तेल उद्योग सुरक्षा निदेशालय
Oil Industry Safety Directorate
ISO 9001:2015 certified

सुरक्षा संवाद
Suraksha Samwad

An opportunity to learn from mistakes....

Disclaimer

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Presented by :

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He is a Chemical Engineering graduate from the Govt. Engineering College, Trichur. He has more than 33 years of diverse experience in Refinery Operations, Oil Economics, International Trade and Supply Chain Optimization, Process Engineering, Quality Management Systems, Process Safety Management and Fire, Safety & Environment. He is currently heading the HSE Department consisting of Occupational Health Centre, Fire, Safety, Contractor Safety, Process Safety Management & Environment Sections of BPCL-Kochi Refinery.

He was the Project Manager & Lead for the Planning Scheduling & Blending (PSB) module of the Manufacturing Execution Systems (MES) project which includes the use of advanced LP systems for decision support to help the Manufacturing Processes in improving the margins. He was also instrumental in implementing the Process Safety Management elements in the refinery in line with the Occupational Safety and Health Administration (OSHA, USA) and Centre for Chemical Process Safety (CCPS, USA) for improving the safety systems in the refinery to meet global standards. He is the Chairman of the HAZOP and SIL sessions handled at BPCL-KR and has participated in many hazard analysis sessions and SIL sessions. He has presented many papers at the Refinery Technology Meet, Regional Quality Conclave conducted by FICCI, Corporate HSSE Meet, National Safety Council, Kerala Chapter and Annual Meet of M/s Cholamandalam Risk Services Ltd., Chennai.

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Hydrocarbon leakage from the reflux line of Debutanizer in DCU

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INCIDENT

- On 23rd June 2017, around 13:15 hrs, Heavy leakage of LPG from the top portion of Debutaniser column in DCU
- MCP activated and emergency shut down of DCU was taken.
- HVLR and sprinkler system of the column operated to prevent spreading of the vapour cloud.
- All the works including hot works in the nearby PFCCU site were stopped.
- Evacuation of all the contract labourers in the project areas
- Contain the spreading of H2S and HC smell to the neighbouring areas
- Debutanizer section was depressurized and the situation was under control by 15 30 hrs.

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EVENTS PRIOR TO INCIDENT

- H_2S smell reported on 23rd June morning
- Alarms from H_2S / HC monitor at air fin platform of TS #01 got actuated
- Plant personnel were on the look out to identify the source of the leak
- At 11.58 hrs, about 8 pumps in GCU got interrupted due to electrical problem.
- Operators focus shifted to containing the process upset due to the tripping of the pumps.
- Subsequently the Operators identified the heavy leak from top portion of the Debutanizer column.

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SOURCE OF LEAK

- Leak was identified due to the failure of weld joint of the elbow in the overhead reflux line.
- A crack on the Heat Affected Zone (HAZ) of the bottom weld joint between the 45 degree elbow and slanting pipe was identified.

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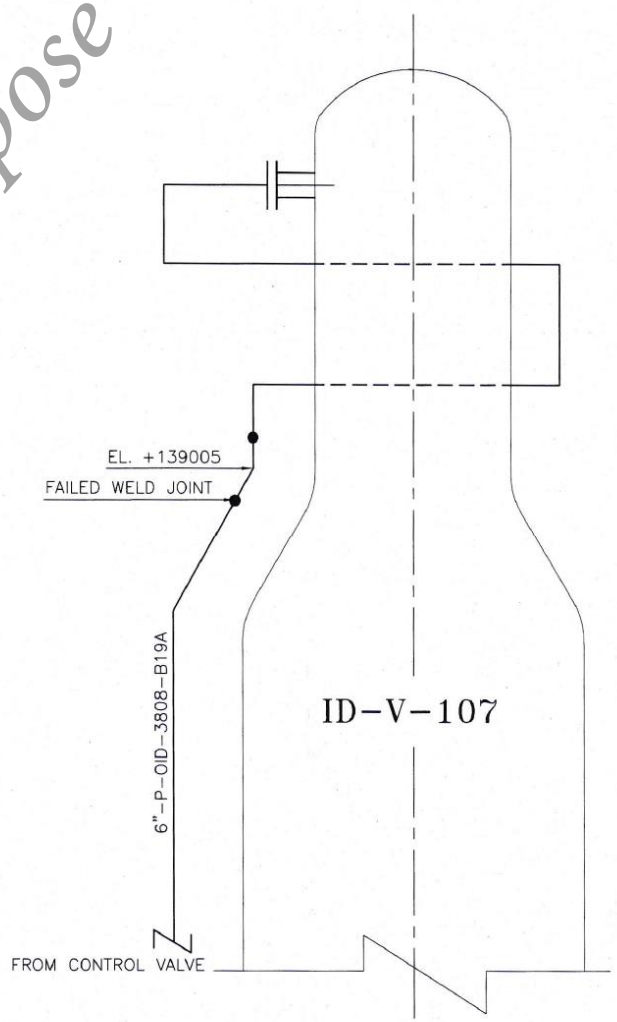

OBSERVATIONS

- The crack was circumferential in nature and was extending almost 100% of the circumference.
- The nature of crack indicates brittle failure through the HAZ

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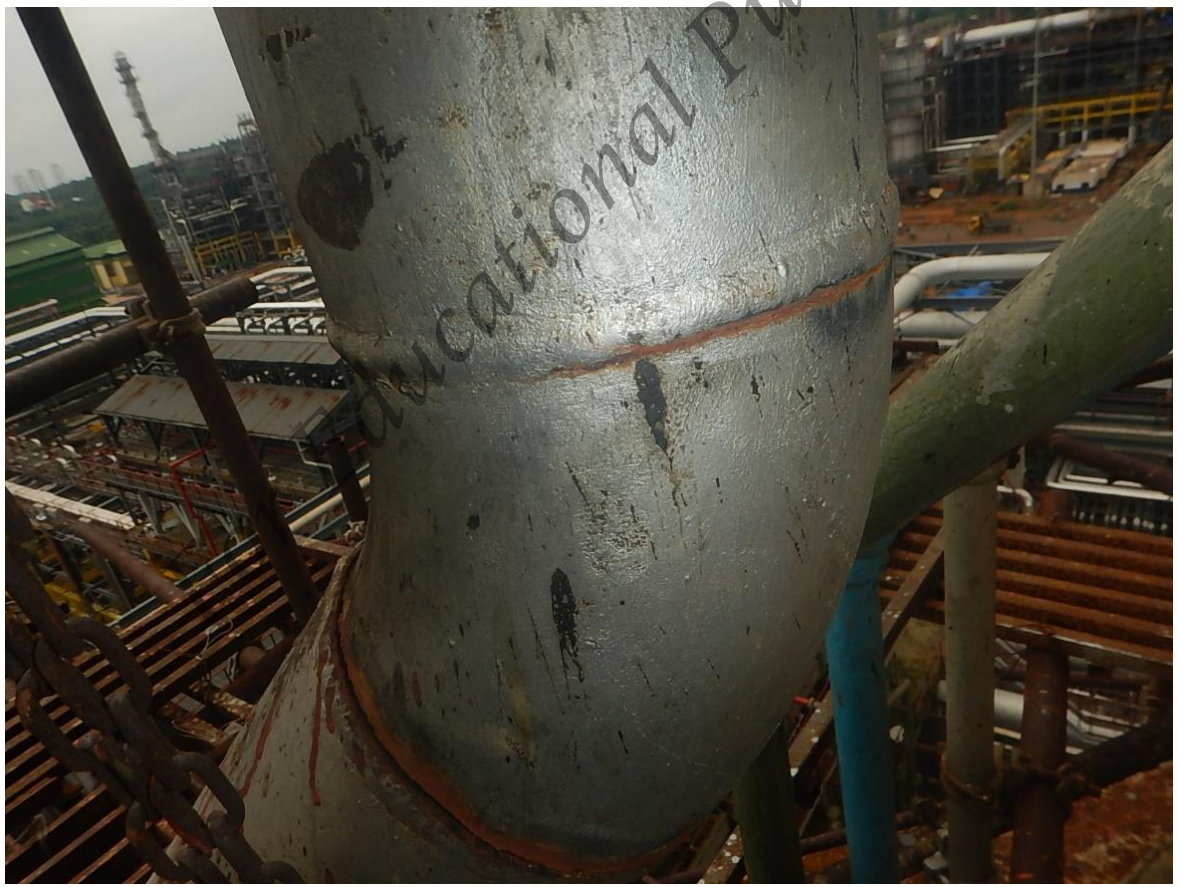
OBSERVATIONS

- Another crack of around 4 cm length was noticed on the top joint of the same elbow.



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OBSERVATIONS

- Considering the brittle nature of the failure, Positive Material Identification (PMI) of the failed elbow and the pipe was carried out.
- The elbow was found as Alloy Steel (P9 – 9 Cr metallurgy) instead of carbon steel.
- Weld joint on either side of the elbow was of dissimilar weld

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ANALYSIS

- Weld joint failure pattern indicated stress rupture
- Internal pressure by service medium - less than 18 Kg/ cm^2
- High amount of residual stress in the joint
- Weld joint failure due to high residual stress on account of :
  - Absence of inadequate PWHT of the weld joint
  - Use of different metallurgy piping components
  - Stress created by self-weight of the piping and service load due to inadequate supports

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ANALYSIS

- Presence of alloy steel elbow
  - A dissimilar weld joint between carbon steel pipe and alloy steel elbow.
- The HAZ of the weld joint on alloy steel
  - hardened martensitic structure
  - brittle in nature and undesirable.
- The welding procedure followed was not suitable for the dissimilar weld joint.
- PWHT cycle followed was for carbon steel metallurgy only.
- All these has contributed towards additional residual stresses in HAZ of weld joint.

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ANALYSIS

- The 6” reflux line was supported as per the Engg Dwg.
- The weight (Self and service fluid induced) of around 40 M of the line was shared by only two load bearing support.
- The stress analysis of the line was carried by our Design group.
  - The failed joint was stressed to higher levels (60% of allowable stress)
  - Two other elbows -stress levels higher than allowable stresses
  - This additional stress on account of inadequate support is also a contributing factor.

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CONCLUSION

- Use of Alloy Steel elbow in Carbon Steel piping & resultant residual stress in HAZ of the weld joint was the root cause.
- Inadequate supporting
- The sudden pressure fluctuation due to starting of reflux pump and
- Brittleness of the joint due to LPG leak also contributed in aggravating the failure.

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Actions taken

- Alloy steel elbow replaced with new carbon steel elbow.
- Additional support was provided on vertical portion below the failed area.
- After PWHT and radiography, the line was hydro tested.
- PMI of the entire line was conducted and found satisfactory.
- PMI of other A19A and B19A lines also done in DCU

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Recommendations

- PMI for carbon steel piping in hydrocarbon services and critical services requiring PWHT shall be carried out, prior to hydrotest in ongoing / future projects in addition to the existing practices.

- In the case of IREP units, stress analysis of the column (having more than 15 m height) connected piping shall be carried out to find-out the adequacy of piping supports / routing.

- For future projects, the extent of stress analysis for piping was modified considering the above aspects.

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Thank you