CASE STUDY

OISD/CS/2023-24/P&E/14 Dt.:27/03/2024

INTRODUCTION

Title: Fatal accident during adsorbent removal.

Location: Petrochemical Complex

Loss/ Outcome: 2 fatalities.

BRIEF OF INCIDENT:

Two contract workers, employed by a catalyst loading/unloading agency, were working inside the chloride guard vessel of Ethylene Recovery Unit, trying to extract the caked-up adsorbent of the chloride guard under the confined space entry permit. A sudden eruption occurred in the vessel, resulting in the fatality of both workers.

OBSERVATIONS/ SHORTCOMINGS

1. The chloride guard vessel had been commissioned about a month ago.
2. The pressure drop across the chloride guard was observed to be increasing since commissioning, reaching a peak of 3 kg/cm^2 against a normal of 0.2 kg/cm^2 in about a fortnight.
3. On analysis, it was suspected with water carry-over from wash water section might be the cause of increased pressure drop. The increase pressure drop was also correlated to the high level in the upstream column.
4. Due to the constrained operation caused by high delta pressure, the chloride guard vessel was taken offline and unloading of adsorbent through vacuuming was initiated by opening the top manhole after the required purging and necessary clearance & job safety analysis (JSA).
5. Plant Air (PA) supply through a ¾" hose had been connected to a flange of the bottom drain point of the vessel after nitrogen purging of the vessel.
6. However, removal by vacuuming could not be continued after removal of top material (ceramic balls, etc.) due to observed caking of the adsorbent. Therefore, it was decided to take out the adsorbent manually. The JSA was reviewed. The bottom manhole was in closed condition, in deviation to JSA recommendation.
7. Two contract workers, equipped with airline masks, entered the vessel with buckets for the manual removal job after getting the man-entry permit. Two contract workers were on the platform top to pull the buckets out.
8. The air was in charged condition from the temporary bottom connection. The contract workers at the top were monitoring the gas condition inside the vessel (H_2S, CO, LEL and O_2).
9. Checking of pressure gauge at the bottom of the vessel, before or during the man-entry, could not be corroborated.
10. Reportedly, within about half an hour, a sudden eruption sound with spray of catalyst beads/ dust gushing out from the reactor top manhole was observed. The beads/ dust kept coming for about 10-15 seconds projecting to a height of 5-6 meters spreading all around the nearby area.

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11. One contract worker died inside the vessel while the other, who was pulled out, succumbed to his injuries after some time.
12. CCTV cameras were installed, but no historical data was available although its operationalization before commissioning had been recommended in PCSA of the unit.

CONCLUSION / ROOT CAUSE

The plant air supply, connected to the reactor through the hose with flanged connection, might not have passed through caked adsorbent bed (caked due to probable moisture absorption). Consequently, the empty space below the adsorbent bed must have pressurized. This trapped air eventually erupted. The plant air header pressure dropped momentarily at the incident time, suggesting a release of airflow restriction.

The trigger for the air release could be:

a) During bucketing, the caked catalyst crust holding the pressure below may have thinned/broken, suddenly releasing pressure and causing adsorbent/inert balls to fly as projectiles.
b) Alternatively, incomplete hydrocarbon removal during purging could have led to a localized explosion if ignited, fracturing the lump and releasing air carrying adsorbent pellets at high velocity.

While ignition cannot be entirely ruled out, there was no concrete evidence of burning or soot found.

RECOMMENDATIONS

a) No connection shall be made to a confined space during man-entry that may pressurize or create any hazard in the confined space.
b) When vessel is purged for vessel entry, the air or nitrogen connection shall be equipped with a flow regulator containing an excess pressure release mechanism. Manual air pressurization checks can be done by closing the supply for a while and checking the time taken for release of pressure.
c) Perform Job Safety Analysis (JSA) with a diverse team, including contract personnel, if applicable, to assist in envisaging all sorts of safety aspects and thereby addressing them. Deviations, if any, should be deliberated again for taking alternative measures.
d) Supervise catalyst loading/unloading activities in running process unit closely in person or using CCTV. Moreover, CCTV should be strategically placed to cover most of the process units. History data for the CCTV footage should be configured. Pre-Commissioning Safety Audit (PCSA) recommendations shall be implemented before commissioning.
e) Integrity Operating Window (IOW) for critical parameters and deviations from the IOW shall be investigated properly and corrective measures shall be taken accordingly.
f) Hierarchy of hazard control, i.e. elimination, substitution, engineering controls, administrative controls, and use of PPE, shall be followed while addressing a risk. Hence, incorporating engineering controls like de-entrainment separators in case of susceptibility of downstream equipment/ material to any carryover of material from upstream, provision of differential pressure indicator across adsorbent/ catalyst beds, etc. should be contemplated.

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