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Learning experience from a case study on failure of a product pipeline due to internal & external corrosion leading to a massive fire

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ABSTRACT

This paper is a case study of a major fire which took place in a multi-product pipeline at Mumbai due to extensive internal and external corrosion. This pipeline was being used by multiple operators to transfer product from HPCL & BPCL Refinery to HPCL Marketing Terminal, Wadala-1; BPCL Khau Creek Marketing Terminal and IOCL Marketing Terminal, Wadala-2 for transfer of POL products. No health check-up such as thickness survey of the subject pipeline or hydro test of this pipeline was carried since its inception way back in 1984. There was no procedure for maintenance of this pipeline, which was passing along a busy road in Mumbai. There was no cathodic protection provided for the buried portion of the pipeline. Most of length of the pipeline was above ground and number of pipes were running parallel to each other alongside a busy road and on either side of the road were Marketing Depots of HPCL, BPCL & IOCL each of which were having product storage tanks. The pipeline was internally coated, however, the girth weld joints were not coated, only sleeves were provided on the external pipe surface.

The common notion in the industry is that if the length of the pipeline is less or if the operating pressure of the pipeline is less the risk of failure of the pipeline and consequent losses is less. This case study is a glaring example to deny such misconceptions. The basic purpose of this paper is to emphasize that the danger imposed by such multi-product low pressure pipelines may prove to be no less than a high pressure cross-country pipeline.

The practice of flushing the lines with sea water is detrimental to the health of the pipeline.

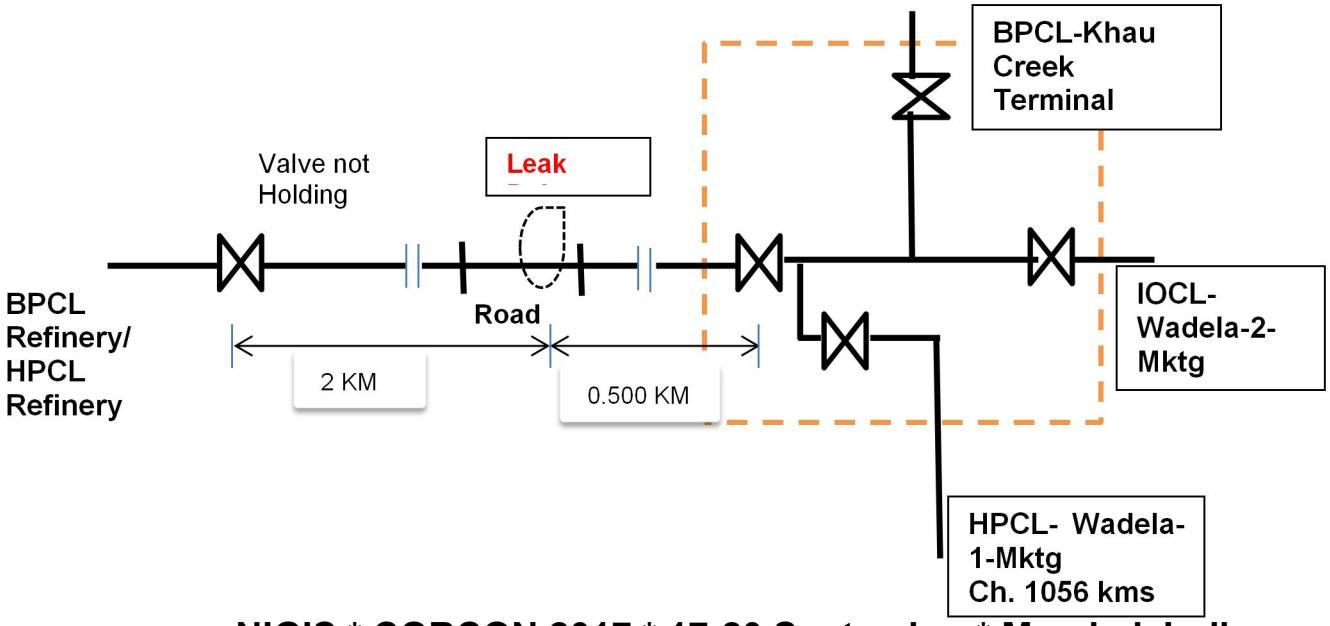
INTRODUCTION :

A major fire took place in the Mumbai Port Trust jetty pipeline on 13th June, 2015 at around 1845 hours. The leak developed in the 7.500 KM long 14" OD carbon steel pipeline that connects HPCL & BPCL Refinery to HPCL Marketing Terminal, Wadala-1; BPCL Khau Creek Marketing Terminal and IOCL Marketing Terminal, Wadala-2 for transfer of POL products at around 2.5 KM away from HPCL refinery. The line was commissioned in 1984. At the time of leak, MS was in the pipeline which was being transferred from HPCL refinery to its marketing terminal.

SEQUENCE OF THE INCIDENT :

The salient highlights are:

- At 0900 hrs of 13th June, 2015 BPCL watchman informed about the leakage in front of Castrol Gate & near Khau Creek,
- HPCL was informed to stop pumping MS from HPCL refinery to HPCL terminal,
- Since MS had spilled to creek, gully sucker & other firefighting accessories etc., were mobilized to recover the oil that spilled into the creek,
- Flushing of the associated lines started by HPCL to undertake repair of the line. After sometime it was observed that there was very heavy leakage of product and hence HPCL stopped the flushing,
- During evening hours, dark smoke was noticed in Khau Creek, near the leak spot,
- Fire tenders were put into service to douse fire: Mumbai fire Brigade was also informed,
- Fire was put under control but kept on re-occurring due to spillage of oil in the creek & it's after burning effect,
- Finally the intermittent fire was put off at 0245 hrs, on 14th June, 2015.



SCHEMATIC SKETCH OF THE LEAK/ FIRE LOCATION AT MUMBAI PORT TRUST (MAHUL - WADELA ROAD)

ANALYSIS :

- No health check-up such as thickness survey of the subject pipeline or hydro test of the pipeline was done since commissioning of the line.
- Proper maintenance of the pipeline has not been undertaken; no reportable preventive maintenance of the pipeline was carried out.
- The line was not piggable and therefore, cleaning of the line was not carried out.
- Corrosion coupons and corrosion probes were not installed in the pipeline for ascertaining internal corrosion rate.
- Corrosion inhibitor injection was not carried out.
- There was no system of carrying out feed analysis of the product.
- Cathodic protection which is usual practice was not provided in the subject pipeline for the underground sections.
- The uniform thinning of the pipeline, as may be seen from the attached photo indicates uniform external & internal corrosion in the longitudinal section of the pipeline was taking place for prolonged period of time.
- Further, there was no external coating in the underground pipeline.
- The practice of flushing the lines with sea water is detrimental to the health of the pipeline w.r.t. enhancing internal corrosion.
- Earlier leakages were controlled through clamps and S-wraps, which are purely a temporary measure & not a good engineering practice.
- Normally road crossings are provided with casing pipes/ sleeves to take the additional load; in the instant case which was not provided.
- The philosophy of replacement of pipe segment as & when required without proper maintenance practices cannot ensure integrity of the pipeline.

A VIEW OF SEVERELY CORRODED PIPE

ROOT CAUSE ANALYSIS (RCA) :

REASONS RESPONSIBLE FOR ENHANCING INTERNAL CORROSION :

- There was no system of monitoring the internal corrosion rate. Corrosion coupons and corrosion probes were not installed in the pipeline and corrosion inhibitor injection was not carried out.

- The internal corrosion in the line is attributed to use of saline (sea) water as flushing media.

- The pipeline was internally coated with cement lining, however, there was no coating on the inner side of the girth weld. Sleeves were provided on the external surface of the pipe in all the girth joints to provide additional protection. The uncoated portion of pipe on the inner pipe surface in all the girth welds acted as anode, consequently, the internal corrosion rate was much faster in these areas. The same was evident after checking the physical condition of the pipe.

REASONS RESPONSIBLE FOR ENHANCING EXTERNAL CORROSION :

- Further, in absence of periodic planned maintenance activity such as direct corrosion assessment tests (hydro test, thickness measurement etc.,) the damage in the line could not be assessed till the same failed.

- It may be pertinent to note that nearer to the sea location indicate that the soil resistivity is low which in turn enhances the rate of external corrosion.

- Since there was no external coating in the underground pipeline and no cathodic protection, it caused severe external corrosion of the pipe.

EVIDENCE :

- The uniform paper like thinning of the pipe indicates corrosion for a prolonged period of time. The corrosion in the pipeline is both internal & external in nature; no Cathodic Protection and no external coating of the line made it vulnerable against external environment. This is evident from the physical condition of the pipe. Above photo is the evidence of extensive corrosion (both internal and external). It is a live case study pipe failure has occurred due to extensive corrosion.

SOURCE OF IGNITION :

After the failure of the pipe, the leaked product, MS got mixed with the water in the adjacent creek. It was raining heavily and due to the tidal effect MS got spread up and flowed to nearby mangroves field, which was already flooded with water. It was reported that a passer-by lighted a bidi, which provided the ignition.

RECOMMENDATIONS :

- Regular health & integrity assessment of the pipeline shall be carried out by carrying out thickness measurement of the pipes, hydro testing etc.,
- Maintenance schedule must be prepared for carrying out regular maintenance of all the associated accessories like valves including the maintenance activities like partial stroking, stem greasing, drain flushing, seat sealant injection etc.,
- Proper painting of above ground pipes shall be carried out at regular intervals; the saline environment hastens up the external corrosion & application of suitable paint would reduce external corrosion.
- Underground pipes shall be provided with suitable external coating such as 2-ply/ 3-ply cold tape, PU coating, High Build Liquid Epoxy etc.,
- Sleeves shall be provided in all the road crossings after putting a corrosion resistant paint at the outer surface of the pipe, for strengthening the pipe. This would prevent cyclic load on the pipe segment while vehicles pass over the crossings.
- Corrosion probes/ corrosion coupons shall be provided for monitoring the rate of internal corrosion. Corrosion inhibitors may be used in the pipeline, if the internal corrosion rate exceeds 1 mpy.
- Flushing of pipeline with sea water to be dispensed with. In the event line flushing is absolutely necessary, must be done with fresh water or ideally kept with product fill; in the later case, necessary accounting must be done.
- Since HPCL/ BPCL tank farms are in close proximity to these pipelines, risk analysis shall be carried out for product transfer/receipt lines and necessary remedial measures may be taken.
- Periodic mock drills must be conducted for effective handling & preparedness of emergency situations.

CONCLUSIONS :

The danger imposed by such multi-product low pressure pipelines, which are used intermittently by multiple operators is no less than a high pressure cross-country pipeline. If these lines are not properly operated and maintained it may lead to disastrous circumstances. In the instant case, these lines were passing through a cluster of Class-A tanks on either sides. The fire reached as close as to nearly 15 Metre for one of the MS Tanks. What if the MS tank got fire ? It could have resulted in a catastrophic and fatal situation as there was a cluster of class-A tanks nearby and the population density was also very high.

The take aways from this case study are :

(1) All the hydrocarbon pipelines, ir-respective of the pipe length, operating pressure, should have a proper and a robust operation and maintenance philosophy in line with standard and statuary requirements.

(2) Regular health & integrity assessment of the pipeline shall be carried out by carrying out thickness measurement of the pipes, hydro testing etc.,

(3) Internal and external corrosion monitoring should be carried out regularly.

(4) Flushing of pipeline with sea water to be dispensed with. In the event line flushing is absolutely necessary, must be done with fresh water or ideally kept with product fill; in the later case, necessary accounting must be done.

(5) Ownership of the pipe maintenance should rest with pipe operators and not on Port Trust.

(6) The underground pipe must be provided with suitable external coating.

(7) Corrosion coupons/ probes to be provided in the line for monitoring the rate of internal corrosion. Corrosion inhibitors to be used

(8) The mind set that risk of leak or fire is less if the line is operating at low pressure or length of line is less or the line is being used intermittently should be done away with.

(9) Regular Feed Analysis of the service fluid must be carried out.

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REFERENCES

No references as it is a case study.

ACRONYMS :

HPCL	:	Hindustan Petroleum Corporation Limited
BPCL	:	Bharat Petroleum Corporation Limited
IOCL	:	Indian Oil Corporation Limited
POL	:	Petroleum, Oil & Lubricants
MS	:	Motor Spirit
OISD	:	Oil Industry Safety Directorate
mpy	:	Mills per year
PU	:	Polyurethane