NGA NORTHEAST GAS ASSOCIATION
NYSEARCH

Technology Brief

Feasibility Study for a Robotic Platform and Suite of Sensors to Identify Degradation in Non-Conforming Driscopipe® 8000

Description: To develop a new cutting-edge robotics platform and array of sensors capable of navigating 2" and larger polyethelene pipelines and associated features to detect degradation and delamination, and other defects.

Status: Feasibility proven. Final report issued December 2022.

BENEFITS

With PHMSA's increased focus on integrity management, the NYSEARCH consortium has invested considerable resources in the development of new non-destructive evaluation (NDE) technology to provide pipeline operators with solutions to efficiently and effectively inspect natural gas pipelines. The benefit of this project is that it provides a new cutting-edge robotics platform and an array of non-destructive evaluation sensors capable of internally inspecting polyethelene pipe, as small as four (4) inches in diameter, to detect internal and external defects, including the potential degradation and delamination in non-conforming Driscopipe®8000 (NCDP) highlighted in PHMSA's March 2012 Advisory Bulletin. This in-line inspection (ILI) tool will allow the inspection of NCDP pipes and other PE pipes from the inside over long distances and under live conditions. Such a system will allow the systematic inspection of potentially compromised pipes and the detection of cracking and delamination before they result in gas leaks and potentially catastrophic failure.

BACKGROUND

Driscopipe® is a type of high density polyethylene plastic pipe used in the natural gas distribution system since the 1960s. Driscopipe® type 8000 pipe was produced from late 1979 through 1997 and was available in sizes from ¼" to 8" in diameter. In November 2013 Performance Pipe, a division of Chevron Phillips Chemical Company and the manufacturer of the pipe, published a report on the findings from an engineering analysis and tests conducted to identify the source of the problem.

The report recommended that "*operators in the highest temperature regions, such as the desert southwest and southern most regions of the United States may want to inspect and sample a broader portion of their system in conjunction with the risk ranking*." To the naked eye, the degraded pipe displays delamination or peeling on the outer surface and a crumbling appearance with many cracks on the inner surface of the pipe. (Figure 1)

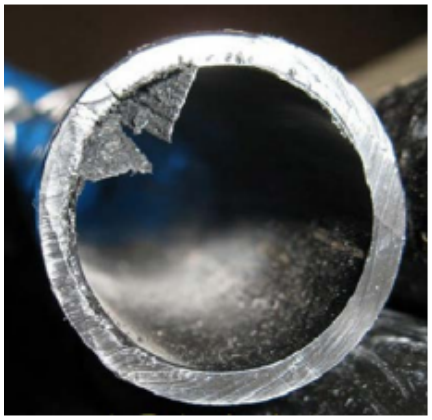

Figure 1: Sample of Degraded Driscopipe® 8000

With the life of PE pipe sometimes exceeding (50) years for some inventories, information is needed to provide predictive analytics on fusions on PE pipe as well as straight sections to aid asset management decisions and to expand the proactive pipeline safety management culture that the gas industry wants to advance.

A number of limited efforts have been carried out to identify technologies that would be able to inspect from the inside or the outside of the pipe with very limited success. Acoustic technologies were tried for inspection from the outside of the pipe however, it requires excavating and exposing the pipe, which is not practical, if long segments of the network are to be inspected. When tried from the inside of the pipe, the need of a liquid coolant rendered the ultrasonics-based system impossible to use under live conditions. Camera technologies were also tried for internal use but operational range was limited in addition to facing other operational

issues. The industry is therefore in need of a tool that will allow insertion of a sensing element, able to detect degradation and delamination in Driscopipe® 8000, in a live distribution main able to travel long distances and

SYSTEM CHARACTERISTICS		IMPORTANCE
Pipe Material	HDPE	
	MDPE	
Pipe Diameter SDR 11	1"	
	1.25"	
	2"	
	4"	
	6"	
	8"	
Operating Pressure	60psi	
	124 psi	
Launching	Vertical Saddle	
	Angled Saddle	
Live inspection		
Obstacles Negotiation	Vertical Segments	
	Inclined Segments	
	Bends	
	Tees	
	Reducers - Stiffeners	
	Fusion joints	
	Valves	

Figure 2: Partial List of Initial Requirements

negotiate the obstacles encountered in the typical distribution network, such as bends and tees. It should be able to operate without a tether and be controlled by the operator wirelessly while having enough power to provide for a long range. A system with such capabilities was successfully developed, by NYSEARCH/NGA with cofunding from PHMSA, over the last 15 years for metallic transmission natural gas pipelines.

TECHNICAL APPROACH

This project focused on carrying out a feasibility study to identify robotic technologies equipped with sensors capable of detecting degradation and delamination in non-conforming Driscopipe ®8000 (NCDP) through live in-line field inspection. A systematic study of sensory technologies was carried out to identify the best technology in parallel with an effort to identify the best platform on which to integrate the sensor.

The objectives of this project were to: 1) develop appropriate specifications for an in-line inspection system for NCDP pipes (consisting of a sensory system and a robotic platform) that meet industry and other stakeholders needs, 2) identify and evaluate state-of-the-art sensing system(s) for detecting degradation and delamination in NCDR pipes, and 3) identify and evaluate robotic platforms able to carry such sensing systems inside natural gas plastic pipes.

Established technologies such as phase array ultrasonics, as well as emerging technologies in the field of NDE of plastic pipes, such as Terahertz and microwave, were considered and evaluated. A parallel study was conducted to identify the best robotic system able to carry such a suite of sensors. The study investigated a new design for a robotics system that would allow it to be launched, operated, and retrieved under live conditions and travel in natural gas plastic pipes over relatively long distances without a tether attached.

This work was conducted by a team consisting of NYSEARCH, Invodane Engineering (IE), of Toronto, Ontario, Canada, the robotics platform developer; and the Center for Nondestructive Evaluation (CNDE) at Iowa State University, the sensor system developer.

PROGRAM STATUS

This project has successfully developed concepts for advanced inspection systems for 4" and larger PE pipes that would enhance the safety and operational efficiencies of the natural gas distribution network. Additional phases are needed to design, test, and commercialize the technology for the benefit of the natural gas industry and the public.

Highlights

- Successfully developed concepts for advanced inspection systems for 4" and larger PE pipes.
- Developed systems that could enhance the safety and operational efficiencies of the natural gas distribution network.

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