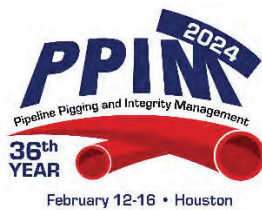


Advanced Permanent Remote Pig Tracking

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Abstract

Recent developments in remote inline inspection (ILI) tool-tracking technology have improved the safety of ILI projects by eliminating the need for field technicians to travel to site to witness tool passages. This is particularly advantageous when tracking overnight and through overly difficult to access terrain. One such development is permanent remote ILI tracking. A permanent remote tracking system consists of a series of permanently installed above ground markers (AGMs) that are strategically located to ensure full tracking coverage and monitored 24/7. This paper will explore the innovative approach PureHM's partner, Enbridge, has taken to mitigate risk via the installation of a permanent remote tracking system on their Athabasca pipeline network, driving a cost saving of over \$4,000,000 over the duration of the 6-year program.

Introduction

Inline inspection (ILI) and cleaning pigs are routinely used to ensure the safe and economical operation of oil and gas pipelines. While in the pipeline, all ILI tools and pigs must be tracked on a real time basis so that the pipeline can be operated safely. Recent developments in remote pig tracking technology have reduced the inherent risk associated with ILI projects by minimizing the need for field technicians to travel to AGM sites to witness the tool passage. These improvements have also made pig tracking more reliable, less carbon intensive and, often, lower cost.

There are 3 methods used to track pipeline pigs:

- Conventional, in person tracking where a technician travels to an AGM site, places monitoring equipment, and waits to witness and record the passage of the pig. Once the passage is verified, the monitoring equipment is retrieved, and the technician moves to the next site. This typically involves multiple technicians who “leapfrog” each other to keep in front of the pig.
- Temporary remote tracking where the technician travels to the AGM locations and places monitoring equipment prior to the launch of the pig. Once the pig is launched, a remote tracking technician connects to the equipment to monitor the passage of the pig. The monitoring equipment is retrieved after the run is completed.
- Permanent remote tracking where monitoring equipment is permanently installed and remotely monitored to record the pig passage. This is the focus of this paper and presentation.

Remote tracking offers pipeline operators an option to track their inline inspection pigs without the need to have field personnel actively on the ROW at all hours of the day in all weather conditions. It also simplifies tracking projects on pipelines located in difficult to access locations that require helicopters or all-terrain vehicles to reach AGM sites. As pipeline owners look to enhance their inspection programs through increased inspection frequency, these issues of accessibility are exacerbated. Advancements in remote tracking technology and services are addressing this issue and making pig tracking safer, more reliable, and less expensive.

Enbridge has installed a permanent remote tracking system on pipelines in the Athabasca region in Northern Alberta. These pipelines run through forested areas with extensive muskeg swamps that make access difficult. They also require multiple cleaning and inspection pig runs. The access issues and multiple runs make these pipelines ideal candidates for permanent remote tracking systems. These systems consist of a series of solar powered AGM boxes that are strategically located at GPS surveyed locations above the pipelines to ensure full tracking coverage. Pure HM has partnered with Enbridge to monitor these systems 24 hours a day all year-round to provide consistent and reliable tracking of any tool used in the line.

Understanding Permanent Remote Pig Tracking

Permanent remote pig tracking monitors three signals that are common to all types of tool tracking:

- Magnetic disturbance caused by the passage of a magnetic field. This is relatively obvious in the case of a magnetic flux leakage (MFL) ILI tool which has a strong magnetic field. Most steel bodied tools have a smaller magnetic field.
- 22 hertz receiver that senses the passage of a 22 hertz transmitter that is attached to the pig.
- An audio signal that a pig creates as it travels through the pipe.

The AGM box in a permanent remote tracking system simultaneously monitors and records all three of these signals. This box is connected to a remote computer by GSM or satellite phone communication devices. Remote technicians monitor the full wave form of all three signals to determine the precise tool passage time without having to travel to site. All the wave form data is saved in case the data needs to be reviewed at a later date.

Advantage of Permanent Remote Pig Tracking

The advantages of permanent remote pig tracking systems include:

- Significantly lower operational risk primarily due to significantly lower windshield time. There is no need for a technician to travel to an AGM site to witness the passage in person.
- Lower cost, particularly on lines that have multiple pig runs and lines that run through challenging terrain that requires helicopters or all-terrain vehicles to access.
- Reduction in the carbon footprint as the need to travel to site is virtually eliminated.

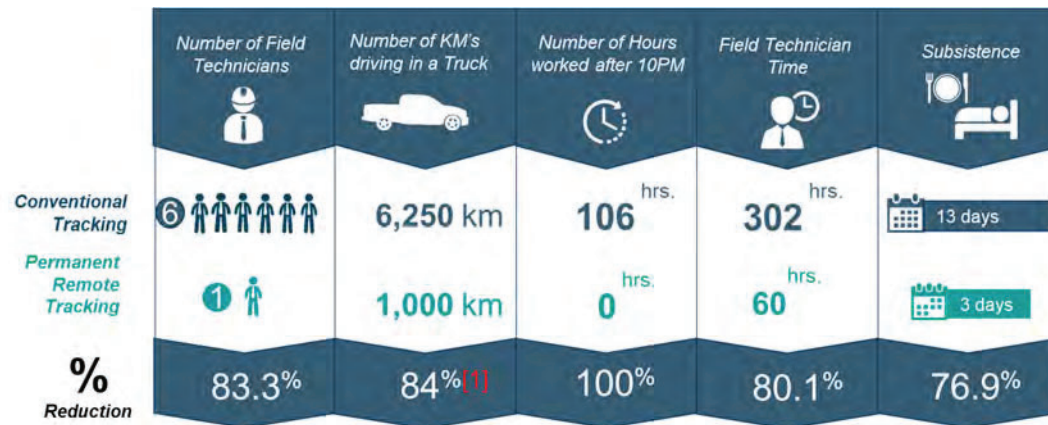


Figure 1. Comparison of Permanent Remote Tracking vs. Conventional Tracking for a typical multiday tracking project. 1.32 tonnes of CO₂e saved by reduction in gasoline vehicle mileage.

- Less interaction with landowners and other stakeholders along the pipeline right of way.
- Last minute schedule changes are easier to manage because fewer field personnel are required.
- More reliable tool passage detection because of the recording of all three wave forms. This data can also be reviewed to identify deviations in the pig travel and to verify passage times in case there are any questions regarding the tool passage times or locations.
- Better operational control because near real-time tracking allows for precise location of ILL tools. This allows the operator to optimize the operation of pumps and compressors.
- The system can provide a beat count to calculate instantaneous pig speed.

Challenges and Lessons Learned

Despite the numerous advantages, implementing permanent remote pig tracking systems poses several challenges:

- Communications issues where GSM networks are not available. Satellite technology can be used in these locations at an additional cost.
- Communications networks are evolving and 3G networks will become obsolete as of the end of 2024. The remote communications devices need to be configured to work with the most recent network protocol.
- Although the permanent remote tracking system is reliable and durable, the system requires some field work to maintain reliability. A yearly maintenance plan is recommended.
- Third party intervention by either well intentioned individuals or individuals who vandalize or steal equipment. This is mitigated by locating the AGM boxes in locations that are not obvious or inside secure enclosures and by making the equipment difficult to remove.

This paper focuses on permanent remote pig tracking systems that are installed on pipelines that run through swampy forested areas where there are few roads and very few people. The technology can also work well in other geographical areas such as prairies and congested urban areas although extra measures are required to conceal the equipment.

Technological Advancements

Improvements in technology in recent years has facilitated the development of economical and reliable permanent remote pig tracking systems. The most important advancements are in the fields of:

- **Smaller, lower cost Sensors:** Advancements in sensor technology have led to the development of smaller, more durable sensors.
- **Wireless Communication:** Improved wireless communication networks enable reliable and seamless data transmission from remote locations on the pipeline to monitoring centres.
- **AI and Data Analytics:** Integration of artificial intelligence and advanced analytics offers considerable promise to make the AGM boxes more intelligent so they can more reliably detect pig passage without human assistance.

Results

Enbridge installed permanent remote tracking systems on 3 pipelines in Northern Alberta during the winter of 2017/18. In total there are 165 remote AGM boxes installed on these lines. Access to the lines is challenging – most of them run through swampy forested areas where the roads are sparse and there are virtually no residents. Each line requires multiple cleaning and inspection pig runs every year.

During the first 18 months of operation, there were 31 pig runs on these lines which resulted in a reduction in tracking costs of approximately \$1.2M. Most of the capital cost of the system was recovered within these 18 months through significantly lower pig tracking costs. There were 27 pig tracking projects during 2022/23 with a resulting cost reduction of approximately \$1.1M. Total savings over the 6 years of the operation of the permanent remote tracking systems has saved Enbridge over \$4M.

There have been no safety incidents during 6 years of the operation of the permanent remote tracking systems. In addition, there have been no operational issues during these tracking projects. The average pig passage capture rate is over 80%.



Figure 2. Example Permanent AGM Installation

Conclusion

The adoption of permanent remote pig tracking systems represents a significant advancement in ILLI tool tracking methodologies. The technology has proven to reduce the operational risk associated with Technological innovations continue to drive the evolution of these systems, offering enhanced safety and lower costs in maintaining critical pipeline infrastructures.

This paper provides an overview of the concept, advantages, challenges, and technological advancements associated with permanent remote pig tracking. As technology progresses, the future holds promising developments in this field, ensuring the continued integrity and safety of vital pipeline networks.

