CASE STUDY

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INTRODUCTION

Title: Fire in Atmospheric Vacuum Unit (AVU).

Location: Process (Crude Distillation Section) unit in refinery.

Loss/ Outcome: Personnel injury, damage of equipment, unit outage & production loss.

BRIEF OF INCIDENT:

AVU was under startup after M&I. The Crude Distillation section was under hot circulation with furnace (4 parallel) coil outlet temperature at 320^{0}C and combined circulation rate of 700 m^3/hr. The medium pressure (MP) steam, imported from battery limit, was routed through the convection section of the furnaces for super heating and subsequent usage as stripping steam. The steam, post convection section, was being vented through the silencer. The next activity was to route the super-heated steam to the stripping steam header for routing to the distillation columns/ strippers.

Accordingly, the field operator was re-routing the steam from vent to the stripping steam header by closing the vent valve (V9- Refer FIG:1) and at the same time opening the main steam header valve (V8- Refer FIG:1), both located on the operating platform at approx.8.5m from grade. Upon diverting super-heated steam to steam header, a flash fire occurred at the vent of the crude furnace. One fire tender was already available in standby at CDU as per unit startup protocol. Fire fighting started immediately. A nearby remote operated “high-volume long-range monitor (HVLRM)” was used. Fire was extinguished within 12 minutes. Nine persons, who were involved in various startup activities in nearby area, sustained burn injuries. They were taken to refinery hospital and then were referred to other speciality hospitals.

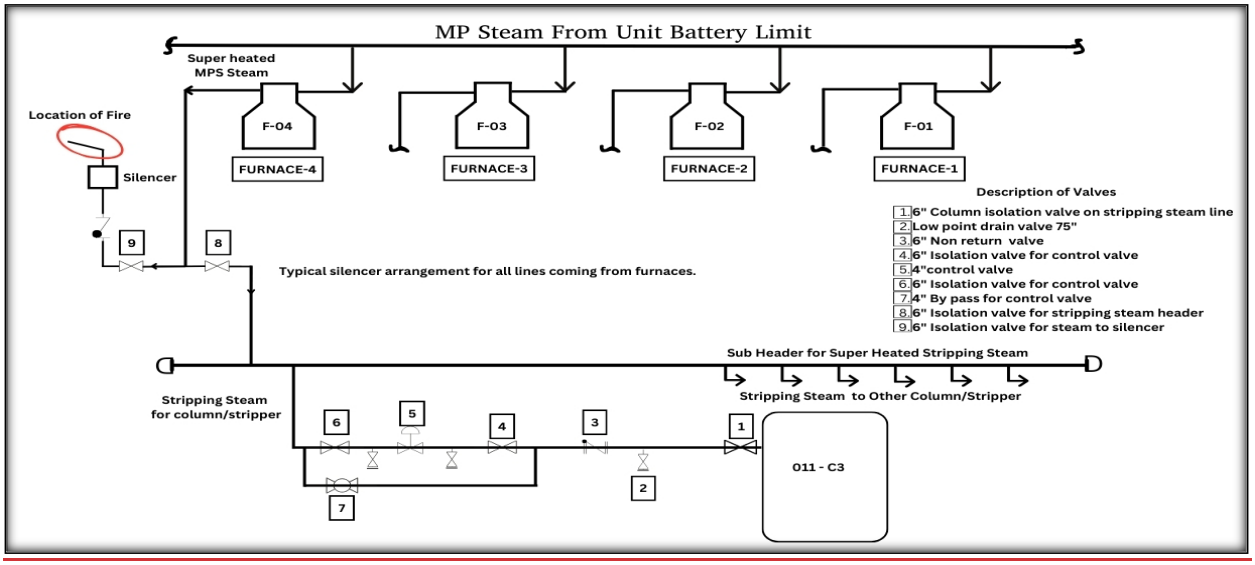

Fig 1: Schematic of MP Stripping Steam to Columns/ Strippers

This Case Study is based on the Investigation report done by OISD and published for information purpose only. This information should be evaluated to determine if it is applicable in your operations, to avoid recurrence of such incidents.

OBSERVATIONS / LAPSES

1. The pipe length from the valve (V8- Refer FIG:1), from where steam was being diverted to the stripping steam header that led to the stripping columns steam inlet control valves, was around 20M implying a hold up capacity of approximately 1.4 m^3. Instead of first preparing the header and heating by means of venting/ draining till the point (V2- Refer FIG:1) nearest to location of process mixing, the diversion was attempted from distant location (V8- Refer FIG:1).

2. The above was also in contravention to the startup checklist illustrated in operating manual mentioning “Charge stripping steam to respective columns & strippers after draining condensate from the header and from upstream bleeders of column valves.”

   However, during interaction with multiple personnel (Manager & Senior Manager) in the production group, it was observed that the clarity about the introduction of stripping steam was absent. Further, the usage point valves (valves admitting steam to columns) were still closed, implying a blocked outlet condition.

3. The startup SOP did not explicitly cover about the steps of charging of steam stripping header, making the line condensate/ vapor (if any) free till the point nearest to the columns, and subsequently charging to the respective columns & strippers. The same was not covered in the AVU Shutdown Manual 2024 (CDU Startup activities) also.

4. Post incident, sample from drain points (V2- Refer FIG:1) of the stripping steam header was collected and sent to QC lab for testing. The reported density of hydrocarbon sample was 731.5 kg/m^3 and the sample also contained 10% of free water.

5. Startup checklist illustrated in operating manual indicated to maintain 60% bottom level in pre-fractionator and then to subsequently introduce superheated steam. For other columns & strippers levels, nothing was mentioned.

   Bottom levels in all the columns/ strippers were considerably on higher side. Specifically heavy naphtha stripper and ATF stripper level were >100%. The actual levels could not be ascertained as the indicators were showing their maximum detection level.

6. Elevation of stripping steam nozzle of heavy naphtha stripper was 2M above the stripping steam diversion valve located at silencer platform indicating an equivalent static head.

7. After the incident, it was reported that heavy naphtha was observed in drain points of the stripping steam header at multiple locations. Reportedly, the 4’’ control valve bypass valve (V7- Refer FIG:1), 6’’ non-return valve (V3- Refer FIG:1). and 6’’ block valve (V1- Refer FIG:1) in the stripping steam line to heavy naphtha stripper were passing.

   Stripping steam lines to the other columns and strippers were reportedly checked after the incident, but no passing was observed in these valves.

8. It was informed that the non-return valves (i.e. V3- Refer FIG:1) in the stripping steam line to the columns had been replaced during the turnaround. The non-return valves had been tested prior to installation.

9. The startup clearance of the unit was given in spite of non-completion of various jobs in the unit like open manholes, mechanical scraps, non-readiness of fire protection facilities, unwanted scaffoldings, etc. The said pending jobs had been noted in the F&S checklist accompanying the startup clearance. It was also noticed that blinding and end cap provision of steam lines had not been considered in the operational readiness review done by operation, inspection, process, etc.

CONCLUSION / ROOT CAUSE

Source of Leak:

Naphtha backed up from heavy naphtha stripper (11-C-3) due to passing of isolation valves and NRV in stripping steam circuit (V1, V3, V7- Refer FIG:1), possibly aided by high liquid level in the HN stripper. Hence, the stripping steam line up to the 6'' diversion valve (V8- Refer FIG:1) located at silencer platform was already full of Naphtha before the 6'' diversion valve for routing steam from vent to the stripping steam header was crack opened. The liquid naphtha, when came in contact with superheated steam (320^{o}C) vaporized and discharged through the steam silencer (V9- Refer FIG:1) as in the downstream side, there was a blocked outlet condition.

Source of Ignition:

Auto ignition of Heavy Naphtha vapours (auto ignition temperature was 287.7^{o}C as per the composition analysis) occurred.

RECOMMENDATIONS

a) SOP to be developed for charging of steam headers. The same shall be known to all the concerned operating personnel.

b) Latest approved version of SOPs with a version number to be made available with proper access control to prevent duplication of SOPs as per 7.5.2.1 of working group report. Industry to make a system to ensure availability of controlled document to the working personnel.

c) Industry shall ensure that all the concerned operating personnel strictly adhere to the operating parameters such as level, pressure, temperature etc. as stipulated in the operating manual/ IOW/ SOP/ Checklist.

d) Necessary job/ role specific training to be provided to all personnel (including contract workers) including refresher training in line with Cl. 6.1 of OISD-STD-154. System to be developed to identify the personnel who have not undergone required trainings as per their job/ role. Structured "Competency assurance" program shall be developed in line with Cl. 7.2 of "Working Group" and necessary action to be taken.

e) All construction and pre-commissioning related activities should be completed before commissioning of unit as stipulated in OISD-GDN-206. Industry to ensure all the stipulations mentioned in the startup clearance are completed with due diligence. Startup clearance shall be given only after completion of all the attributes mentioned in the PSSR.

f) Industry shall ensure minimal manpower is deployed in process area during critical activities such as unit startup, shutdown, etc.

g) Method to check such critical NRVs should be developed. Means should be explored for online checking of such NRVs. Installation of double NRV shall be reviewed in utility/ process interface circuit for enhancing system integrity.

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