INTERNAL CORROSION REMOTE MONITORING ON PIPELINES

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Abstract

Considering Brazil's dimensions, the location of the cities, the distances to the hydrocarbon basins, the demands and requirements for oil and gas transportation in Brazil are huge. The challenges refer both to technical requirements for the pipelines, project organizations and logistics with respect to transport and mobilization of personnel to the different sites. Transpetro is today operating about 15 000 km of pipelines with various features.
Many of the activities related to internal corrosion monitoring of those pipelines require extensive transportation of personnel in order to have access to monitoring data at pre-determined locations, normally far from the support base. With this scenario, Transpetro is evaluating as an option remote corrosion monitoring at selected locations.
This paper presents Transpetro's experience using devices for acquisition and transmission of internal corrosion monitoring data in pipelines, difficulties observed and parameters considered for the implementation of such system.

1. Introduction

Brazil is a big country, with long distances between cities, hydrocarbon basins and petrochemical installations. Transpetro today operates a total of approximately 15 000 km of pipelines, with different dimensions, service and locations.

Over the last decade, Petrobras and Transpetro have increased the focus on integrity management and internal corrosion monitoring, both for platforms and FPSOs, land based production sites and pipelines. Corrosion monitoring has most commonly been based on the use of weight loss coupons, combined with data loggers for ER probes. The data from the data loggers are normally collected using a portable terminal and downloaded to PC, however, on-line communication via 4 – 20 mA or digital communication is also applied.

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In addition to the methods above, Petrobras/Transpetro have also installed a few non-intrusive corrosion monitoring systems. For a particular oil pipeline, there is one non-intrusive system for internal corrosion monitoring installed for continuous monitoring, and Petrobras has furthermore recently installed four other similar systems, where data is recorded manually using a portable meter.

For remote locations, data acquisition is obviously a difficult limitation. It takes time and resources to send personnel to remote locations for collecting data, and consequently, the frequency of data collection will be limited. A system for continuous monitoring of data that could utilize wireless communication would therefore present many advantages:

- Reduced cost and time consumption to data collection;
- More frequent data, and thus higher accuracy and better quality of the information obtained;
- Immediate information to the user if corrosion conditions were significantly changes.

For that particular pipeline, a location for corrosion monitoring was established some years ago. The location comprised both data loggers for corrosion monitoring using ER probes, and also one non-intrusive system for internal corrosion monitoring station for continuous corrosion monitoring. This station is powered through solar panels.

In order to implement the use of wireless communication, it was decided to upgrade this location as follows:

- Update the existing data loggers at that particular location
- Upgrade the existing non-intrusive system for internal corrosion monitoring station for wireless communication
- Install new Field Interface Unit for power and communication for both IC monitoring systems;
- Install wireless communication based on GSM modems for providing data from the field to Petrobras' offices in Rio de Janeiro

This paper presents more details about this installation, including technical solutions and results from the project.

2. Description of the Monitoring Technologies used

2.1. ER probes and data acquisition instruments

The ER (Electrical Resistance) Probe type measures the corrosion rate as an increase in electrical resistance over time for a steel element in the probe face. The increase in electrical resistance is proportional to the accumulated corrosion over the exposed period.

ER Probes may be used in all relevant environments, such as oil, water and gas, and are independent of conductivity of the medium in the pipe. Most of the more sophisticated techniques that can give more immediate information are dependant on a conductive media (fig 1). For gathering the data from these probes, a data acquisition devices are attached to them, in order to store the reading from probes, being downloaded (or transmitted) time to time and processed by specific computer software.

2.2. Non-intrusive system for internal corrosion monitoring

The system method concept was originally developed as a method for crack monitoring in the mid eighties, being its first off-shore installation made in 1991. This method is based on feeding a current through a selected section of the structure to be monitored and sensing the electric field pattern by measuring small potential differences set up on the surface of the monitored object. The first measurement (signature) is unique to the geometry of the object. When general or local corrosion takes place, the pattern of electric field will change and can be compared to the signature. By proper interpretation of the changes in the potential differences, conclusions can be drawn, e.g. regarding general wall thickness reduction or localized corrosion.

The induced electric current in a pipe will create a pattern determined by the geometry of the structure and the conductivity of the metal. This pattern is represented by current flow lines and equip-potential lines which are normal to the current flow. The subsequent potential measurements on each pin pair in a matrix are compared to the unique field signature and the changes processed to define the change in pipe wall over time.

2.3. Communication system

The data acquisition instruments and the non-intrusive IC monitoring unit can receive power and communication through a special field interface units.

The communication options evaluated were:

- Hardwired digital communication (RS 232, RS 485)
- LAN/Ethernet
- Radio modems
- Telephone: - Standard telephone modems - GSM - Satellite telephone

The system can schematically be presented shown in figure 3.

3. Installation at a Pipeline for TRANSPETRO

The wireless system installed comprises of the following components:

- 2 Data acquisition instruments for ER probe monitoring
- 1 Non-intrusive system for permanent non-intrusive internal corrosion monitoring
- 1 Field Interface Unit (FIU) for providing power and communication to the 2 data acquisition instruments and the non-intrusive station
- 1 solar panel for providing power to the FIU
- Modem for data communication via GSM network from the location.

The equipment was installed on the station in December 2006. Figures 4, 5 and 6 shows pictures from the corrosion monitoring vault, where the ER probes and the non-intrusive IC monitoring instrumentation were installed.

The installed system worked immediately upon installation, but it was early discovered a bug in the non-intrusive IC monitoring instrumentation software that created communication problems, but only for the non-intrusive unit. Revision on the software was made, and installed in that unit in June 2007, apparently solving the problem.

Furthermore communication was lost after a period of time. During the site visit in June 2007, it was also discovered that the GSM coverage from the strength of signal of Line Provider in the area was weak. The cell-phone subscription was therefore changed to another Line Provider, which has a more stable coverage in the area. This was also changed in June 2007, and the test phased can proceed.

4. Summary and Conclusions

Brazil is a large country with long distances, having a significant amount of pipelines throughout the country. Access to some of these locations requires a lot of labor time and money. An on-line, wireless system for continuous internal corrosion monitoring is therefore interesting to Petrobras/Transpetro;

A combined system based on traditional ER-probes/data acquisition instruments and non-intrusive technology, powered by solar panels and communicating via GSM modems was installed in December 2006 at the particular pipeline, in order to validate this option.

Although there have been some start-up challenges due to non intrusive IC monitoring software and loss of GSM signal, the test so far proves that the solutions used have the expected functionality, and represents an interesting alternative for remote, on-line corrosion monitoring.

The data package size could be a problem to remote monitoring according to the transmitting technology selected - if its size is too big to be handling by the transmitting line system provider.

Figure 1- Typical ER probes for High Pressure Systems

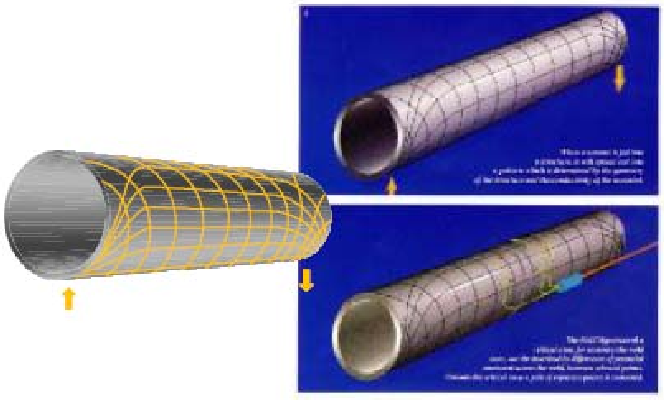

Figure 2 - The system method concept

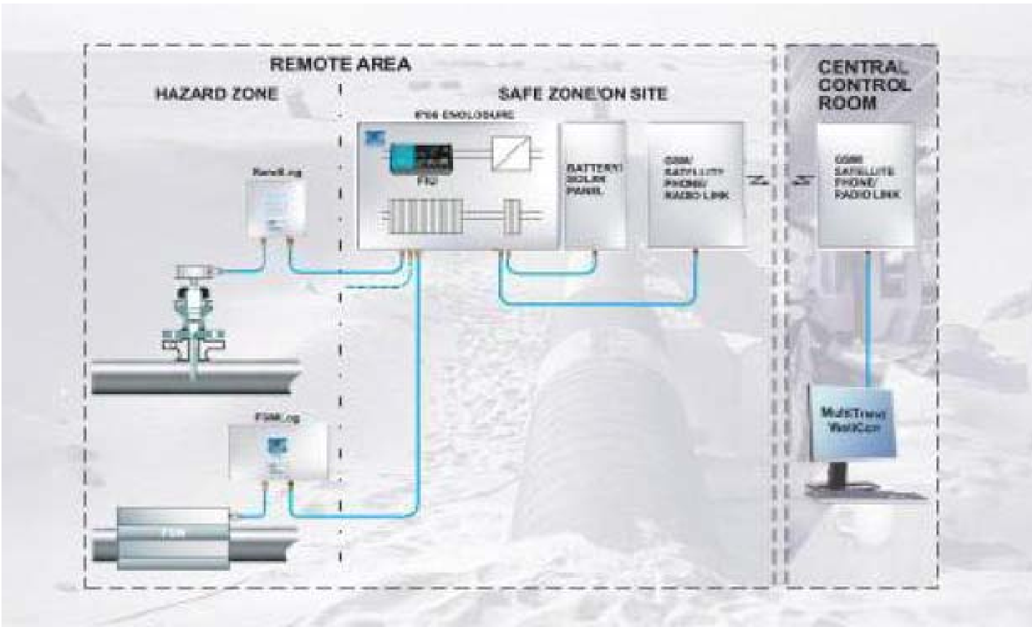

Figure 3 – Communication schemes

Figure 4 – Installation details (Inside Vault)


Figure 5 – Installation details (System Equipments)

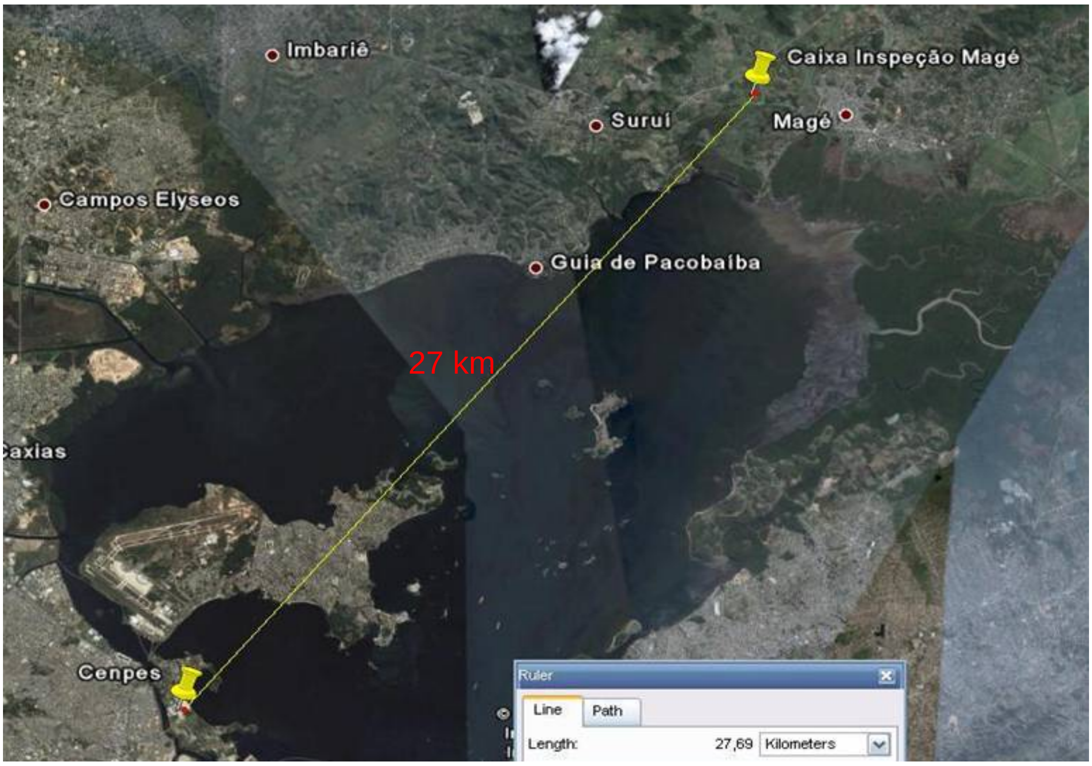

Figure 6 - On Shore Installations distance