Magnetic Flux Leakage (MFL) Inspection System for Gas Distribution Mains: Smart Pig

The gas industry operates and maintains approximately one million miles of pipes consisting of steel, cast iron and plastic pipes to deliver natural gas to customers in the United States. The steel gas mains are prone to time dependent defects such as corrosion, which can reduce safety, security of service and threaten the environment if failure occurs.

The gas industry has recognized the need to inspect these mains to ensure that affected location are repaired or replaced before the failure occurs. Presently, to inspect mains for corrosion requires excavation and visual inspection of the pipe at cost ranging from $1000 to $3000.

Innovation:

In order to reduce the excavation at each affected area of the pipe, an innovative and patented system *(see attached Figure)* was developed based on the well-known Magnetic Flux Leakage (MFL) technique.

- The MFL sensor --Smart Pig was attached to a mechanically driven push-rod for traveling the sensor through the mains while the gas was flowing through the pipe.
- By making one excavation and using the pioneering MFL inspection technology operators can inspect live gas mains, lower operating costs, minimize service disruptions, and increase safety and reliability.

The current inspection system is suitable for low pressure (less than 60 psi), in service, flinch diameter gas mains. Note that the commercial MFL inspection services are performed on high-pressure transmission lines. The pressure in these lines is 500 psi or more and allows the inspection tool to be propelled through the line by the product by forming a hydraulic seal between the inspection tool and the pipe wall using compliant polyurethane seals. The low operating pressures of gas distribution mains prevent this form of movement. This challenge was addressed with development of an external delivery means (tubing or rod) to move the inspection device through the mains.

The second challenge required miniaturization of the MFL sensor. The commercial MFL inspection pigs are quite long relative to their diameter and use stiff steel brushes to contact the pipe wall in order to assure good magnetic coupling. In gas distribution main applications, the MFL probe must be made much smaller in dimension and operate with an air gap between the magnets and the pipe wall. The MFL sensor with 32 hall sensors was designed and tested. The sensor with the air gap was manufactured to allow uninterrupted gas flow, minimize drag, and reduce the potential of introducing particles into the gas stream that could otherwise occur from the scraping **action of the brushes.**

The **third** challenge - access into the gas mains - was addressed through a novel launching and receiving mechanism mounted on the gas main. The **entry fitting and the** procedures used to launch and retrieve the MFL inspection device was easy to install, had a high level of safety, and had minimum left-in-place hardware.

The complete system was evaluated in several operating gas mains in US and Europe. The test results were provided to participating utilities on the real time basis and then documented in the report. The test results documented corrosion detection capability for both internal and external to pipes, accuracy of defect locations, and entering gas mains from one location and propelling to the distance of 1000 ft with gas flowing through the main and without interrupting gas flow to the customers. The system is currently available for inspecting the low-pressure gas distribution pipes.

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