

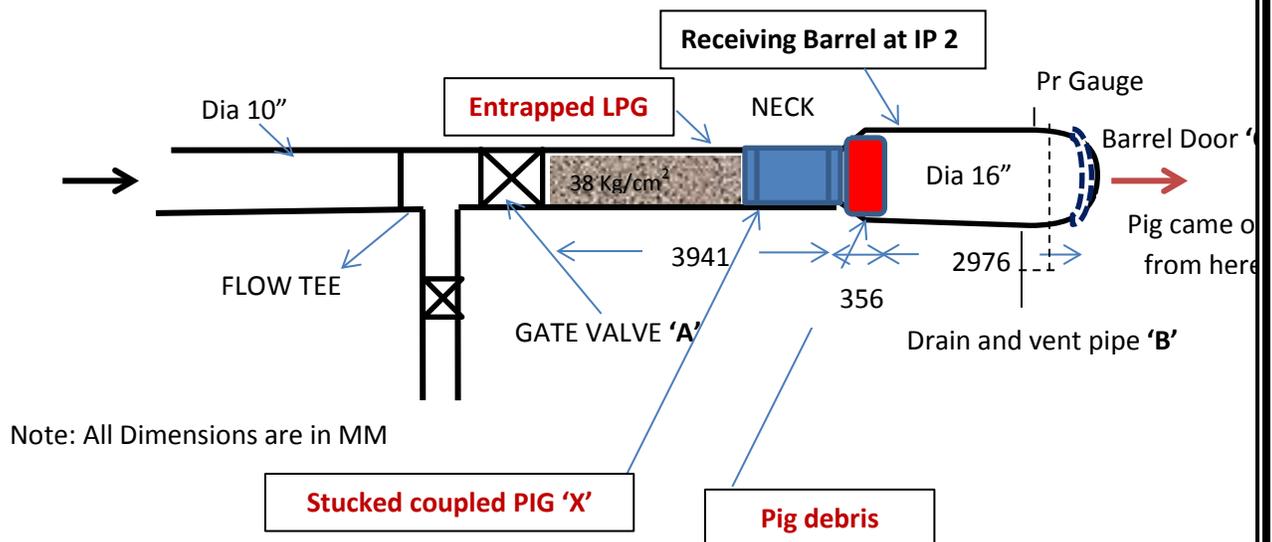
FATAL INCIDENT AT AN INTERMEDIATE PIGGING STATION OF AN LPG CROSS-COUNTRY PIPELINE

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1.0 THE INCIDENT :

As part of pipeline maintenance program, cleaning pigging was being carried out in an LPG cross-country pipeline with a pig train consisting of cup pig, brush pig and magnetic pig, which was launched from preceding station and received in the Scrapper Receiving Barrel at IPS after three days. During the process of the pig retrieval from the barrel it was found that the pig was stuck in the barrel and there was huge quantity of pig residue (muck) in the barrel. After de-pressurization and manually cleaning the pig residue by using water jets etc., efforts were made to pull the pig out of the barrel, when the trapped pig suddenly came out from the receiving barrel with a great force and hit the persons standing in front of the barrel. The impact of the force was such that it broke the compound wall and the metal structure of the pedestal of the pig trolley.

2.0 OBSERVATIONS :



SCHEMATIC DIAGRAM OF SCRAPER RECEIVING STATION (IPS)

- Cleaning pig (consisting cup pig, brush pig and magnetic pig) was launched in the LPG line which reached the next IPS after three days.

- The Scrapper Receiving Barrel was isolated by closing the barrel body valve at A (API-6D Gate Valve) and depressurization was carried out from the vent at B.
- The barrel door at C was opened and it was observed that the pig was stuck inside the barrel and there was lot of pig residue present in front of the pig. The debris was removed by water flushing.
- After water flushing the pig was being pulled out. During this operation, the coupled pig (three pigs were tied together) came out with a great force and hit the persons standing in front of the barrel.
- The impact of the force was such that it broke the compound wall and the metal structure of the pedestal of the pig trolley.
- Due to the impact of the pig, there were two fatalities. In addition, three other persons suffered injuries - one of them suffered major injury.

3.0 ANALYSIS

As may be seen, from the schematic diagram, that LPG was trapped between the valve A and the pig at X, due to the presence of magnetic pig and the high iron content the residue got solidified which acted as sealant, thus not allowing LPG to escape from the open barrel door. Thus, actually, only the portion between the pig and the barrel door was depressurized, while the portion between the valve and the pig remained pressurized with LPG at a pressure of 38 Kg/cm². Further during the day as the temperature soared, it might have further increased the pressure of the entrapped LPG in the rear portion of the barrel. As soon as the pig residue was manually cleaned, the entrapped LPG, which was at a high pressure of > 38 Kg/cm², propelled the coupled pig out of the open barrel door with a huge force.

It is worthwhile to mention that the iron content (Iron sulphide) present in the pig residue was pyrophoric iron in nature, which when exposed to air, is oxidized to iron oxide with the liberation of heat. This reaction between iron sulphide and oxygen being exothermic generated considerable amount of heat; resultantly the pyrophoric iron become incandescent. While the front portion of the pig was being cleaned with water jet, air crept inside the barrel between the barrel valve and the pig resulting in the formation of a combustible mixture. The heat liberated from pyrophoric iron ignited the mixture and there was explosion inside the barrel which acted as propellant & forced the pig at a high speed to escape the barrel through the open door. The pig came out of the barrel with a huge force & hit the persons standing in front of the door which resulted in the fatalities. The pig residue samples collected indicate 5400 ppm of Sulphur & 90.99% iron. This indicates formation of Iron sulphide.

7.0 ROOT CAUSE

1. Pyrophoric iron in contact with air liberated heat which resulted in explosion of LPG-air mixture inside the barrel resulting in propulsion of pig at a very high force/ speed. The persons standing in front of the open door of the barrel were hit by the pig which resulted in fatality & injury.
2. Sudden release of entrapped LPG at high pressure (38 Kg/cm²) might have propelled the pigs out of the barrel. The rise in temperature during the day might have further increased the pressure of entrapped LPG.
3. Draining of entrapped LPG inside the barrel between barrel valve & pig could not be done due to absence of drain or vent in that location (in the neck portion of the barrel).

8.0 INADEQUACIES

1. Inadequate system / approach with regard to evaluating / reviewing the pigging philosophy proposed by the consultant was one of the reason in this accident.
2. Scrapper pigging was not carried out since last about 8-9 years as a result of which lot of muck got accumulated in the line. As a fall out of this intelligent pigging was also not carried out and therefore, the health of the pipeline could not be ascertained.
3. Use of coupled pig i.e. tying all the pigs together for pigging operation.
4. Use of magnetic pig without ensuring minimum iron content in the pipeline.
5. The design of the scrapper barrel was not proper – first, the total length of the barrel was on higher side and secondly, there was no provision of drain/ vent in the neck portion of the barrel.
6. Absence of standard operating procedure (SOP) for pigging.

9.0 LEARNINGS:

The learnings are as follows:

1. Health assessment of the LPG pipeline must be carried out since the pig residue indicated considerable high iron content (90.99%) indicating metal loss due to internal corrosion.
2. Pigging must be done regularly and the residue must be analysed to ascertain the health of the pipeline.

3. An additional vent & drain point with pressure gauge shall be provided in the neck portion of the barrel to drain the Hydrocarbon.
4. Pig train must not be used with all pigs in tied condition. This is not a standard practice.
5. Magnetic pigs should be used only when it is ascertained that the iron content is nominal.
6. SOP has to be prepared for pigging operation and it must be displayed at all the IP stations.
7. SOPs must be properly explained to all the operating crew.
8. While receiving the pigs, it shall be ensured that proper venting has been carried out between barrel body valve and the pig so that the barrel is free from any Hydrocarbon.
9. While receiving the pig it shall be ensured that no person is standing directly in front of the barrel.
10. The set pressure of the PSV to be reviewed and brought down nearer to the MOP.
11. CCTV camera to be provided at all the unmanned stations.



**VIEW OF COUPLED PIG THROWN OUT OF THE RECEIVER
BARREL**