30TH ANNIVERSARY

PIGGING PRODUCTS & SERVICES ASSOCIATION

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Pigging Industry News

the newsletter of the Pigging Products & Services Association

THE PRESIDENT'S LETTER

By Dr. Mike Kirkwood, T.D. Williamson, UK

The words of Heraclitus, "Change is the only constant in life," certainly ring true today. The world continues to be in a pandemic-induced state of flux; even amid the vaccine roll-out, virus hot-spots flare. As if dealing with a pandemic weren't bad enough, the industry has experienced new threats, including the first significant cyber-attack on a U.S. pipeline, which we may see more of in the future.

Fortunately, not all recent news has been negative. For one thing, as lockdowns lifted, oil prices soared to their highest level in two years, motor traffic increased and there are more planes in the air. We are also seeing the drive to decarbonization and the development of a new fuel, hydrogen. Hydrogen is seen as the fuel for the future as it can be generated from green electricity through hydrolysis (green hydrogen) and split from methane with the carbon captured (blue and cyan/purple hydrogen). Many transportation and distribution pipeline operators are either planning or executing projects that will see 100% hydrogen (new and converted) or blended hydrogen and methane in our pipeline systems in the very near future. Our industry is changing with the positives impacting the public as pipelines are a way to decarbonize safely.

As we look forward, we wanted to find out what topics are of most interest to members. To understand that, we went right to the source and polled them. We offered three ideas: Digitization, Future of Pipelines and Public Engagement. It is not surprising that our members chose Future of Pipelines. We kicked off our theme with Aidan O'Donoghue's webinar "Investigation into pigging in hydrogen pipelines" which was broadcast in June (check out https://ppsa-online.com/webinar-video). Please submit any articles, case studies or papers that fit our new theme to ppsa@ppsa-online.com.

Our board has changed this year and I am pleased to accept the role of the President. I am passionate about pipelines and, having spent more than 30 years in an industry that has given me so much it is with great pleasure that I can give something back. I take over from Felix Schmidt, now past president/director. We thank Felix for his excellent leadership over what turned out to be the industries "annus horribilis". I would also like to thank Jessica Nichols and Brett McNabb for their time on the Board. Both have contributed greatly to the Association's future development through their ideas and their commitment. I'm pleased to introduce Jan Frowijn, who was elected to become the 2021 Vice President, and to welcome two new directors, Koty Bogle and Danny Molyneux. I look forward to working with these well-respected industry representatives this year.

We hope to hold our next seminar in Aberdeen in November in person. Our previous "virtual" event was extremely successful with more than 260 attendees and eight papers presented over two days (check out https://ppsa-online.com/papers). We will also be publishing our PPSA Directory - still very popular in printed form for people like me who like such information without the need for a power outlet! We will also continue to support our young pipeliner's through the Young Pipeline Professionals (YPP) all over the world.

I would like to thank all our members, both new and existing, for their continued support. Member participation is integral to the success of the PPSA. As we emerge, from a world-shattering pandemic, we hope to return to some normality and being able to travel and meet our industry peers at all those events we miss so much. Perhaps our November seminar in Aberdeen can be held in person and we can catch up on a missed year of technical exchange and social engagement.

I look forward to meeting you in person or on-line. Until then, keep up the great work managing the energy lifelines that fuel everyday life and, of course, keep yourself and your family safe.

T.D. Williamson performs first SmartPlug® isolation in Offshore Nigeria

Overcoming pandemic challenges enables valve replacement and pressure testing

Replacing platform valves is a complex operation, one that requires successful pipeline isolation to create a safe work zone, minimize downtime and avoid depressurizing the system.

Even a pandemic can't change that.

But COVID-19 did alter the logistics as **T.D Williamson (TDW**) prepared for its first-ever SmartPlug® isolation in offshore Nigeria. Isolating the 267-km (165-mi) natural gas pipeline was necessary for **Strides Energy & Maritime Ltd. (Strides)**, the local partner of a major operator, to replace and leak-test multiple topside valves on a platform.

Through creative planning and the use of remote technology, TDW overcame pandemic-related challenges and delivered the equipment within four weeks, a schedule that would be considered tight under the best of circumstances. The safe isolation remained in place for 32 days, enabling Strides and the operator to complete the required work scope within the shutdown period.

Minimal downtime, no flaring
SmartPlug isolation technology is designed to minimize production downtime during critical repair and replacement work. For natural gas pipelines, it also eliminates the need to flare product. In its typical two-module configuration, the SmartPlug system meets the criteria for a true double block isolation. In this case, to meet the operator's specifications for leak -testing, TDW added a third plug module. Two plug modules provided a double barrier to isolate pipeline contents at 80 bar (1160 psi) line pressure; the third module allowed for in-situ pressure testing of the new valves at 132 bar (1915 psi) while the isolation remained undisturbed and in place.

New ways of doing things
Factory acceptance testing (FAT) that simulates the isolation parameters of the actual operation is a prerequisite to shipping SmartPlug tools. Typically, customers witness FAT testing in person. However, with travel restricted, there was no way Strides or the operator's representatives could make it to the SmartPlug facility in Stavanger, Norway, to be on hand for the tests. Instead, videoconferencing capabilities enabled stakeholders in Nigeria, Norway, The Netherlands and the UK to virtually witness the FAT testing.

"This pandemic has forced us all to rethink the traditional ways we go about our business, from communication with our clients and internally to the way we utilize remote technologies," TDW Project Manager Morgan Swanlund said.

Once the SmartPlug isolation tool was set, crews provided round-the-clock monitoring of seal integrity, both in person during the day and remotely (via satellite) by teams in Norway and Australia at night. The unique TDW remote monitoring technology maintains the high standard of safety required during inline isolation while reducing on site personnel requirements.

"Using our unique technology and in close and constructive partnership with Strides and the operator, TDW delivered a safe and successful in-line isolation within schedule," Nick Matthews, director, SmartPlug Solutions, said.

This first SmartPlug operation in Nigeria adds to the extensive portfolio of services TDW offers across the African continent.

A 3-module, 32-inch SmartPlug® tool ready for launch on an offshore platform

Investment spurs Americas growth for STATS Group

Pipeline technology specialist, **STATS Group**, has continued to grow its market share in North America throughout the Covid-19 pandemic and is now preparing to move into a larger facility in Houston.

The pipeline isolation experts are relocating to new premises double the size of its existing 25,000 sq ft operation, which will allow the business to design and build larger sized assets, to increase its headcount and to provide internal and external training services.

A combination of factors has contributed to STATS extending its footprint in the US and Canadian onshore and offshore pipeline sectors and the company expects further growth into 2022 as the global economy recovers from the pandemic.

A regional strategy in which STATS has invested heavily in recent years in establishing local bases and staff in Texas and Alberta, including the onsite manufacturing of tools, fittings and assets, has increased responsiveness to client requirements and led to increased market penetration.

The company has also extended its range of assets to accommodate the isolation of higher pressure and larger diameter pipelines which has secured new clients and more large-scale workscopes.

STATS Group's Regional Director for Americas region, Stephen Rawlinson, said: "Despite some travel limitations due to Covid, in the last 12 months we have executed a record number of projects both in the US and Canada and we forecast that will continue throughout 2021 and beyond.

"The investment we are making in extending our facility and capability in Houston will allow us to recruit extra staff and to strengthen our support for clients, and we are forecasting a higher than anticipated growth than was budgeted."

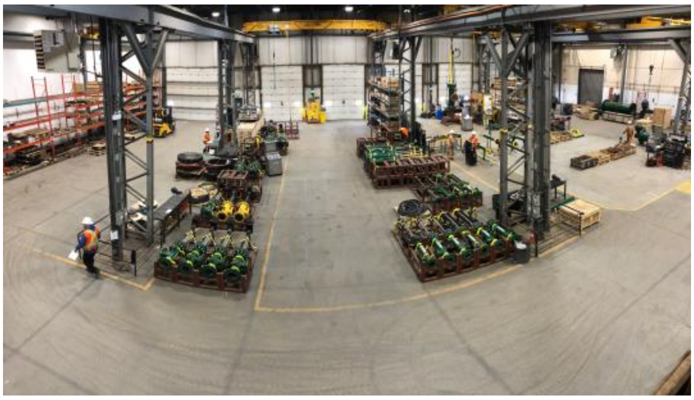
STATS has invested $10 million in North America in the last three years which has included a similar expansion of operations in Edmonton in 2019, continued investment in the company's tools and technologies, and the move to new Houston premises.

Scott McNae, President & General Manager for STATS Group in America, said: "This sustained growth, during what is arguably the toughest trading conditions we have faced for many years due to a fluctuating oil price and the challenges of Covid-19, is testament to the success of our regional strategy.

"This new base allows us to recruit more technicians and design engineers and gives us the opportunity to focus on training and competency which is paramount in maintaining our excellent health and safety record.

"We have worked hard to establish our brand as the innovative, reliable and above all safe solution for upstream and downstream pipeline projects and that is now paying off. We are engaging in multi-faceted and bespoke projects and a growing client list is aware of our range of capabilities and our reputation for responsiveness and reliability."

STATS principal activity is providing specialist engineering services for the maintenance, integrity and repair of oil, gas and petrochemical installations and infrastructure. Headquartered in Aberdeen, UK, the company also has operation in the Middle East and Asia Pacific and employs 300 staff globally.



STATS Group's Canada facility

Starting off on the right foot

In a Nutshell:
New pipeline construction is a complex process in which many aspects have to be considered to ensure safe operation right from the start. An integral part of the process often is collecting baseline knowledge of the pipeline condition. Knowing the baseline condition provides reliable knowledge and allows improved integrity assessments in the future. Pre-commissioning processes of a pipeline are elaborate; in many instances, one element includes in-line inspection. During the manufacturing process, oils, greases, rolling imperfections and mill scale can contaminate the wall of the pipe. Oftentimes when constructing a new pipeline, internal coating is applied. In this case, it is vital to ensure correct coating thickness and proper bonding. This is particularly important if a corrosion resistant alloy (CRA) is used as internal protection of a pipeline. Pipelines exposed to high-temperature mediums and products containing highly corrosive components often are internally protected by metallurgical bonded corrosion-resistant alloy. Such preparation is very important for operational aspects, especially in offshore environments[1]*. This was also the case for a newly constructed 31-kilometer-long offshore gas pipeline in ROSEN's Asia Pacific region.*

The 16-inch pipeline was ready to commence operation with one of the final steps remaining to be carried out: the in-line inspection (ILI). As is so often the case, the ILI requirements did not come without their challenges. In this particular instance, the activities included providing access points for the inspection tool, as no traps were installed, as well as the specific condition for the inspection tool to have minimal contact with the internal coating to avoid damage to the CRA lining.

When selecting an in-line inspection solution for a pipeline, there of course are many conditions to be considered and questions to be answered. Common questions thus often include:

- How do we physically get a tool into and back out of the pipeline?
- What is the goal of the inspection, i.e. the type of anomalies expected?
- What measurement technology is best suited to gather much needed data?
- What customizations, if any, would have be done to the inspection tool to ensure success?
- What kind of testing needs to be completed prior to the actual inspection to minimize risk and increase confidence in the solution?

What goes in must come out
In this specific case, the launching and receiving of the tool was one of the primary challenges, not only due to the missing launcher and receiver but also because of the existing space restrictions. The limit area available did not allow for the connection of a suitable launcher barrel, allowing only work around the existing piping. It was also important to minimize any modifications. During site visits, suitable insertion and retrieving methods were reviewed before the most ideal solution was selected and agreed upon together with the operator. The agreed work methods allowed for all essential supporting equipment and tools to be mobilized.

The on-site crew disassembled a spool at the beginning of the pipeline in order to pull the tool directly into the pipeline, making it possible to safely launch the tool. The work could be carried out smoothly because of proper preparation and upfront agreements. At the receiver end of the pipeline, adaptations were also required but could be solved by adding a temporary – albeit shorter-than-standard – receiver barrel. The operation also included a specific lifting plan for the receiver barrel, as the crane at the receiver platform had not yet been commissioned for use. The operator, as well as ROSEN, carefully carried out every step to ensure safe operation for personnel, equipment and tools.

Technology and Modifications

The goal for this inspection was clear: to collect baseline survey data and verify the thickness of the CRA lining. Having a good understanding of an asset prior to commissioning allows for future improved integrity management decisions to be more educated and less of a guessing game. Verifying the thickness of the CRA liner is part of integrity assessment, particularly if the pipeline will be transporting highly corrosive products. Determining the best-suited technology to collect this initial ILI data ensures that it is best suited for future decisions – starting on the right foot. Given the inspection goal in this case, ROSEN experts recommended and chose ultrasound (UT) as a measurement technology. UT can measure the pipeline wall thickness. Depending on the orientation of the sensors mounted to the measurement carrier, sound waves propagate through the pipe wall by vibrating the particles that make up the material. The transducer generates these waves directly in the sensor through a liquid couplant, meaning a liquid batch was required for this specific case. The difference between the reflections caused by the front and back wall are also recorded, as they are directly related to wall and coating thickness. Based on these reflections, thickness can be assessed[2].

The specific tool chosen was a three-meter-long UT tool originally designed for waxy pipelines. This tool could address the need of minimal surface contact with the interior of the pipe wall. The sensors on this tool are designed with a polyurethane (PU) coating, reducing the tool's metal contact with the inner pipe wall to less than 5% during the entire inspection. To eliminate additional risk and instill confidence in the solution, ROSEN additionally performed a scratch test on a test spool of the CRA section to ensure the remaining 5% metal contact (mainly odometer wheels) would not damage the internal coating surface.

What now?

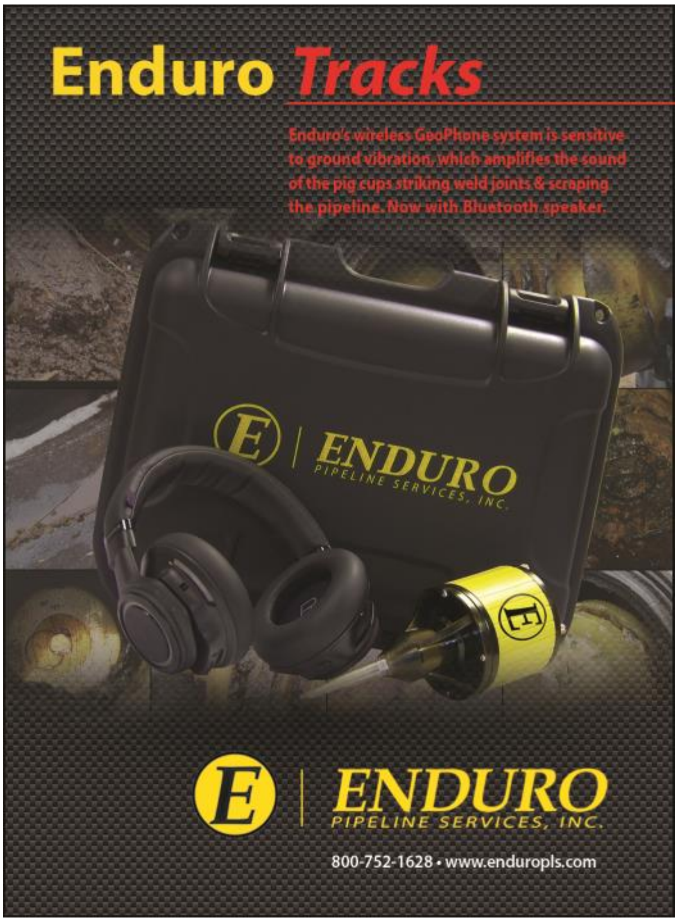
Now that the baseline inspection, or pre-commissioning ILI, is complete, the pipeline can be put into operation. However, pipeline integrity management never stops, and the next question will be how future in-line inspections will take place. Again, the operator and vendor must ask themselves how to get a tool in and out of the pipeline, what technology is best applied and which threats need to be identified (i.e. corrosion, cracking, geometry threats, etc.). Given the CRA coating, this pipeline will be inherently challenging to inspect. Solutions may include creating odometer wheels in non-metallic materials to consistently avoid damage to the CRA layer, customizing geometry tools to have less metal contact with the pipe wall, using foam tools with geometry inspection capabilities and much more.

The Big Picture

Ensuring the integrity of this subsea pipeline prior to its commissioning not only allows for optimal operation and likely an extended lifetime, it also ensures its safety. Taking a comprehensive look at this line means not "just" sending a pig through the line but rather taking goals, operational needs and environmental circumstances into consideration. All elements of this solution have their purpose, both to ensure the success of the inspection and to provide a solid foundation for this pipeline's future lifecycle.

References:

[1] ROSEN-Group_In-line-Inspection-corrosion-resistant-alloys.pdf
[2] ROSEN-Group_In-line-Inspection-corrosion-resistant-alloys.pdf



NDT Global awarded baseline inspection survey contract, Switzerland

NDT Global, a leading supplier of ultrasonic inline inspection (ILI), acoustic resonance technology (ART), and advanced data analytics are proud to announce they have been awarded the contract to complete a baseline inspection survey for Trans Adriatic Pipeline (TAP) AG, headquartered in Baar, Switzerland.

This 878 km large-diameter gas pipeline system possesses many challenging characteristics, including mountainous terrain, high elevation profile, high wall thickness and a complex subsea depth profile. NDT Global's ART Scan™ technology manages all these challenges, while seamlessly combining wall thickness, geometry, and mapping survey capabilities into a single inspection.

Willem Vos, Head of Product Management comments, "NDT Global are excited to begin this baseline inspection program with Trans Adriatic Pipeline. This award further illustrates that gas pipeline operators recognize the advantage of high accuracy UT inspections and further solidifies the future of Acoustic Resonance technology in the global gas pipeline market."

3X Engineering repairs 850m of pipeline in India

Overview
The objective of the repairs, started in January 2021 by **3X INDIA**, is to reinforce several pipelines of various diameters (from 18" to 36") and geometries (straight line, elbow and tee) in Rajasthan region (west India) suffering from external corrosion or hole defects.

Scope of Work
According to ASME PCC-2 requirements and 3X design repair calculations, between 4 and 12 composite layers of REINFORCEKiT® 4D, are needed to reinforce the various defects (external corrosion and hole) and restore the original pipelines integrity.

A total of around 850m repair length will be achieved to completely restore the client's assets. This represents approximately 150 km of Kevlar® tape and almost 17 tons of 3X bi-component epoxy resin.

In one month, 80 meters have been already wrapped on the 36" pipeline. For this particular project, up to 16 technicians are involved and will be deployed for the next 24 months.

To increase the productivity of this huge project, the application team was divided in 3 sub-teams. One team is dedicated to the pipe cleaning and coating removal, the second one conducts the surface preparation and the last one proceeds with composite wrapping.

Below are the different steps performed for the 36" pipeline reinforcement affected by external corrosion:

- Surface preparation was made according to 3X requirements to get a good surface roughness (60µm at least) and ensure a good bonding between the steel of the pipe and the composite of the repair. Hygrometric conditions were checked and the surface was cleaned using acetone.
- 3X filler was applied over the defects to restore a smooth shape.
- Composite wrapping was then applied using Kevlar® tape impregnated with R3X110 resin (dedicated for high temperature) → 4 layers (design pressure is 3bars) were applied for a total of 80m repair length.
- Reference plate was installed for traceability purpose.

Samples of filler and resin were taken during application for quality control.

Results

This is just the beginning of this fantastic project. Repair design lifetime: 10 years. The quality of the first wrappings done and the good hardness measurements already performed predict a coming success.

Elbow reinforcement – R4D wrapping on progress

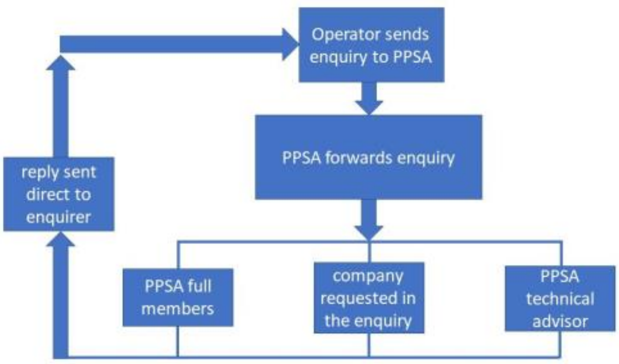
PPSA technical information service

PPSA provides a free of charge technical information service for operators all over the world. By sending just one email to PPSA, operators can easily reach all the Full PPSA members at once. Operators can ask technical questions or make sales enquiries.

When PPSA receives the enquiries we pass them to the PPSA Full members if it is a technical information request or sales enquiry, or if a manufacturer is named in the enquiry the request is forwarded direct to them.

Otherwise the enquiry is sent to one of PPSA's technical advisers, particularly if it is confidential or related to their area of expertise.

To submit a technical enquiry simply email ppsa@ppsa-online.com More information is available at https://ppsa-online.com/technical-enquiries.

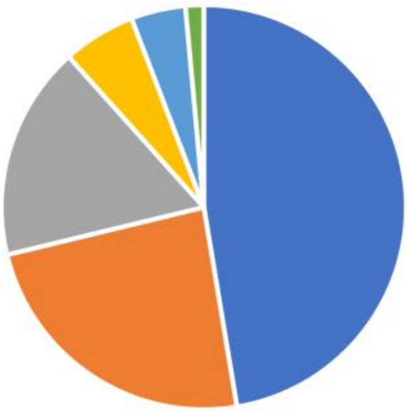


Process for PPSA's technical information service

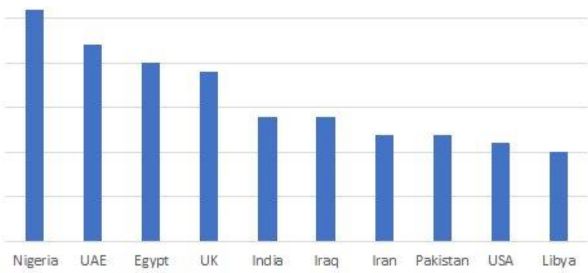
Analysis of enquiries received between 2019 and 2021 shows that the majority of requests are for cleaning pigs, the second most popular type of request is for inspection pigs and services and the third most often request type is for pig traps.

Breakdown of enquiries by type (2019 to 2021)

When looking at the area that enquiries are received from by continent, the majority are sent by operators in Asia, with Africa second highest and Europe the third highest.



Breakdown of enquiries received by continent (2019 to 2021)



Top ten countries that enquiries are received from

Balanced electromagnetic technology in pipeline crack inspection

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Abstract
In order to realize the detection of crack defects in different directions on the pipe surface, this paper proposes a detection method based on balanced electromagnetic technology. In this technique, a U-shaped sensor with AC excitation is used, and the distortion of magnetic flux and eddy current generated on the surface of the pipeline is used as the basis for the detection of crack defects. The finite element analysis combined with experiments shows that the pipeline balanced electromagnetic detection technology by single sensor can produce alternating magnetic field and alternating electric field, at the same time, with a single sensor structure, which can effectively detect pipe cracks in any direction of the pipeline, and remains sensitive for the weld cracks. The signal characteristics can effectively distinguish both horizontal and vertical cracks. The maximum effective crack detection depth is within 10mm from the inner surface of the pipeline.

Keywords: Balanced electromagnetic technology, Crack detection, AC excitation, Magnetic field distortion, Eddy current distortion

Introduction
Pipelines have become the best way to transport oil and gas products due to their low transportation cost, high safety, and large transportation volume. During construction and operation management of long-distance pipelines, due to the influence of factors such as pipe manufacturing defects, welding defects, internal and external loads, stress concentration and corrosion defects, the pipeline will crack and expand, which will be forced to operate under reduced pressure or cause major hazards. From the perspective of the national economy and for safe use, timely detection of cracks and defects in long-distance pipelines is an effective means to ensure the safe operation of pipelines, so as to realize pipeline integrity management and make any risks under control.

In terms of detection technology, there are many types of cracks and different detection methods, but it is difficult to guarantee a sufficient range of use for different detection methods. For non-destructive testing, cracks are still technical difficulties and focus. Pipeline MFL detection technology is the most widely used technology in the pipeline inspection field. This technology can detect and identify cracks and crack-like defects with a certain opening width. However, it is difficult to effectively detect and identify crack defects with a small opening width. Due to the magnetization direction, there is an angle detection blind zone for cracks. The weak magnetic method also has good application in pipeline crack detection. It can detect the crack defect by detecting the stress distribution and the crack magnetic signal characteristics near the pipeline. However, the magnetic signal characteristics of the crack defect and the corrosive defect need to be further studied. Other pipeline crack detection methods such as radiographic technology inspection, traditional ultrasonic inspection, traditional eddy current inspection, etc. also have problems including difficulty in meeting actual inspection conditions or limitation of inspection scope, etc., which have not been well applied in actual pipeline crack inspection.

Balanced electromagnetic technology is an AC electromagnetic nondestructive testing technology that does not require coupling agent and has no special requirements for the operating environment. Based on the principle of electromagnetic induction, by passing an alternating current to the excitation coil of the sensor, and by observing the presence or absence of the detection coil signal, the existence of cracks can be determined.

1.Principles of balanced electromagnetic detection technology
Balanced electromagnetic detection combines AC electromagnetic and AC magnetic flux leakage

detection technology. It uses AC excitation to determine the existence of defects through changes in the spatial magnetic field on the pipe surface. These changes in spatial magnetic fields are caused by changes in eddy currents and magnetic fluxes.

1.1 Balanced electromagnetic detection sensor structure

Balanced electromagnetic detection sensor mainly includes four parts: excitation coil, detection coil, U-shaped ferrite core and detection module. The sensor is composed of a U-shaped high-conductivity magnetic ferrite wound with an excitation coil and a detection coil. The detection coil and the excitation coil are orthogonal to each other and the detection coil is located at the geometric center of the ferrite feet. The plane where the excitation coil is located is perpendicular to the tested surface. The plane where the detection coil is located is parallel to the surface to be tested, and the structure is shown in Figure 1.

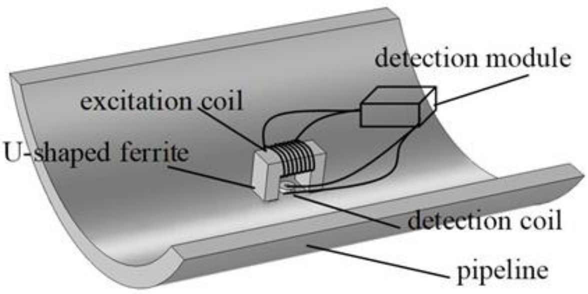


Figure 1. Structure of sensor

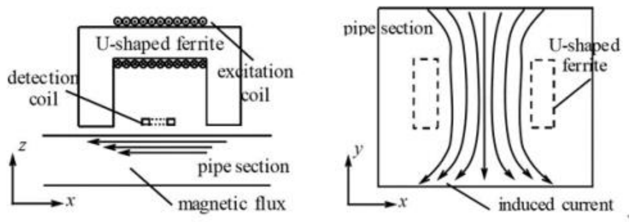
The sensor is placed on the surface of the pipeline. Detection module generates an AC signal to generate a magnetic field around the excitation coil, which is conducted to the surface of the pipeline through the U-shaped high-permeability ferrite, generating a magnetic field in the same direction as the excitation coil. The detection coil is connected to the detection module, and it is used to sense the magnetic field changes on the surface of the pipeline. Detection coil senses that the magnetic field is in a balanced state when there is no defect on the surface of the pipeline to be inspected due to the symmetrical geometric structure of the detection coil and the excitation coil, that is, there is no induced voltage. When there is defect on the surface of the pipeline, this electromagnetic balance will be disrupted, causing the detection coil to receive an induced voltage. This structure can be used to determine whether there are defects on the surface of the pipeline.

1.2 Crack signal generation mechanism

When the excitation coil is energized with an alternating current, a magnetic field that changes with the direction of the current will be formed on the surface of the pipeline. The changing magnetic field will form an eddy current field on the surface of the pipeline. At the same time, the detection coil will generate an induced current under the action of the alternating magnetic field. The electromagnetic distribution on the surface of the pipeline is affected by the changes of the magnetic field and the eddy current field.

1.2.1 Electromagnetic distribution without cracks

When the pipeline surface is free of defects, the magnetic flux will always remain in the XY plane as the direction of the excitation current changes due to the skin effect, that is, flow along the pipeline surface and the plane where the excitation coil is located. The magnetic flux generated in the direction perpendicular to the excitation coil does not pass through the detection coil, and the eddy current generated under the excitation coil is symmetric about the axis of the excitation coil on the pipe surface, and this eddy current changes with the direction of the excitation current. At the same time, the electromotive force generated on both sides of the detection coil is equal to the winding direction of the detection coil, but the direction is opposite. At this time, it is in the state of electromagnetic balance and the detection coil has no signal. Shown in Figure 2.



(a) The magnetic flux distribution *(b) Eddy current distribution*

Figure 2. Electromagnetic distribution on the pipe surface when there is no defect

1.2.2 Electromagnetic distribution when there is a transverse crack defect

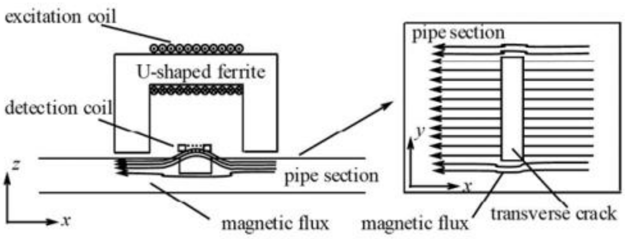


Figure 3. Magnetic flux distribution on the pipe surface when there is a transverse crack

The partially hindered magnetic flux flows to the air with lower magnetic permeability since the existence of the transverse crack defect hinders the flow of magnetic flux generated on the surface of the pipeline, destroying the original electromagnetic equilibrium state. The Z-direction magnetic flux passes through the detection coil above the pipe.

1.2.3 Electromagnetic distribution when there is a longitudinal crack defect

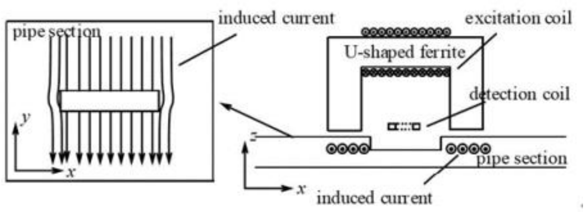


Figure 4. Electromagnetic distribution when there is a longitudinal crack defect

The induced current on the pipe surface is hindered due to the existence of longitudinal crack defects, and the induced current flows vertically under the excitation coil. This phenomenon interferes with the spatial magnetic field, destroys the electromagnetic balance of the pipeline surface when there is no defect, and causes the electromotive force to be generated in the detection coil.

2. Pipeline crack inspection tool

The pipeline crack inspection tool is based on the above balanced electromagnetic technology. It consists of five parts: driving disc, sensor, main processing module, odometer wheel and transmitter. The sensors are arranged in multiple circles to form a multi-channel detection unit to ensure full coverage of the pipe wall circumference. As shown in Figure 5.

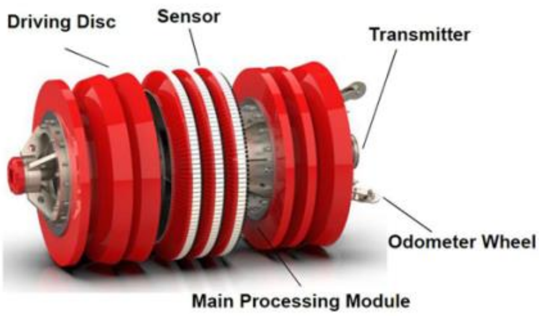


Figure 5. Pipeline crack inspection tool

Pipeline crack inspection tool runs in the pipeline to complete the detection by the pressure difference of the conveying medium in the pipeline. Data acquisition by multi-channel sensors. The main processing module controls the sampling and storage of signal from the sensor, and the electrical signal from the odometer wheel. The power supply to each part is completed by the battery pack. Working principle is shown in Figure 6.

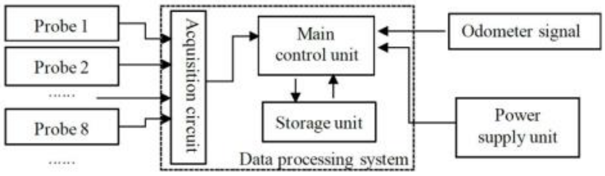


Figure 6. Working principle block diagram of Pipeline Crack Inspection Tool

3. Experiment and Application of Balanced Electromagnetic Inspection Technology

A steel plate experiment was performed on the pipeline crack balanced electromagnetic inspection sensor in order to analyze the characteristics of the detection signal, and a pull through test was implemented to clarify the detection capability of the whole tool.

3.1 Steel plate testing experiment

3.1.1 Horizontal and vertical crack detection

Using a 10mm thick steel plate engraved with 1mm wide, 40mm long, and 1~6mm deep opening cracks, the experiments were carried out from the front of the steel plate and the back of the steel plate respectively. Along the direction perpendicular to the crack and the direction parallel to the crack, open-type and buried-type cracks are simulated, and the crack forms are transverse cracks and longitudinal cracks.

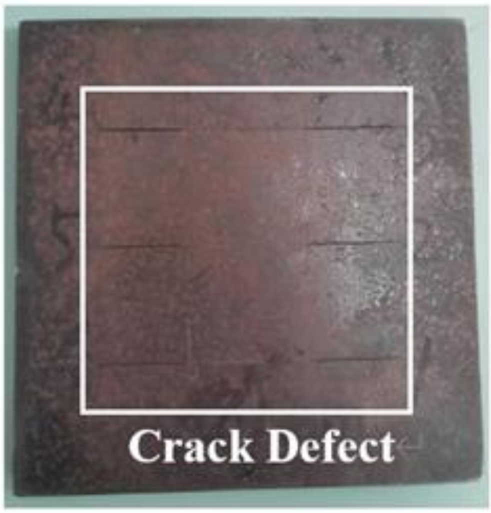


Figure 7. Physical image of experimental steel plate

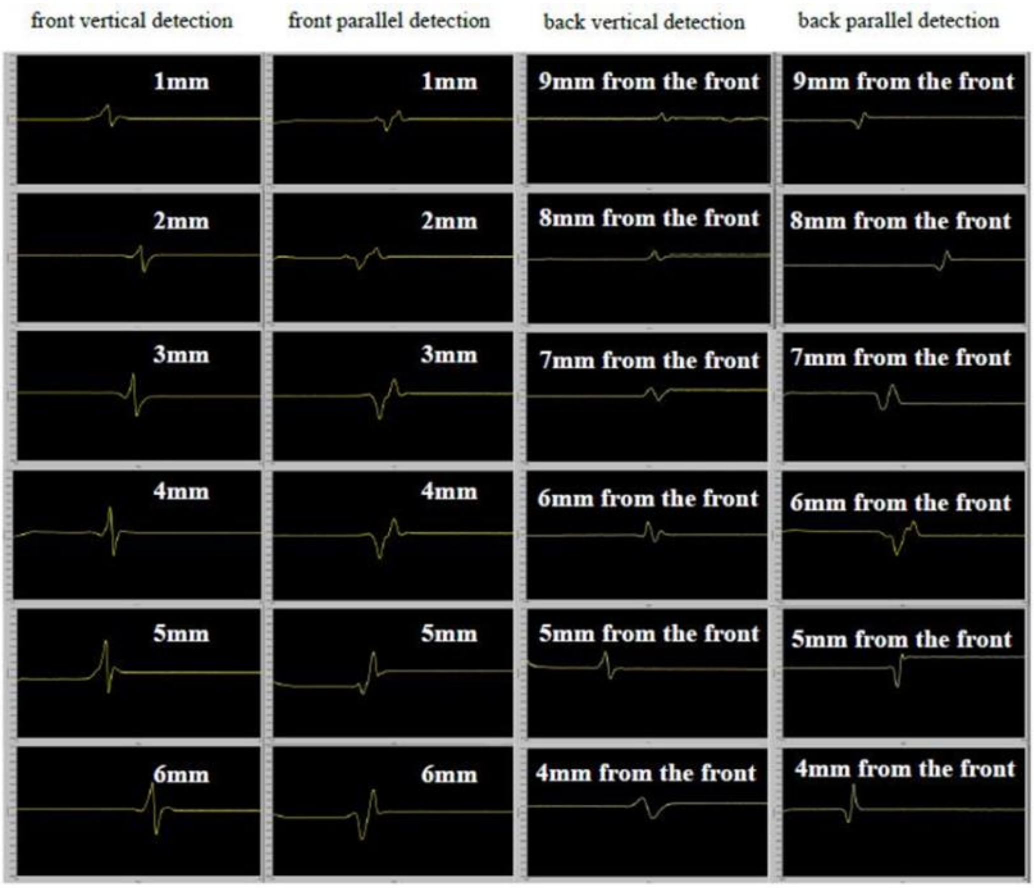


Figure 8. Signal diagram of steel plate

It can be seen from the experimental detection signal diagram that effective detection has been achieved for a 10mm thick steel plate from the front and the back respectively in the direction perpendicular to the crack and parallel to the crack. The signal has the following characteristics: when there is no defect on the surface of the steel plate, the sensor has no detection signal. With the increase of the opening crack depth, the peak-to-peak value of the detection signal increases. With the increase of the buried depth, the peak-to-peak value of the detection signal decreases. The overall amplitude of the detection signal from the back of the steel plate is smaller than that of the front. For testing perpendicular to the direction of the crack (simulating a transverse crack), the signal presents the form of peak first and then valley. For detection parallel to the crack direction (simulating longitudinal cracks), the signal presents the form of troughs first and then peaks, which is opposite to the characteristics of transverse cracks.

3.1.2 Crack detection at the weld

A 16mm thick welded steel bar was used to engrave a 3mm deep, 1mm wide, and 45mm long crack defect in the weld to conduct a crack detection experiment on the weld.

Figure 9. Physical image of experimental welded steel bar

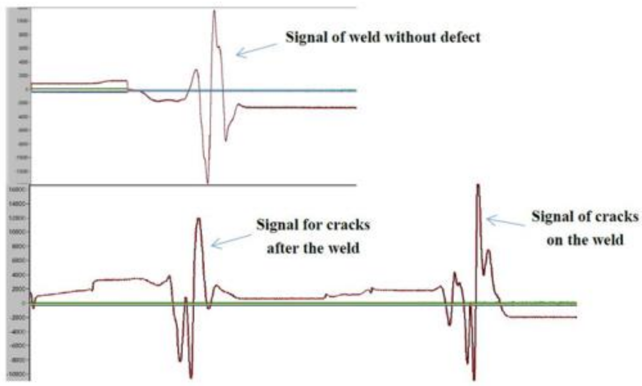


Figure 10. Signal diagram of welding steel bar

It can be seen from the experimental detection signal graph that the pipeline crack balanced electromagnetic sensor can also effectively identify crack defects on the weld. Different from the single-peak-valley signal characteristics of steel plate test, the signal presents a double-peak-valley form when there is no defect at the weld. When there is a crack defect after the weld, the signal appears after the double-peak-valley feature and a single-peak-valley signal of the crack. When there is a crack defect on the weld, the signal will be superimposed on the original double-peak feature with a single-peak-valley signal of the crack. The sequence of the signal peaks and valleys of the transverse and longitudinal cracks at the weld is consistent with the law of the non-welded joints.

3.2 Pull through test

Implement pull through test and analyze the test data. It can be seen from figure 11. that the Pipeline Crack Inspection Tool has the practical application capability. It can effectively detect cracks at different angles of the pipe body, girth weld cracks, and straight weld cracks. And the signal characteristics are consistent with the steel plate experimental analysis, can be used as a reference for crack identification.

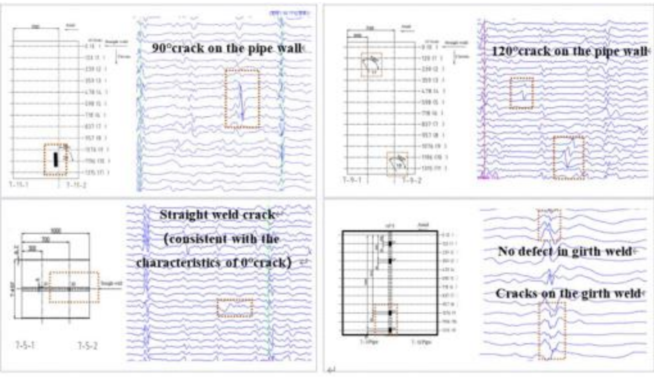


Figure 11. Signal comparison chart

4. Conclusion

Balanced electromagnetic technology uses AC excitation to detect the space electromagnetic field distortion caused by the crack on the pipeline surface. Unlike single AC magnetic flux leakage and AC electromagnetic technology, there is no special requirement for the crack angle and detection direction, and the full angle can be achieved. A clear distinction can be made between transverse and longitudinal cracks, and identify cracks within 10mm from the inner wall of the pipe effectively. It has a good detection effect for the cracks at the weld, and can identify the cracks on the weld through the signal characteristics.

ptc 2021 successfully converted into online-only event with record attendance

With around 1,000 participants and an above-average number of participants from pipeline operators, the Pipeline Technology Conference (ptc) is a unique meeting place for the exchange of operator knowledge across national borders and continents. This defining characteristic was confirmed again this year at the purely online ptc.

A total of 861 conference delegates from 64 different countries attended the online version of the 16th Pipeline Technology Conference from March 15-18, 2021. Two-thirds of the participants came from pipeline operators around the world. In addition to the traditionally strong participation from Europe, Asia, Africa and Latin America, this year's registration included many representatives from the U.S. and Canada.

Dennis Fandrich as Director Conferences together with Marian Ritter as Director Exhibitions opened the conference part of the virtual ptc on March 16 with a short review of the last face-to-face event and the wish to meet again next year live in the conference, at the exhibition and at the evening events.

"We all had to learn a lot of new things during the last 12 months. I am sure that I am not the only one for whom home office from time to time means taking multi-tasking to a whole new level. But it’s working and we all know that this pandemic made the whole world to adapt to the new challenges of remote work and restrictions on the freedom of movement. Many of the presentations will pay special attention to the lessons learned from this unprecedented pandemic situation," Dennis Fandrich said at the opening.

Video streaming of Session 2.2 "Hydrogen" (© 2021 Philip Wilson / EITEP)”