CASE STUDY

OISD/CS/2025-26/P&E/02 Dt.:21.5.2025

INTRODUCTION

Title: Fire in compressor house.

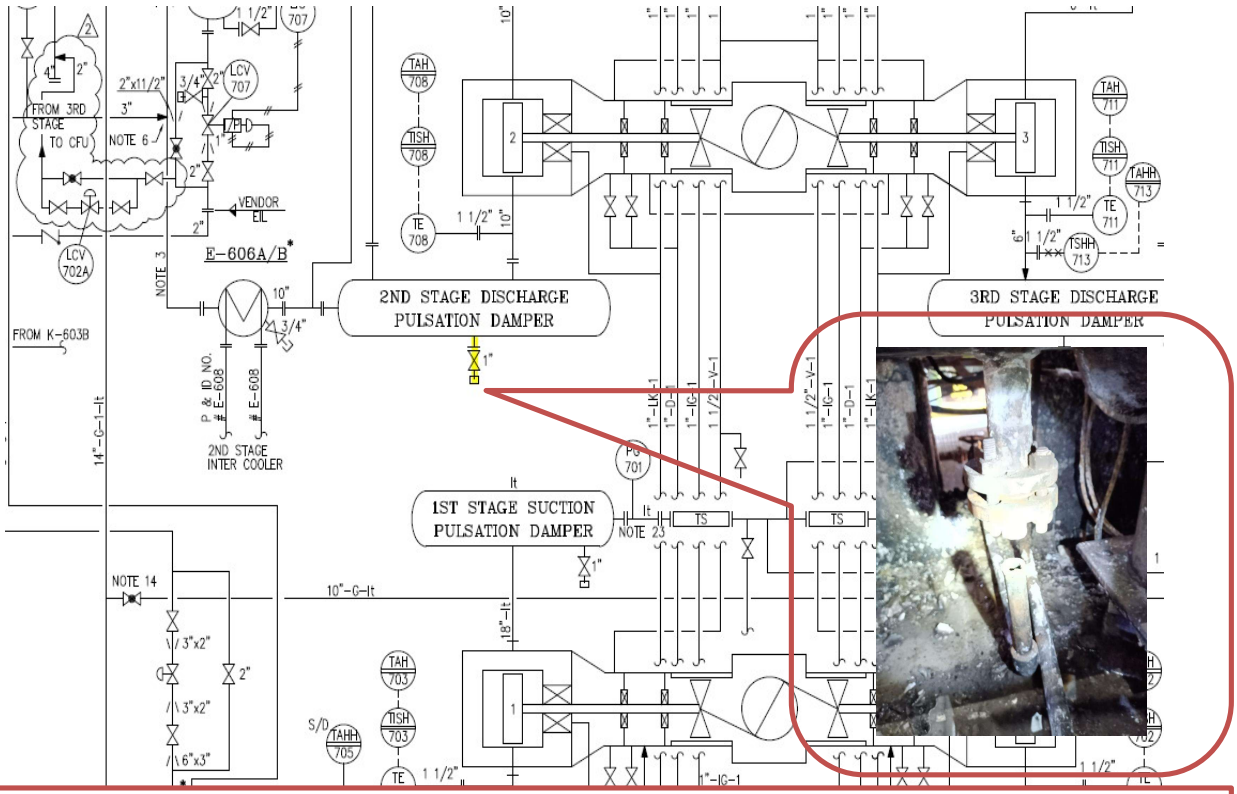
Location: Off Gas compressor in Gas Processing Plant.

Loss/ Outcome: Damage of equipment, unit outage & production loss.

BRIEF OF INCIDENT:

A fire incident occurred in an off-gas compressor within a gas processing facility. Prior to the incident, maintenance personnel, engaged in some other job in the area, noticed unusual vibrations and abnormal noise emanating from the off-gas compressor. On closer inspection, they observed gas leakage from the compressor and asked others to clear the site before rushing off. Subsequently, a loud sound was heard followed by a fire outbreak in the compressor area. The fire was extinguished in about 55 minutes with no casualties reported.

The compressor was around 50 years old. It was a multi-stage 5-cylinder reciprocating compressor. In the recent past a few modifications had been carried out in suction/ discharge volume bottles of the compressor and minor overhaul had been carried out.



1" drain line from the weld joint connected to the 2nd stage discharge volume bottle of the compressor snapped at the weld joint

a. The piping and instrumentation diagram (P&ID) reflected a 1” drain line fitted with a gate valve and end cap. However, in field the drain line had been modified downstream of the isolation valve to a 2” line, extended to the oily water system.
b. The modification was carried out without formal documentation under a Management of Change (MOC) or hazard identification and risk assessment (HIRA). Furthermore, none of the personnel could provide the genesis/ reason for the change.
c. In the drain line, no piping support existed for the modified line, unlike the standby compressor, where support for the original 1” line was present.
d. Structural support was retrofitted beneath one of the discharge vessels in response to recurring vibration complaints. This alteration was made without any formal analysis or engineering evaluation.
e. A previously reported leak in a suction vessel had prompted a thickness check of the vessel itself, but associated piping was not inspected, nor was a root cause analysis undertaken.
f. No in-situ probes were available for vibration monitoring on the casing. Periodic vibration monitoring was not practiced.
g. Volume bottles of the compressor, which had been replaced, weighed around 30-40% more than the original. No pulsation and vibration study had been carried out post replacement
h. Hydrocarbon gas detectors triggered repeated alarms in the nine and a half hours preceding the incident, but no field inspection or corrective action was taken in response.
i. No cognizance of the significant drop in gas flowrate in the evening shift, 13 hrs prior to incident, was taken. No analysis for possible process upsets or gas leakage was carried out.
j. Persistent reports of abnormal vibration and knocking noises were recorded by field personnel over since about 10 days prior to incident. Despite this, no escalation to maintenance or safety departments was done, and the issue was neither discussed in safety committee meetings.
k. There was no inspection practise in place for small-bore piping.
l. Failure analysis report revealed heavy internal corrosion at a butt-welded joint of the high-pressure line. Crevice was observed in butt weld area with thickness locally reduced to 1 mm from 5 mm. Sludge had accumulated near the butt-welded. The Energy Dispersive Spectroscopic (EDS) analysis revealed presence of Sulphur, oxygen and waterborne contaminants on inner surface.
m. CCTV footage revealed that the fire suppression system failed to auto-activate despite activation indicators being present, and emergency response was carried out manually using foam tenders.
n. Only foam was deployed during the fire suppression efforts, despite foam being primarily for liquid fires. No specific guidance was provided in the Emergency Response and Disaster Management Plan (ERDMP) about the appropriate f fire suppression media to be utilised based on type of fire, indicating a critical deficiency in emergency preparedness documentation.
o. Most recent internal audit, conducted around 18 months ago failed to identify key hazards such as high vibration, absence of small-bore piping inspections, and the lack of mock drills. There was no audit evidence conducted subsequently.
p. Several pipeline flanges were found without continuity bonding jumpers, increasing the likelihood of electrostatic discharge—a known ignition source in flammable atmospheres.

CONCLUSION / ROOT CAUSE

The 1" drain line from the weld joint connected to the 2nd stage discharge volume bottle of the NP-B compressor snapped at the weld joint, weakened by internal corrosion and erosion. The failure was aggravated by mechanical stress due to absence of proper pipe support coupled with high vibration in the equipment.

The lapses leading to the failure are indicative of:

i. Non-adherence to management of change procedure and, specifically, not carrying out Hazard Identification & Risk Analysis (HIRA), while changing the line size, volume-bottles, provisioning of supports.

ii. Not following equipment monitoring/ inspection procedure including absence of vibration monitoring/ small bore piping inspection/ root-cause-analysis of failures.

iii. Ignorance of various audio/ visual warnings including noticeable vibration, noise, instrument alarms as well as sudden deviation in process parameter by operating personnel.

Probable source of ignition:

a. The broken line must have hit other metallic surface in the vicinity due to vibration leading to generation of spark, igniting the leaking hydrocarbon vapour.

b. Alternately, the absence of continuity jumpers (electrical bonding) across flanged joints in the hydrocarbon piping system could have resulted in electrostatic charge accumulation that may have discharged after snapping of the line and generation of vapour cloud.

RECOMMENDATIONS

a. Pulsation and vibration study shall be conducted for compressors. Based on the findings, necessary design modifications, as required, shall be carried out.

b. Pipeline supports shall be provided based on detailed load calculations.

c. The material of construction of piping should be evaluated and revisited based on its exposure to corrosive operating environment.

d. Timely response to various audio and visual indicators inclusive of those by panel officers should be ensured.

e. Deficiencies in firefighting methodology should be reviewed. Fire Order should be reviewed and updated accordingly.

f. Management shall ensure proper implementation and adherence to all aspects of Safety Management System in line with OISD-STD-206. For example, any repairs (temporary/ permanent), connections, bypasses, or operational modifications shall only be undertaken following proper MOC procedures.

g. Robust and effective internal audit program shall be developed and implemented that should bring to notice the deviations with respect to stipulated requirements inclusive of gaps in maintenance/ inspection/ monitoring practices.

h. Personnel should be encouraged to report and register unsafe conditions inclusive of abnormal noise/ vibrations, improperly supported equipment/ pipeline etc.

i. All safety-related concerns should be discussed during sectional safety committee meetings and resolved within a stipulated timeframe. Unresolved issues should be escalated to higher-level safety committee meetings.

****