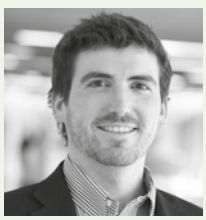
Impact Objectives

- Development of the iPerm pipeline monitoring solution
- System validation and certification
- Market preparation and commercialisation of the iPerm system

Preventing pipe failures

__Borja Hernandez__ and __Anurag Dhutti__ are part of a consortium developing technology for continuously monitoring the structural integrity of major oil and gas pipelines, based on ultrasonic guided-wave technology



Borja Hernandez

Anurag Dhutti

Please tell us a little about the background to the iPerm project and what timeframe you are working to.

BH: iPerm's objective is to develop and commercialise a new product for monitoring the integrity of pipelines using guided-wave technology. The project runs for two and a half years from October 2016 to March 2019. The first part of the project was mostly dedicated to the finalisation of the hardware design and optimisation of the software package. The design packaging and integration of the guided-wave monitoring system was optimised for improved performance and rapid installation and with principles of mass manufacturing for scaling up production. The software optimisation included refinement of the graphical user interface and development of the cloud infrastructure. The second part is focused on performance validation under real conditions, obtaining the required certification for commercialisation, plus dissemination and exploitation of the project results.

Why is the project necessary? What impact will it have on existing pipelines?

AD: The emphasis is on oil leaks as a major problem experienced by the oil and gas industry, with over 30 percent of pipeline accidents attributable to corrosion. According to the European Association of Oil Companies, 15,900 km (46 percent of the total network) of major pipelines are over 40 years old, while only six percent are 10 years old or less. The average annual corrosion-related cost for monitoring, maintenance and replacement of the oil and gas pipeline network in Europe is approximately seven billion US dollars. Failure of ageing pipelines is impacting negatively upon the environment and nations' economies and there is an urgent need to solve this problem. To address this challenge, the iPerm pipeline monitoring system has been developed for early damage detection, optimised maintenance planning and reduced operating costs.

There are already several inspection technologies available for monitoring pipelines including corrosion coupons, pigging, acoustic emission, magnetostrictive, eddy current, microwave backscattering and fibre-optic sensing. However, none of these solutions offers a complete non-invasive, autonomous real-time, energy-efficient pipeline monitoring system that can provide the 100 percent pipe coverage offered by iPerm.

Why was the European Fast Track to Innovation pilot programme the right funding vehicle for iPerm?

BH: The pilot is an innovation support programme available to industry-driven consortia to promote close-to-market innovation activities. It provides a platform for partners to co-create and test breakthrough products and services that have the potential to revolutionise the market. It is an ideal instrument for iPerm since our project consists of a trans-disciplinary and cross-sectoral consortium including all the elements needed to take this innovative product to market. The funding enables us to leverage our own investment and reduce the time needed to refine, scale-up, test and commercialise our concept.

What is your background and how has that led to your involvement with iPerm?

BH: My background is in aerospace engineering, specialising in structures and materials. Currently, I am completing PhD studies in mechanical engineering, focused on structural health monitoring of composite structures using guided-wave technology. With this background, I was appointed to lead the iPerm project, a role that requires technical knowledge of the cutting-edge technology of guided-wave testing and mechanical engineering input for product development.

AD: My background is in electronics engineering and I am currently a research assistant at the Brunel Innovation Centre, developing condition and structural health monitoring technologies for critical assets in the nuclear, renewable and oil and gas industries. I am also completing my PhD studies in electronic and computer engineering. With my experience in guided-wave technology and transducer design, I was made responsible for designing the iPerm transduction system to achieve optimised ultrasonic performance at a reduced cost. ▶

Guided-wave technology for pipeline monitoring

*The six-company consortium developing **iPerm** brings together industry and research organisations to refine and commercialise a practical and durable instrument for permanent monitoring of the structural health of oil and gas pipelines*

Oil and gas flows from one region or country to another through large-diameter pipelines that are hundreds of kilometres long and run through all terrains, along the seabed and through hostile climatic zones. On arrival at a major terminal, the oil or gas is distributed through smaller pipelines to refineries, storage sites and downstream users. This network of interconnecting pipes represents important infrastructure, not only to the companies that operate them, but also to the nations and users relying on a continued supply of energy. Anurag Dhutti, from the Brunel Innovation Centre, part of the iPerm consortium, explains that billions of dollars are spent on the monitoring and maintenance of this network in Europe alone. Despite this, leaks frequently occur, damaging the environment, wasting a scarce resource and adding a significant cost to the economies of whole regions.

Borja Hernandez of TWI Ltd., Coordinator of iPerm, says the consortium's objective is: 'to commercialise a metal pipeline-monitoring system that remains *in situ* and provide early warning of corrosion so that corrective measures can take place before a failure occurs.' The iPerm project comprises six partners from four European countries that between them supply all the technical expertise and commercialisation know-how to bring the iPerm system to market. TWI possesses the expertise in ultrasonic guided-wave technology (GWT), on which iPerm is based; the Brunel Innovation Centre has collaborated with TWI on a number of GWT research activities and has expertise in developing ultrasonic transducers which form a key component of iPerm; iKnowHow is a Greek expert in automation and remote sensing, including cloud infrastructure and graphical interfaces; Turkey's major oil refiner, Tüpraş, is testing the products; Hortec of the Netherlands is finalising development of the electronics and Plant Integrity Ltd. is responsible for the product packaging and encapsulation of the iPerm system. The current and final phase of development is a two-and-a-half-year project funded by the European Union under its Fast Track to Innovation programme.

The iPerm system installed at Tüpraş facilities

GUIDED-WAVE TECHNOLOGY

GWT is a non-destructive testing (NDT) technique that is successfully used for integrity evaluation of oil and gas pipelines.

The ring of transducers within iPerm converts the electric signal from batteries into fast intermittent ultrasonic pulses that travel through the pipeline bounded by the pipeline's outer and inner walls, inspecting the entire cross-sectional area. When a pulse hits a defect or a fitting such as weld, flange or branch, an echo is generated and received by the transducer. By using the ultrasonic pulse's time of flight, together with knowledge of the pipeline's configuration, the speed of the pulse and temperature, it is possible to calculate the position of pipe wall-thinning or pitting with accuracy.

IPERM: A PIPELINE MONITORING SOLUTION

Dhutti goes on to explain: 'GWT is already applied in industry, but until recently has been undertaken periodically with detachable transducers on pipelines.' IPerm will be a permanent installation on the outside of operating pipelines and can either be installed when a new pipeline is laid or retrofitted onto existing pipes. Hernandez says: 'IPerm will be especially useful for sections of pipe that are hard to access or need frequent inspections owing to their criticality for the network.'

The iPerm unit comprises an encapsulated collar that is bolted around a pipe, fitting snugly against the metal. From this, a lead runs to a convenient point where a connection box is installed. For instance, the pipeline might be below ground, under a road, or straddling a river, whereas the connection box would be installed above ground with easy access. Each iPerm unit is pre-programmed during the installation by a qualified technician to enable straightforward data collection each time the pulser-receiver is connected

A metal pipeline monitoring system that remains in situ and provides early warning of corrosion so that preventive measures can take place before a failure occurs

to the connection box. When subsequent inspections take place, the operator need only plug their tablet-controlled pulser-receiver into the connection box, open the iPerm software and click 'one-click collection' to download the test data to the tablet. Once a batch of guided-wave data has been gathered from a series of iPerm units, it is uploaded to the iPerm cloud infrastructure that is accessible via secure link for remote analysis and interpretation by a suitably qualified inspector. While not generated in real-time, the information is supplied in a realistic and practical timeframe for the operator to make decisions regarding preventative and scheduled maintenance.

GAINING MARKET ACCEPTANCE

Hernandez believes that iPerm has many advantages over existing monitoring and inspection technologies: 'Difficult-to-access pipelines can be easily reached without removing outer layers of insulation or putting the inspector in hazardous situations every time the pipeline is inspected.' Also, the inspection operation is de-skilled and can be performed by one person in most situations. Each iPerm collar can monitor several tens of metres of pipeline in each direction and can conceivably be used to monitor the entire length of critical pipelines. Dhutti explains that the greatest challenge to the project has been: 'reducing production costs to achieve greater market acceptance and penetration. This has been achieved through careful component selection.' In addition, he explains that installation must be quick and foolproof for industry and this has been achieved, with each iPerm device typically taking less than two hours to install.

The project is virtually complete, with the transduction and pulser-receiver electronics finalised. The system's software modules and communication protocols have been married to the graphical user interface and cloud infrastructure. Earlier this year, iPerm systems were installed on three separate pipes at Tüpraş' facilities for validation of in-service performance. Tüpraş is regularly using the system, providing inspection data to the consortium. A successful field trial will lead to the necessary certification to enable the product to be sold as fit for purpose. Dhutti says: 'The next big hurdle is convincing end users that our product will work for them. We are in the process of setting up a steering committee of end users and stakeholders and are providing product demonstrations to build confidence.'

Given how close to market this project is, dissemination and business development have been important activities, undertaken in parallel with technology development to ensure iPerm achieves quick industry take-up. As iPerm becomes widely used by pipeline operators, we can be confident our oil and gas assets are being conserved and the environment through which they pass is protected. ●

Project Insights

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PARTNERS

TWI Ltd. (UK) • Brunel Innovation Centre (UK) • Hortec B.V. (the Netherlands) • Tüpraş (Turkey) • iKnowHow (Greece) • Plant Integrity Ltd. (UK)

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Borja Hernandez completed a double MEng degree in Aerospace Engineering at UPM (Spain) and at the ISAE – ENSMA (France). In 2012, he finished his MSc in research and development in mechanics in Poitiers, France, and in 2013, he completed a master's in composite materials organised by Airbus and UPM in Madrid, Spain. He is currently pursuing a PhD degree in Mechanical Engineering at the University of Bath, UK. In 2013, he was awarded a Marie Curie fellowship to research damage sensing in wind turbine blades. Currently, he is working as a project leader at TWI Ltd. His research interests include signal processing, guided waves, damage detection and data analysis.

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