on 25th April 2020 / 28th April 2020. The management considered polymer content as a quality measure for Styrene rather than a safety measure. The early indications of a runaway reaction shown in the rise in polymer content in the M6 Tank was totally ignored.
- ✓ Onset of runaway polymerization reaction is the critical parameter in the root causes of the accident. There was only one sensor for temperature which measured only the local temperatures and did not indicate the temperatures at the higher level of the tank as the contents were not well mixed. The measured temperature reported by LG Polymers did not reflect any potential catastrophic high temperature hot spots in the tank. Polymerization was ongoing and unnoticed in zones that are not near the lone temperature sensor for the quantity (1937 MT) of Styrene monomer in (in 18 m dia. x 12.185 m tall vertical cylindrical fixed roof tank). The uncontrolled Styrene vapour release from the M6 Tank was due to high temperatures, well beyond the company's protocol temperature of 35°C.
- ✓ The company failed to consider the TBC stratification and measured TBC only from the samples from the bottom layer. Further, there was no stocks of TBC available in the LG Polymers at the time of accident. The quantity of high temperature inhibitors like TDM & NDM was also limited, which got exhausted after few hours and failed in preventing the runaway reactions.
- ✓ There was no monitoring device or no monitoring system in place to measure the quantum of dissolved oxygen in the Styrene monomer in M6 Tank.
- ✓ As clarified later in this chapter, no process safety management system was followed in LG Polymers.
- ✓ There was a dearth of knowledge and talent among the top, middle and shift management in LG Polymers. Most of the present shift in-charges / engineers were not qualified engineers. Hence, their knowledge and skills were not adequate when faced with a challenge or an emergency.
- ✓ LG Polymers was closed during the Covid-19 lockdown period as it is a non-essential industry and the minimum staff were given permission to maintain the factory during the lockdown period. However, the LG Polymer management was irresponsible, as they followed the same SOP as applicable for regular steady state operational circumstances, during the lockdown period as well and did not consider the idling conditions in the M6 Tank. Further, they ignored the early indications in rise in polymer content.
- ✓ No separate SOP was created for the lockdown and restart operations (PSSR: Pre-Start up Safety Review). Thus, the LG Polymers did not at all consider the idling conditions in all the tanks including M6.
- ✓ The safety protocols were not followed. The Process Safety Management (PSM) systems were not implemented.
- ✓ Failure to submit HAZOP & Risk Assessment Reports
- ✓ The Onsite Emergency plan of LG Polymers did not take into account any likely scenarios of Styrene vapour release from storage tank and such a case was never considered for emergency mock drill.
- ✓ The Offsite Emergency plan was not followed. Even the Siren, which was in working condition and had multiple activation points including near the factory gate, was not activated at the time of the accident.

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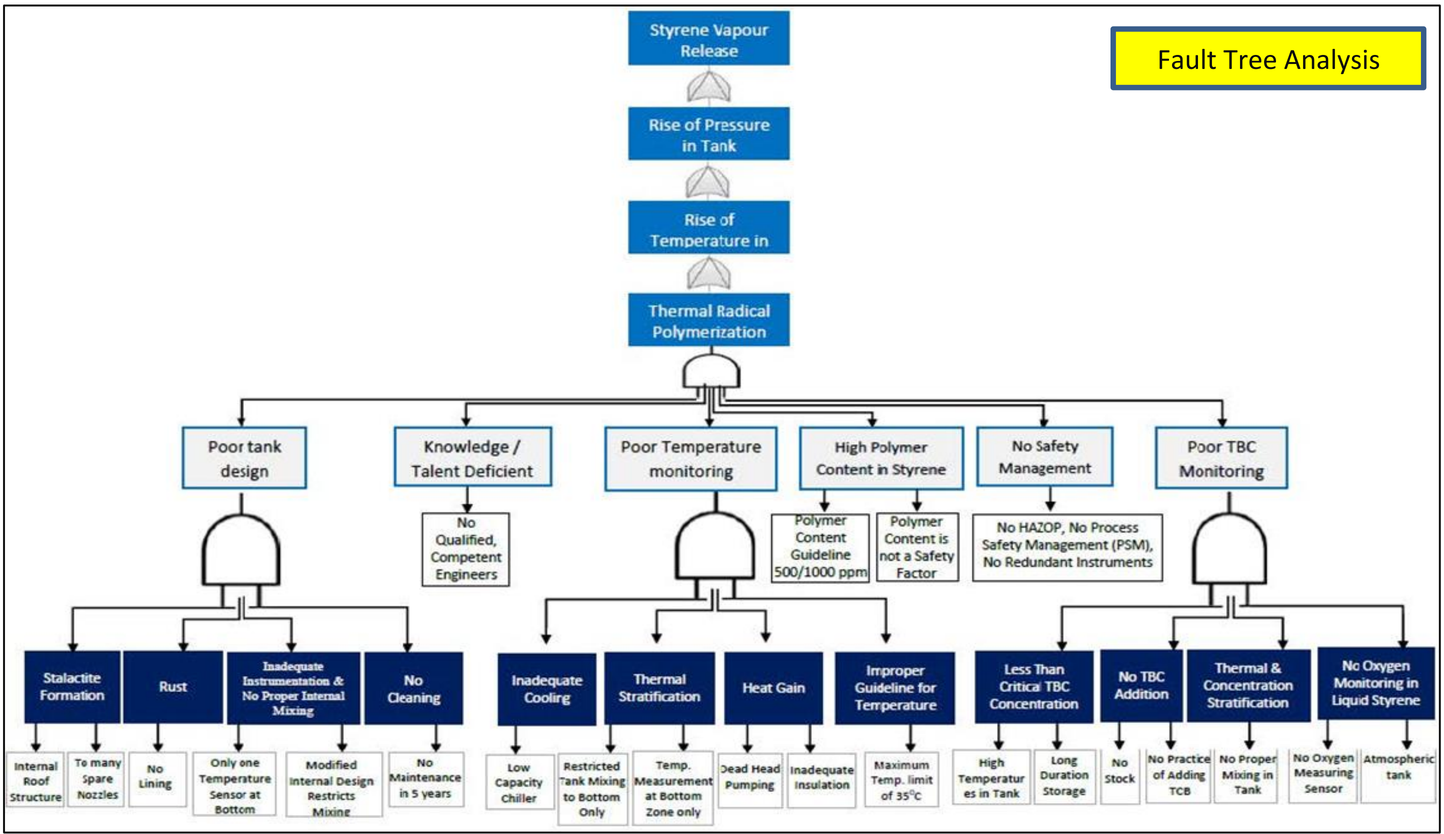
Other Findings



Recommendations from Investigation Committee

- ✓ Hazard and Operability Study (HAZOP) and its compliance shall be made compulsory for all Hazardous process factory/unit wherever there is processing/storage of hazardous chemicals.
- ✓ The industry should arrange for Annual Safety Audit and Annual Environmental Audit. The recommendations of the audit shall be meticulously complied within a reasonable timeframe.
- ✓ All officers working in regulatory departments dealing with factories shall undergo Safety course once in every 3 years. This is especially important for Fire Department and Police Department personnel posted in the areas having jurisdiction over the hazardous chemical units/factories.
- ✓ All employees and people in the vicinity of the industry shall be made aware of the MSDS of hazardous chemicals.
- ✓ The MSDS of the chemicals which has potential to create Offsite emergency should be displayed at the factory gate, on the website of the company and should also be informed during the Offsite emergency mock drill.
- ✓ The hazardous industry should prepare a uniform standard format for the emergency plans with full details including the equipment and chemicals required in the event of an emergency.
- ✓ The industry shall identify Process Safety Competency-based training needs and shall develop training modules and the training to be imparted till the competency levels are improved.
- ✓ The hazardous industry must undertake competency mapping for all the operating and maintenance staff. The gaps incompetency should not be tolerated in respect of hazardous chemicals industries at all.

Source: http://www.indiaenvironmentportal.org.in

Pl note our New Web site ID: URL: http://www.safetyengineersassociation.org