PROPOSAL

PREDICTING CHANGE IN TRANSMISSION PIPELINE CORROSION FROM ULTRASONIC AND MAGNETIC FLUX LEAKAGE IN-LINE INSPECTION INSTRUMENT DATA

Submitted to

The Engineering Honors Committee

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Abstract

In the pipeline industry, the most widely used method of inspection is to employ in-line instruments. These instruments travel down the center of the pipe gathering data, which are used to make predictions regarding size, shape, and location of corrosion patches on the system. The purpose of this project is to produce a computer program that will automatically process and analyze this data. The outputs of this program will include information about how and where the reported corrosion areas in the pipeline are changing and growing. This type of information could assist a pipeline owner/operator when making important decisions involving pipeline replacement and repair. The result of this project will be an economical method to help identify possibly active corrosion, and therefore extend the life of the pipeline infrastructure in the U.S.

Introduction

The transmission pipeline infrastructure in the United States could be called the veins and arteries of our society. Today, of the 300,000 miles of natural gas transmission pipelines in the U.S., 62% were built between 1940 and 1970 (Clark, Leis, and Eiber 2004). If this aging infrastructure were to fail, the results would be crippling to our way of life. For this reason it's imperative that these lines maintain structural and operational integrity.

Maintaining pipeline integrity can be quite challenging. Occurrences such as, dents, cracks, and corrosion can end the life of a pipeline prematurely. Because of this, pipelines must be routinely checked for these problems. Since most pipeline systems are many miles long and underground, inspecting them presents severe challenges. Probably the most common method for inspecting transmission pipelines is to use in-line inspection instruments (ILIs), also called pigs. Pigs are sent down the center of a pipe, propelled by pressure in the line. There are different types of pigs available, which use different technologies to collect information about the pipeline. A geometry pig has calipers, which measure the pipe radii in many directions as it moves through the line. This tool is useful for finding and measuring dents in the system. Another type of ILI uses properties of magnetic flux leakage to measure areas of pipe wall thinning caused by corrosion or other factors. Ultrasonic ILIs bounce sound waves through the pipe wall to detect wall thinning (i.e. corrosion) and cracking. A picture of a typical ILI is shown in Figure 1. All of these pigs produce huge amounts of data when sent down a long pipeline, which are used to make predictions for the length, width, and location for each reported defect. This can be quite useful if analyzed properly.

Reported corrosion data will be the focus of this project. Specifically, changes in ILI corrosion data over time will be analyzed to extract as much useful information as possible. Information about a pipeline, such as, corrosion growth rates at specific locations and new corrosion patches, is valuable to the owner/operator of the line. If one can predict this information accurately enough, then the severity of corrosion in certain parts of the pipeline system can be ascertained, categorized and prioritized. This will dictate important decisions, such as, when and if a pipe section should be replaced or repaired. When one considers the costs involved with digging up and repairing or replacing buried pipeline, the economic implications become apparent. For this reason, a premium value can be placed on the information to be produced by this project.

To obtain information about how corrosion patches are growing and changing at specific locations over time, an efficient and accurate computation program is needed. A well-written computer program using sound methodology could analyze the huge amount of pig data. It could then compare the findings of subsequent ILI runs to identify changes in corrosion patches and possibly predict local corrosion growth rates.

Objectives

The objective of this project is to use reported ILI results from subsequent runs to identify changes in the corrosion on a pipeline system. The outcome of the project is a program in Matlab and/or Visual Basic, which is to be ported to Excel for compatibility with industry practice. This program must be written in a very efficient manner so that it will be able to handle extremely large amounts of data (i.e. 65,000 entries per run) in a reasonable amount of time. The results will be useful to a pipeline owner/operator when making critical decisions about pipeline repair options. This resulting program output will, at a minimum, report new corrosion patches, that have recently appeared on the pipeline. The resulting program could also provide local corrosion growth rates for specific sections of the pipeline. Finding a corrosion growth rate is anticipated to be quite difficult because it depends highly upon the accuracy and consistency of the ILI instruments. Finally, this information must be presented in a simple manner, such that a pipeline owner/operator can easily comprehend where the high priority sections are located.

Methods of Procedure

The execution of this project will begin with a review of current literature relevant to the subject. This will include literature on current ILI technology and its capabilities and limitations. Relevant ASME and/or NACE codes will be reviewed so that proper procedures are followed when applicable. Since the data being processed in this project may be a few years old, historical accuracy of these instruments must be analyzed as well. Field literature will also be researched to learn about any similar data analysis being conducted.

The methodology that will be utilized in this project requires conversion of the reported corrosion patch dimensions and locations into Cartesian coordinates in a two-dimensional plane. An example of ILI data being converted into Cartesian coordinates and then plotted is shown in figures 2a-c. These coordinates will then be used to determine relative position of corrosion patches from subsequent pig runs. For completeness the background research should be used to give error estimates when possible.

Task Timeline

Task 1. Literature Review

Sept. ’06 - Oct. ‘06

Task 2. Computer Program Construction

Nov. ’06 - Dec. ‘06

Task 3. Results Analysis and Program Refinement

Jan. ‘07

Task 4. Report, Conclusion, and Deliverables

Feb. ’07

Capability

The mechanical engineering program at Ohio State has prepared me well for this type of project. I have used programming many times to complete laboratory and design work in class. In some cases, I was required to graph and plot large amounts of data. Professor Marcelo Dapino, Ph.D. will be advising me while I prepare this report.

My experience as a Co-op at CC Technologies will also be an asset when working on this project. During my previous work with ILI data I have become accustomed to some of the unique ways in which it can be presented. I have been working for nearly one year under the direction of Thomas A. Bubenik, Ph.D. in CC Technologies' pipeline integrity services department. I will be consulting Dr. Bubenik as an expert in the field of pipeline integrity throughout my project.

I feel a project like this will be extremely useful in the future. The world's pipelines including onshore natural gas lines and offshore oil lines continue to age. Their integrity is vital to our economy and way of life. Pipeline owners/operators will always be looking for ways to prevent corrosion and extend the life of their system. For this reason there will always be a premium on information, which helps them do so. I believe this program could be immediately put into practice upon completion. This project will be a great step in the right direction, for myself, as a professional mechanical engineer.

Reference

1. Clark, E.B. and B.N. Leis and R.J. Eiber, Integrity Characteristics of Vintage Pipelines. Technical Report Prepared for The Interstate Natural Gas Association of America, Battelle Memorial Institute 2004.

Figures

Figure 1: This is a combination MFL/Geometry pig, which could be used to inspect a 20" diameter transmission pipeline. Baker Hughes model: CPIG MFLCal HR20.

Figure 2a: This is a typical sample of delivered data from an actual gas transmission line ILI vendor.

PigRunID	CallID	StationStart	StationDeep	StationEnd	DegreeStart	DegreeDeep	DegreeEnd	MinRWT	JointID	InvestigatedFlag	MaxDepth	PerMaxDepth
2001	952896	277253.82	277253.95	277254	315	323	324	417	5192	T	45	0.097
2001	952897	277253.82	277253.85	277254.05	333	342	352	406	5192	T	56	0.121
2001	952891	277255.13	277255.16	277255.57	266	269	269	413	5192	T	49	0.106

Figure 2b: These are generated Cartesian coordinates corresponding to the data sample from figure 2a.

Corner 1x (Feet Odometer)	Corner 2x (Feet Odometer)	Corner 3x (Feet Odometer)	Corner 4x (Feet Odometer)	Corner 1y (Pipe O'clock)	Corner 2y (Pipe O'clock)	Corner 2y (Pipe O'clock)	Corner 2y (Pipe O'clock)
277253.82	277254	277254	277253.82	10:30	10:30	10:48	10:48
277253.82	277254.05	277254.05	277253.82	11:06	11:06	11:44	11:44
277255.13	277255.57	277255.57	277255.13	8:52	8:52	8:58	8:58

Figure 2c: These are representations of the corrosion patches in a 2D plane, which represents the surface of the pipeline. The plot is specifically scaled to show only the three corrosion instances from figures 2a and 2b.