Technology Brief

Northeast Gas Association
NYSEARCH

Stand-Off Acoustic Sensor for Pipeline Inspection

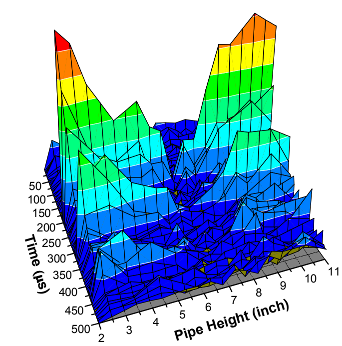
Description: To determine the feasibility of using a revolutionary low power sensor for predicting internal and external pipeline anomalies from a robotic pipeline inspection platform.

Status: Phase I has shown successful performance for identifying areas of defect wall loss. Phase II is evaluating the technology's performance for accuracy and repeatability.

BENEFITS

Swept Frequency Acoustic Interferometry (SFAI) is a technology which offers the possibility of a new generation of non-destructive evaluation methods in the environment of an unpiggable pipeline. Advantages which outperform current pipeline inspection technologies include: substantially lower power requirements, increased sensor and subject clearance, fewer sensors and a more compact electronics platform.

Concept Aboard a Robotic Platform



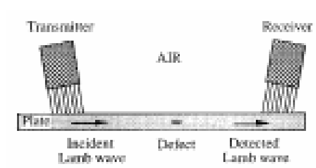
Defect Characterization

BACKGROUND

Pipeline integrity regulations have prompted NYSEARCH in 2000 to develop a set of robotic platforms for the inspection of unpiggable natural gas pipelines. In the early stages of that program, the developers were directed to concentrate resources on developing the platforms and rely on established sensor concepts. As a result, one of the two platforms under development, TIGRE™, is utilizing an MFL sensor while the other, Explorer II™, is utilizing a Remote Field Eddy Current (RFEC) sensor being developed by SwRI. Additional sensor concepts have been funded over the years by government and industry with mixed success.

MFL is the standard for the industry, having being used for over 30 years. The operational experience available and the improvements made over its life have made it the benchmark against which any new technology is to be compared. It offers relatively high accuracy in detecting defects, good repeatability, and relatively high levels of confidence in measurements. Its major disadvantage, especially as it pertains to its integration in robotic devices rather than on "pigs", is the high magnetic drag forces generated, which result in excessive power consumption and heavy duty mechanical components. Therefore, the identification and development of technologies that offer the same accuracy, repeatability, and detection confidence with lower power and larger spacing capability becomes of interest to the industry.

The USDoE initiated the funding of an effort at the Los Alamos National Laboratory (LANL) to develop an acoustic sensor that would fulfill this need. After USDoE funded the initial concept generation work, Niagara Mohawk funded a short, proof-of-concept study which reported signs of success. Now, a more comprehensive effort is in place at LANL to establish the actual potential of the method for gas transmission pipes and determine the impact of real-life effects on its performance.



Air-Coupled Acoustic Sensor Concept

TECHNICAL APPROACH

When shear waves and longitudinal waves are superimposed onto each other they generate interference. This combination of waves creates a lamb wave, and when confined to plate surface becomes guided – hence the term 'guided wave'. Guided waves reflect back towards their origin if they encounter an inconsistency during their propagation in the medium. SFAI utilizes such guided waves at the transducer to find local anomalies in the plate (or wall of a pipe).

Phase I of this project was a proof of concept effort funded by Niagara Mohawk. A total of four equally sized pipes – one with no defects – and three with machined defects varying in depth were tested. The tests were manually performed on a lab bench-scale apparatus consisting of a fixture having two air-coupled transducers and signal processing equipment. The data revealed distinguishable signals corresponding to each defect depth. These results were repeatable and developed further interest for a second phase.

The current phase II work at LANL involves a more detailed study on (30) individual defect styles and combinations on pipes with varying coatings.

LANL Lab Setup

PROJECT STATUS

Defect specifications have been designed for several coated and uncoated pipe samples. These represent common challenges that may exist within a pipeline. LANL has developed an automated process to build an acoustic sensor data base for examining the technology's abilities and repeatability. Efforts are in progress to develop algorithms which determine anomaly size and shape. The sensors' speed for performing SFAI is being studied to determine if the robotic platform speed will have an effect on the overall ability of this new technology.

HIGHLIGHTS

- Low power consumption
- 1 inch allowable clearance between pipe and sensor
- Fewer sensors
- Compact electronics platform

FOR ADDITIONAL INFORMATION

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