

Annular Space Direct Inspection Robot

Description: A tethered robotic inspection device for cased pipeline inspection.

Status: Development and shop testing are complete. Field demonstrations are in progress. Commercialization is underway.

BENEFITS

This program is developing a system which helps operators meet ECDA or ICDA requirements under the rules of the Pipeline Hazardous Materials Safety Association (PHMSA). The Type I and Type II casing robot systems both provide video inspections of cased pipe. The Type II casing robot system features additional capabilities such as temperature, humidity and wall thickness measurements. Both systems address the requirement to inspect cased crossings and help fill technology gaps.

BACKGROUND

The 2002 DOT/OPS Pipeline Integrity ruling requires integrity assessment of pipes in high consequence areas without exception to special areas such as cased crossings. NYSEARCH and NGA members have evaluated an assortment of inspection options with initial focus on guided wave ultrasonic inspection technologies. While guided wave has made significant advances, tests have shown that improvements are required. Therefore, NYSEARCH has been evaluating and developing technologies addressing the issue and filling technology gaps. A suite of options can enable pipeline integrity engineers to judge the integrity of cased sections through the use of a combination of tools and technologies.

Casing inspections with pushrod-mounted cameras yielded limited success due to inadequate control of the camera and insufficient inspection distances. Such activities inspired NYSEARCH and ULC Robotics to develop a specialized solution that yields a more thorough inspection. Phase I developed and successfully

tested a tethered robot with video camera designed for inspections via the annular space of a cased pipe.

Successful inspections of cased pipe using the casing robot inspired gas operators to pursue additional capabilities to the Type I system. Therefore, ULC Robotics and NYSEARCH continued to develop a more advanced Type II system.

TECHNICAL APPROACH

The program began by developing specifications for a casing robot through an industry survey of casing configurations. A conceptual design emerged into a robot with rubber tracks providing locomotion and steering to maneuver around obstacles such as casing spacers. Magnets attach the robot to the inner surface of a casing and enable tether-controlled inspection distances of up to 150 feet. The casing robot (Figure 1) is designed to fit within most annular spaces (1-1/2" minimum). It employs high-



Figure 1: Shop Testing the Casing Camera
Note: 1-1/2" Minimum Clearance Required

resolution video assisted by LED lighting for detailed inspection. Successful cased pipe inspections at field tests and demonstrations compelled the continuation of a more advanced version.

The Type II casing robot system is redesigned with enhancements to the video inspection capability (Figure 2). An ultrasonic thickness (UT) sensor added to the robotic platform enables pipe wall thickness measurements without coating removal.

The UT sensor is housed at the end of a positionable arm and is fitted with a couplant delivery system. Temperature and relative humidity sensors added to the casing robot give the integrity engineer additional facts when



Figure 2: Type II Casing Robot

conducting risk assessments based on corrosion rates within an annulus (Figure 3). An inclinometer enables accurate navigation within the annulus and inclination measurements of the casing.



Figure 3: Image Acquired Using the Type II Casing Robot

A video-based feature measurement system was developed to provide the integrity engineer with

the dimensions of artifacts, scratches and coating problems. Improvements made to the locomotion system with the addition of debris-clearing brushes and self-cleaning drive wheels ensure greater inspection distances. Finally, an advanced user interface allows improved operator control and a means for data exportation (Figure 4).



Figure 4: Control System and User Interface

The Type II system is intended to be used in conjunction with the Type I system. Given prior use of the casing robots, a pre-inspection checklist is also completed by the pipeline operator to ensure before the robot is deployed that the technology can be used on each job.

PROGRAM STATUS

Field demonstrations of the both Type I and II casing cameras in live cased crossings are ongoing. Commercialization is underway.

Highlights

- High resolution video inspection
- Wall Thickness Measurement
- Temperature, Humidity & Inclination Measurement Feature

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