

Major Fire Incident in an Indian Refinery

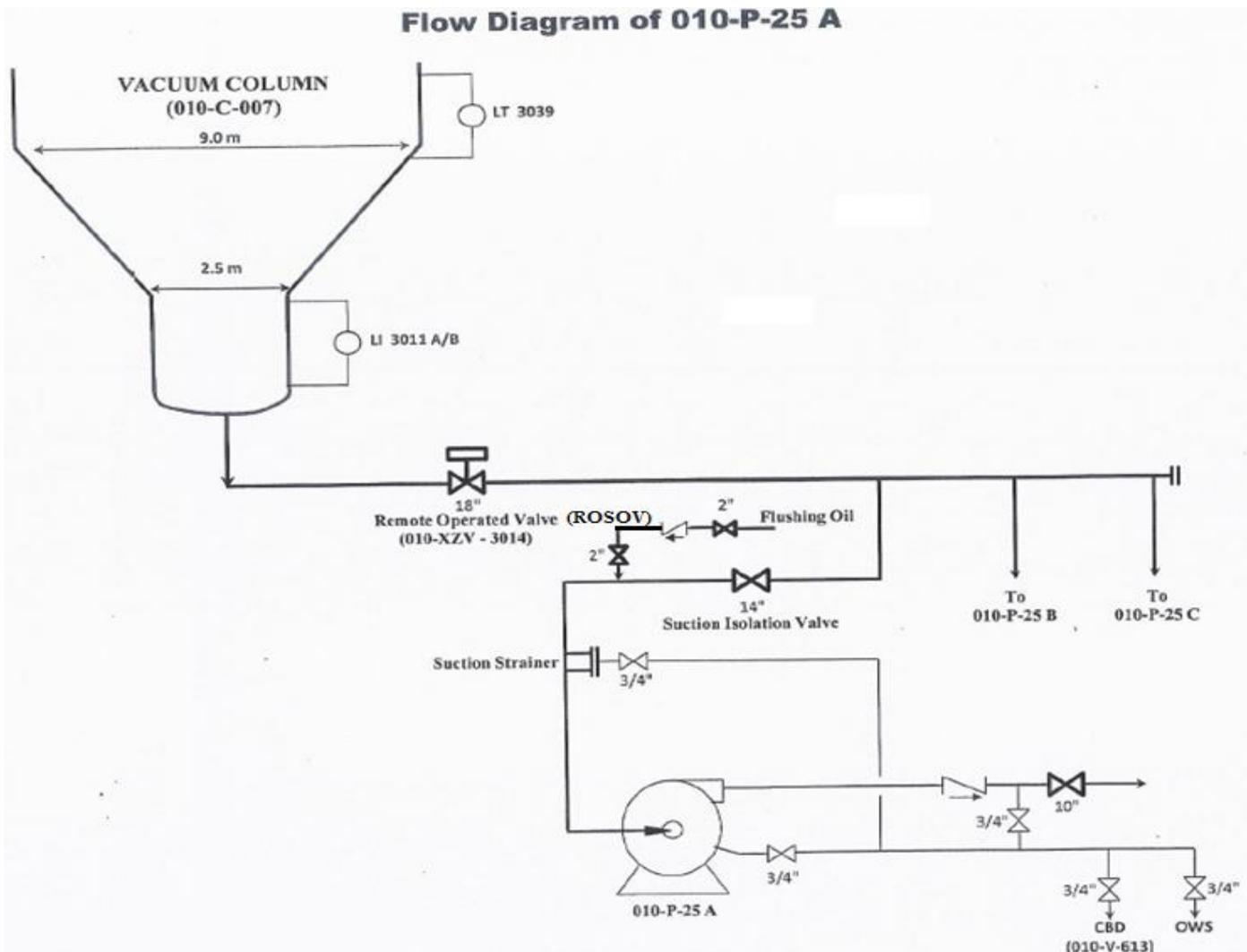
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The Incident:

- A fire broke out in the month of January, 2016 from the strainer flange of VDU column bottom pump in Atmospheric & Vacuum Distillation Unit (AVU) while carrying out the strainer cleaning job of the pump in an Indian Refinery.
- There was no injury to any person during the incident.
- The impact of the fire was felt locally around the source of the hydrocarbon (strainer flange) and damaged some cables, small pipeline sections, a few air fin coolers fans, insulation and cladding.

Sequence of events.

- The general arrangement view of the VDU column bottom to pumps suction is given in Sketch below.



- Pump P-25A was isolated at around 09-30 hrs. It was allowed to cool for some time to avoid draining of high temperature vacuum residue (VR) to closed blow down (CBD).
- In the second shift (starting at 14-00 hrs) the operator started flushing oil (FLO) at the pump suction (downstream of isolation valve) valve to flush the VR. Operator had kept the pump casing drain and the suction strainer flange drain open and after considerable flushing was done, the sample at the OWS point was checked and found that a thin black liquid was coming. Operator shut all the valves including FLO and made ready to be handed over to maintenance.
- Meanwhile the running pump P-25B started which was making heavy noise. Maintenance advised stopping the pump to check. Accordingly, P-25 C was started and P-25B was stopped.
- However P-25C was also found cavitating with heavy noise and vibration. The pump was started and stopped several times thinking that lighters are causing the cavitation.
- Meanwhile P-25A was ready for handover and the permit for opening the strainer was given to maintenance crew.
- To ensure that pump P-25A is isolated, the crew was asked to open the flange on the strainer drain line downstream of the isolation valve. Since no liquid was observed the alternate bolts of the main strainer flange of 14 inches was opened.
- Since again no liquid or gas was observed the other bolts were loosened and a gap of about 1 inch between the two flanges was made. Nothing came out immediately.
- However, some small amount of vapour started coming after a few minutes when maintenance team disturbed the strainer inside using a rod. The amount of vapour coming out increased after another couple of minutes.
- Within another 1-2 minutes some liquid started pouring down from the bottom of the flange.
- Immediately the liquid caught fire and the vapour travelling up also caught fire.
- Firefighting was started with all resources. Fire was put off by around 21-30 hrs.

Analysis:

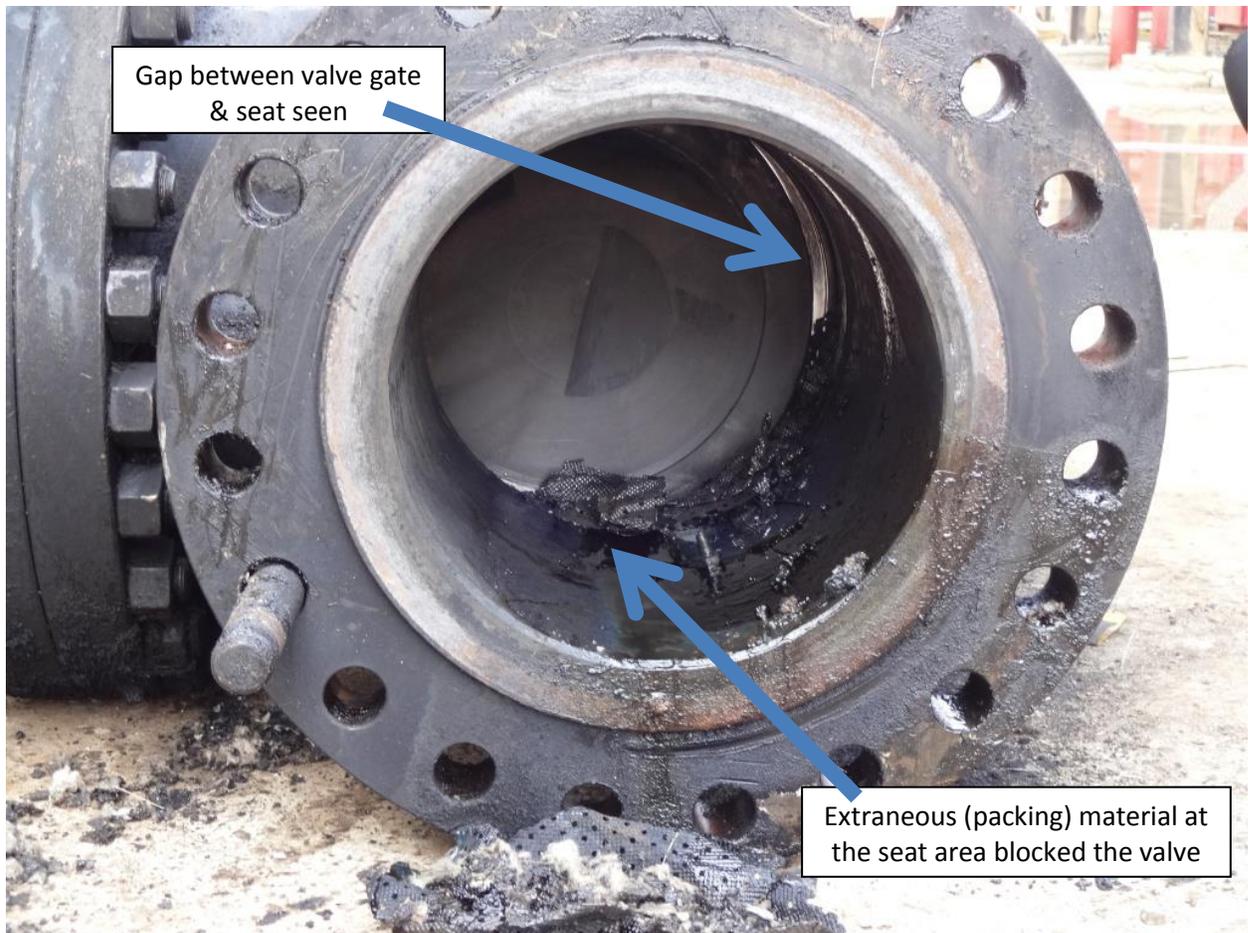
- There was no oil/ vapour coming out of the strainer drain valve flange when it was opened. This indicates that there was no flow from the strainer to CBD/OWS.
- When the strainer flange was opened, again nothing came out indicating that no liquid has flown through the small bore drain line.

- When the contractor workmen started creating space between the two opened flanges and disturbed the strainer inside, small amount of vapour came out indicating that the strainer disturbance created a path for the liquid to flow.
- It was found that lot of structured packing material from inside the column was found in the strainer and the same was removed when the strainer was opened after the fire incident.



Strenuous material in P 025A suction strainer

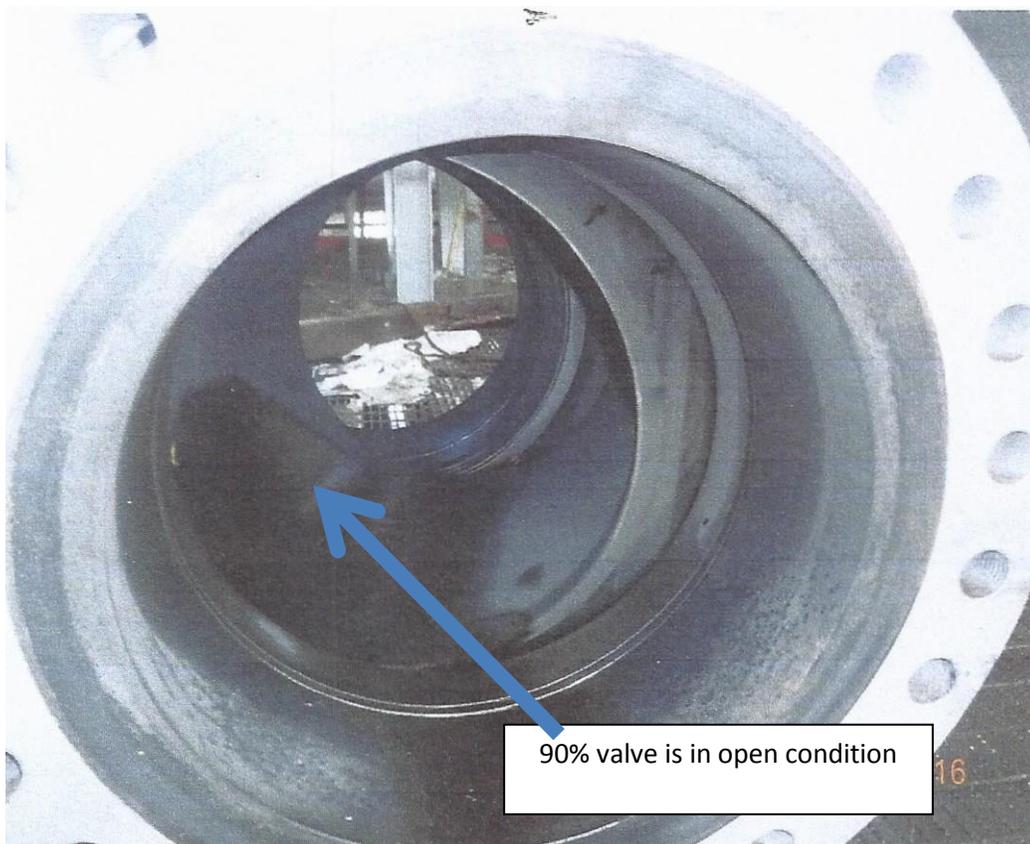
- The isolation valve of P-25A (which was lying outside) was also observed with structured packing between the valve gate and the valve seat restricting the full closure of the valve. It was observed that about 5-8% of the valve remained open due to this structured packing.



Reconstructed sequence of events:

- When the pump was isolated and allowed to cool for about 4 hours the VR inside the suction & discharge piping partly got congealed but was not depressurized as the suction valve was passing.
- When flushing was done and checked at OWS the liquid was coming from pump casing and not strainer flange. This was because the strainer flange was choked with structured packing material and hence did not allow the partially congealed VR to flow out. FLO flowed past the strainer to the casing and got drained from the casing drain.
- Since the strainer drain flange was kept open during FLO flushing, the operator thought that flushing oil has come out through this strainer drain line also, which was not true as observed.

- When the strainer was disturbed by the contractor workmen, the liquid pressure due to the passing suction valve found a way to come out from the open strainer flange.
- VR started coming out first as vapour and then in large amounts when the congealed VR started de-congealing at the temperature of about 300 deg C and finally the liquid VR came out and started falling down.
- VR temperature being higher than auto ignition temperature (220 deg C), it caught fire immediately.
- Although the common remotely operated isolation valve (XZV-3014) on the line was shut by remote PB as well as local push button but it did not function. It was observed (when the valve was opened up after the fire) that the ball valve was stuck at 90% open and hence the complete liquid hold up volume in the column fed to the fire which lasted for more than 3 hours.



XZV 3014 (Shut off valve)

Root Causes of the Fire:

- The extraneous structured packing material blocking the suction valve and choking the strainer drain flange opening – misguided / misled the operations team to believe that the pump was isolated and depressurised.
- But in reality, it was not depressurised / drained and not positively isolated from the pressurised system.
- This led to Vacuum Residue (VR) at more than auto-ignition temperature to come out of the suction strainer flange (when it was wedge gapped for opening) and continuously fed the fire that broke out.

Major Recommendations:

- When the VR pumps are isolated, the cooling period should be reviewed so that it does not get congealed and draining with FLO can be ensured. The SOP on this aspect should be reviewed.
- The isolation valve of the pump was not fully closed as could be seen from the spindle and from the gap in valve gate & seat when the valve was opened. A fool-proof mechanical arrangement to be made (like it is made in all gear operated valves) to ensure that the operator is guided to understand the valve is fully closed or not.
- When flushing is carried out for any isolated equipment (especially congealing liquids), Job Safety Analysis should consider the chances of congealing or extraneous material choking the drain line and accordingly SOPs for handing over of equipment to be made.
- The strainer area of each of the VR pumps to be checked with standards (for congealing /choking VR service) and accordingly modified, if required.
- Before every start-up of the unit the ROV/SOV has to undergo functionality test and recorded.
- Additional escape route on the strainer platform to be provided near the pump.