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Survey of Gas Pipeline Leakage Accidents and Introduction of New Prevention Method

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Abstract: Among natural and man-made disasters, Gas pipeline leakage accidents are man-made. In order to increase the economic wealth of one's country, more of such industries are developed. These pipelines carry natural gases. Natural gases are colorless, odorless and shapeless. The rapid growth of business all over the world requires increasing hydrocarbon transport capacity. They are harmful to human beings in many ways. The gas leakage will lead to blow-out say explosion which will destroy lives of many innocent people, their environment and habitation. While the anthropogenic hazard results in the form of human intent, negligence, human error and involving a failure of man-made system. There is a list of such occurrence of accidents recorded for decades. As per recent record from 2009, some of the accidents include GAIL pipeline blaze in east Godavari of A.P India, Alberta pipeline explosion in TransCanada, PETRONAS gas explosion in Malaysia .In this paper, we will see the list of accidents occurred due to the leakage of gas from pipelines, its cause and effects and prevention methods. The prevention method proposed to reduce this leakage from pipeline will be detecting the leakage using a robotic system.
Keywords: Gas pipeline leakage, Explosion, Natural gas, Robotic system

I. INTRODUCTION

Natural gas is a naturally occurring hydrocarbon mixture consisting of methane, nitrogen, carbon dioxide and hydrogen sulphide. It is usually odorless, colorless and shapeless. It is also an energy source used as fuel for heating, cooking, vehicles etc. To carry such gases a pipeline system is developed. A pipeline is a system of equipment designed to transmit the gases from one place to another. With sophisticated technologies, the pipeline developments are gaining more advantages as they are preferred to be economical and safest mode of transport.

Fig 1: An example of a pipeline system

United States had longest pipeline network of about 548,665 km whereas in India it's about 26,000 km as per 2009 research. Natural gases are highly flammable substance transported to a very long distance across highly populated areas and its surrounding. Their protective measures should meet two requirements such as hazardous properties and quality of the natural gas. When these are not met, it leads to open fire or explosion which causes blow-out and can also cause oxygen deficiency leading to unconsciousness.

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II. SOME OF THE PIPELINE ACCIDENTS OCCURRENCE, CAUSES AND AFTERMATH

A. *In India*

1) *GAIL (Gas Authority Of India Limited) Pipeline Accident*

a) June 27, 2014 a GAIL pipeline blast in Southern Indian state of Andhra Pradesh.

i) *Aftermath:* Killed 22 people and injured 37.

ii) *Causes:* Faulty operational procedures. No set up of the GDU (Gas Dehydration Unit) at Tatipaka, as committed while seeking CCOE permission under manufacture, storage & transportation of hazardous chemical rules of 1989.

b) April 29, 2017 a fire broke out in a GAIL operated gas pipeline in a stretch of road between Garvebhavipalya and Bandepalya, off National Highway 44.

i) *Aftermath:* The fire was minor, so no danger occurred.

ii) *Causes:* Faulty civil construction operations. BWSSB (Bangalore Water Supply and Sewerage Board) workers had dug close to the pipes despite the markers that GAIL has put.

B. *In other countries*

1) *Canada*

a) *July 20, 2009:* Alberta pipeline explosion & fire involved a TransCanada Corporation natural gas pipeline. The explosion, which sent 50 meter flames into the air, destroyed a two-hectare wooded area.

i) *Causes:* The line ruptured in 2009 due to corrosion. The Peace River Mainline pipeline, built in 1968, had ruptured six times and leaked on 17 occasions until 2014.

b) *February 19, 2011:* TransCanada Pipelines Limited's gas control operator received notification through its emergency notification line of a pipeline fire and explosion, near Beardmore, Ontario.

i) *Causes:* At the time of the occurrence, TransCanada was transporting sweet natural gas. Escaping gas from a pipeline rupture had ignited, resulting in the explosion. A large crater was created and three pieces of pipe broke from the system, with pipe and other debris being ejected up to 100 m from the rupture site.

ii) *Aftermath:* There were no injuries. Six residents near the site evacuated until the fire was extinguished.

c) October 17, 2013: A 36-inch natural gas pipeline ruptured southwest of Fort McMurray, Alberta. An estimated 16.5 million cubic meters of natural gas were released.

i) *Causes:* A fracture in a pipe elbow was the identified for the reason of the failure.

ii) *Aftermath:* The rupture did not result in a fire, there were no injuries and no evacuation was required.

d) January 25, 2014: A TransCanada Corporation gas transmission pipeline 762 mm (30-inch) Line 400-1 exploded and burned, near Otterburne, Manitoba, causing a natural gas shortage in Manitoba and parts of the United States. Natural gas burned for approximately 12 hours.

i) *Aftermath:* Five residences in the immediate vicinity were evacuated, and Provincial Highway 303 was closed until the fire was extinguished. There were no injuries.

e) May 5, 2015: A gas transmission pipeline failed approximately 36 kilometers southeast of Drumheller, Alberta.

i) *Causes:* The incident resulted in an undetermined volume of sweet natural gas and associated hydrocarbon liquid being released onto agricultural land.

C. *Belgium*

1) July 30,2004 : Rupture and ignition of a gas pipeline system in Ghislenghien, Belgium

a) *Aftermath:* 24 dead, including 5 fire-fighters, 1 police officer and 5 employees killed on the spot, plus 132 injured, this accident was qualified as Belgium's most serious industrial disaster in half a century.

b) *Causes:* An expert appraisal conducted on the pipe section ejected 150 m from the blast revealed scratch marks. This observation led investigators to focus on a potential mechanical aggression that would have weakened the pipe wall; 3to 4 mm of material remained at the level of the scratch, thereby creating a zone of lower pressure resistance. Based on an expert's investigation report, the Tournai Prosecutor's Office confirmed in July 2006 the hypothesis of "an external aggression" acting on the gas pipeline during previous earthworks held at the site.

Fig 2: Explosion due to gas leakage in pipeline across Ghislenghien, Belgium city

D. Malaysia

1) 2014: PETRONAS gas pipeline explosion in the state of Sarawak, Malaysia ripped apart a portion of the RM3bil Sabah to Sarawak interstate gas pipeline between Lawas town and Long Sukang in the northernmost district of Sarawak at 2 a.m.

ii) Aftermath: Resulting in the evacuation of nearby villagers.

E. USA

1) *May 26, 2014:* A Viking gas pipeline explosion near Warren.

i) *Causes:* Authorities suspected natural causes because there was still frost in the ground and the soil was wet.

ii) *Aftermath:* Minnesota was "hell on earth," shaking the ground and shooting a fireball over 100 feet in the air. Roads within a two-mile radius were blocked off.

2) *Feb 11, 2014:* A Hiland gas pipeline exploded about six miles south of Tioga, North Dakota.

i) *Causes:* Hiland was "blowing" hydrates, ice-like solids formed from a mixture of water and gas that can block pipeline flow, out of the pipeline.

3) *August 20, 2013:* Explosion of a natural gas pipeline near Kiowa southwest of Oklahoma City.

4) *September 9, 2010:* The San Bruno pipeline explosion: At 6:11 PM, a PG&E 30-inch natural gas line exploded in San Bruno, California.

i) *Aftermath:* Killed 8. 66 were burned and injured, including four firefighters who suffered smoke inhalation. Eyewitnesses reported the initial blast "had a wall of fire more than 1,000 feet high".

ii) *Causes:* The loss of pressure control at this station minutes before the explosion spiked the pressure in Line 132, ultimately precipitating the final catastrophic failure. Fatigue cracking of the pipeline was also a cause for the explosion.

III. GENERAL CAUSES OF PIPELINE FAILURE

A. Corrosion
B. External interface
C. Rupture
D. Fatigue cracking
E. Defect in construction/ material failure

Basically, these causes are due to human intent, carelessness, negligence, human error and involving a failure of man-made system.

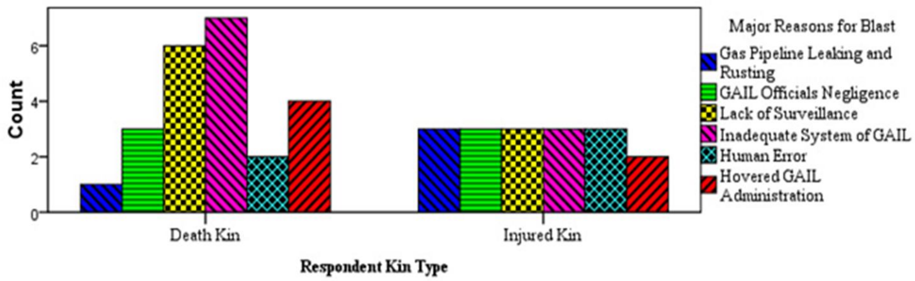

Fig 3: Causes of pipeline failure in GAIL

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IV. PREVENTION METHODS AS STATED BY THE INDUSTRY

A. GAIL

1) Standards such as OISD, PNGRB, IS, ASME 31.8B, API are being strictly followed. Layout blueprint, distance and thickness of the pipeline are properly analyzed before construction.
2) Pipelines are given 3 layers of polyethylene as external coating. Gas detection and Fire detection systems are to be installed.
3) GDU is used to strip water and condensate from "wet" natural gas so as to prevent pipeline corrosion and leakage of inflammable condensate gas in the open.

B. Ghislenghein Site

1) At the Ghislenghien site, the gas leak lasted more than 45 minutes before igniting and, in so doing, created a pressure surge. The line was placed back into service at a reduced pressure level. The pressure was gradually raised so that a service pressure of 70 bars had been restored. Several tests were performed and proved to be conclusive.
2) Cathodic protection systems were installed.

C. San Bruno Pipeline Explosion

1) The CPUC enforces a variety of federal and state laws that impose safety requirements pertaining to the design, construction, inspection, testing, operation, and maintenance of investor-owned utility intrastate natural gas transmission pipeline systems in California.
2) Replacement of old cracked pipes by new pipeline system.

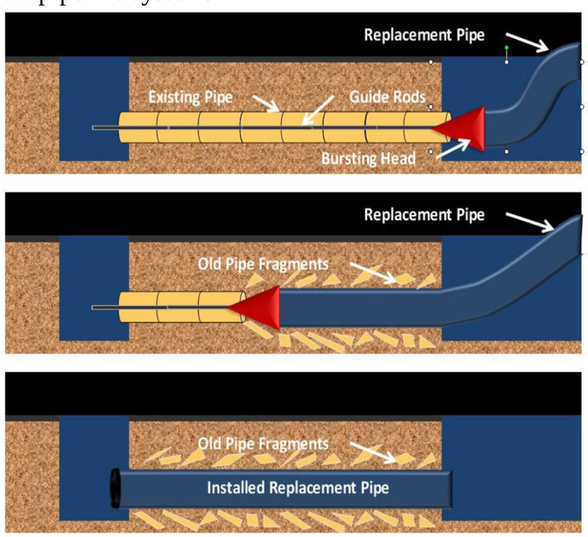


Fig 4: Replacement of Pipeline system

V. ANALYTICAL TECHNIQUES USED FOR INSPECTING THE PIPELINE SYSTEM

A. Macroscopic visual inspection.
B. Sectioning and cleaning.
C. Microfractography.
D. Metallographic analysis.
E. Analysis of chemical and mechanical properties.

VI. NEW LEAKAGE PREVENTION TECHNIQUE USING A ROBOTIC SYSTEM

Apart from the various prevention methods taken by the industries themselves to prevent leakages and to stop human loss due to explosions, there can be another solution to end this by developing a new robotic system. Besides checking the mechanical ailments, a robotic system could be developed to detect the leakage alongside the pipeline. This robot is meant to carry gas detecting sensors and should be programmed in such as a way that it travels transversely (i.e.) forward and backward and should continuously be monitored by the stations at certain locations. These stations will be indicated by displays and digital messages in case of any leakages.

This development will be in competition with the technology and will definitely prevent leakage and hence will minimize the human loss and their environments due to fire explosions.

VII. ADVANTAGES OF USING A ROBOTIC SYSTEM

A. Reduces the risk and determination of leakage is made simple.

B. Death rate due to explosions can be reduced.

VIII. DISADVANTAGES OF USING A ROBOTIC SYSTEM

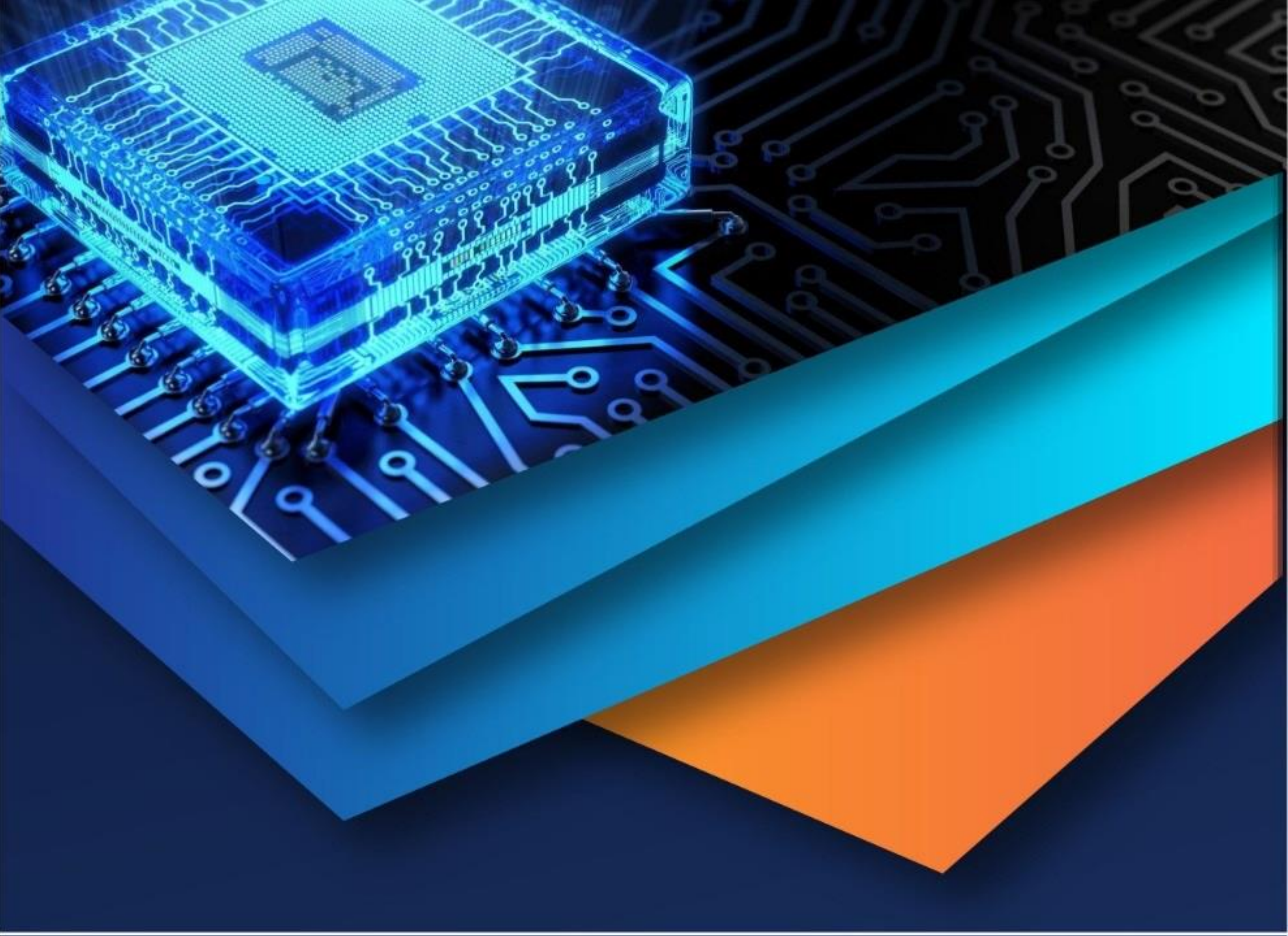
A single robot cannot be used to monitor for a very long area of pipeline. So many such robots has to be developed specifically for certain distances and should be continuously monitored at base stations located at certain interval of distance. It is not cost and time efficient.

IX. CONCLUSION

Prevention of explosions is mandatory and it is clear that it is only due to human errors and negligence. To make sure that this never repeats, some developments should be implemented such as above stated robotic system or so. It will be better if the disadvantages are overcome before putting the system into action. These new inventions in near future would definitely control explosions which in turn will reduce death rates of innocent people.

REFERENCES

[1] Url:https://en.wikipedia.org/wiki/List_of_pipeline_accidents
[2] Url: https://timesofindia.indiatimes.com/india/GAIL-pipeline-fire-raises-safety-concerns/articleshow/37383387.cms
[3] Url: https://www.twincities.com/2014/05/25/northwestern-minnesota-gas-pipeline-explosion-it-was-just-hell-on-earth/
[4] C.K. Jain1, S.S. Yerramilli, R.C. Yerramilli, “A Case Study on Blowout and Its Control in Krishna-Godavari (KG) Basin, East Coast of India: Safety and Environmental Perspective”, Journal of Environment and Earth Science, Vol 2, No.1, 2012
[5] M.Roja Lakshmi, V.Dileep Kumar, “Anthropogenic hazard and disaster relief operations: A case study of GAIL pipeline blaze in east Godavari of A.P”, Elseiver science direct, 2015
[6] E. Philip Dahlberg, T.V Bruno, “analysis of gas pipeline failure”
[7] “Rupture and ignition of a gas pipeline 30 July 2004 Ghislenghien Belgium”, French Ministry for Sustainable Development - DGPR / SRT / BARPI
[8] S.P. Garg, General Manager,“ Measures adopted for MonitoringSafety of Natural Gas Pipelines”, GAIL
[9] Steven R. Meyers, “The San Bruno, California Natural Gas Pipeline Explosion: Response, Investigation and Regulatory Actions” International Municipal Lawyers Association (imla) 2012 annual conference October 21-24 Austin, Texas



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