Combo Robot Reviews for Techomech Inspection

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Abstract--- *Sophisticated electronics from more conventional pigs such as cleaning (i.e. poly, brush, bullet, etc.), gauging, or batch pigs that are simple mechanical devices run in pipelines for various purposes. Existing technologies for inspecting pipelines and other things, such as the human body, are surveyed. A sensor that could record multiple data types, such as temperature, pressure, and acceleration, flow and distance and store them on the unit was selected and adapted for use in pipelines.*

Keywords--- *Pipeline Inspection, Visual Inspection, Robot.*

I. Introduction

Pipelines represent a considerable investment on behalf of the operators and can often prove strategic to countries and governments. They are generally accepted as being the most efficient method of transporting fluids across distances. In order to protect these valuable investments, maintenance must be done and pigging is one such maintenance tool. During the 1940s, pipelines in the United States were mainly pigged to remove paraffin to increase efficiency in crude oil pipelines in order to maximize flow conditions for the war effort. The pigging equipment utilized at that time was limited to a few applications while being very crude in nature. In today's world, pipelines are pigged for a variety of reasons and the pigging equipment used is designed by engineers to perform particular functions.[2] Pigging is a widely utilized process which is the act of propelling a properly sized spherical or cylindrical device through the interior of a pipeline by manipulating the pressure & flow of the existing media, or by artificially introduced media or by mechanically pulling the device through the pipeline for the specific purpose of cleaning, inspecting or distributing inhibitor throughout the pipeline. A pig is a device inserted into a pipeline which travels freely through it, driven by the product flow to do a specific task within the pipeline.

One theory is that two pipelines were standing next to a line when a pig went past. As the pig travelled down the line pushing out debris, one of them made the comment that it sounded like a pig squealing. The pig in question consisted of leather sheets stacked together on a steel body. Without doubting the authenticity of the story, it does indicate that these tools have been around for some time. Another theory is that PIG stands for Pipeline Intervention Gadget. The first pigging operation took place around the year of 1870, a few years after Colonel Drake discovered oil in Titusville, Pennsylvania. Before pipelines were used for transporting it, the oil was trucked to the refinery by horse-drawn tank wagons. This proved to be very difficult during winter months because of heavy snows and frozen wagon tracks, and in wet weather when wagons would sink in the mud. To improve upon this method of transportation, a pipeline was constructed, the material of which is not recorded, but each length of pipe was almost certainly joined by the bell-and-spigot method that we see today in plastic pipe. After transporting crude oil for a year or two through this pipeline, the flows began to decrease, and the pumping pressure increased, indicating that

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there were deposits building up on the inside walls of the pipe. Many things were tried to remove the paraffin deposits, but nothing worked effectively for any period of time. Eventually the idea of pumping something through the pipeline was considered. It has been suggested that a bundle of rags tied in a ball was used, and with positive results. Later, bundles of leather were used in place of the rags. Leather will swell when wet, so it created a tight seal going through the pipeline.

II. STRATEGICALLY REVIEW REPORT

The Paper Titled "Introduction to Pigging & a Case Study on Pigging of an Onshore Crude Oil Trunk line" by Anand Gupta1, Anirbid Sircar2 While build-up in a pipeline can cause transmittal slows or even plugging of the pipeline, cracks or flaws in the line can be disastrous. A form of flow assurance for oil and gas pipelines and flowlines, pipeline pigging ensures the line is running smoothly. In the context of pipelines pigging refers to: The practice of using devices known as "pigs" to perform various maintenance operations on a pipeline. This is done without stopping the flow of the product in the pipeline. Pigs are introduced into the line via a pig trap, which includes a launcher and receiver. Without interrupting flow, the pig is then forced through it by product flow, or it can be towed by another device or cable. Usually cylindrical or spherical, pigs sweep the line by scraping the sides of the pipeline and pushing debris ahead. As the travel along the pipeline, there are a number functions the pig can perform, from clearing the line to inspecting the interior. The current paper focuses on understanding the theoretical & practical aspects of crude oil trunk line pigging. An OLGA model is used to predict the Wax deposition Mass, Peak thickness, Average Pig Velocity & Pig travel time. This model is based on actual pipeline condition, fluid parameter and previous pigging data. Actual results from Supervisory control And Data Acquisition (SCADA) and real time monitoring were found in agreement with the OLGA model. The OLGA model predicted nearly 110 kg of dissolved wax and in actual nearly 40 kg of wax was obtained after pigging the trunk line. The model also accurately calculated the pig velocity considering the backpressure & completed the run in nearly 42.5 hours. This shows that the model which we have developed is competent enough to predict the tinkling behaviour, with fine tuning and history matching more accurate results are possible in near future.

The paper titled " Multi-Diameter Pipeline Inspection Gauge for Lang Distance Industrial Application by Ali Ahmadian Mazraeh, Firas B. Ismail Alnaimi .This paper presents an innovative approach for the design and development of Pipeline Inspection Gauge (PIG) which can inspect pipes from 15" up to 30" with a simple change of shirts using the latest technologies such as Electromagnetic Acoustic Transducer (EMAT) sensors as well as Remote Field Eddy Current (RFEC) sensors for oil pipes inspection, through the creation of a simulation tool capable of generating simulated images from pipeline using Inertial Navigation System (INS) for highest accuracy and precision inspection to protect the environment and equipment from any unexpected accident. There are several dynamo motors utilized to regenerate green efficient power from the flow of the medium inside the pipeline to elongate the distance of investigation by the mean of reduction of the number of individual pigging processes to save time and cost for companies. The INS uses accelerometers and gyroscopes of the type "Integrated Micro Electro-Mechanical Systems" (iMEMS), to carry out the mapping corresponding to the inspected pipes. Fluid hammer effect is another factor which has been considered during designing this pig. To avoid such case to occur the design has been revised and several arms have been devised around the robot to maintain the speed and position of pig all the way through the pipeline.

The paper titled " novel fully plastic caliper pig for low-risk pipeline inspection - Design, Characterization and Field Test Alberto Di Lullo Andrea Tasso Matteo Cocuzza Marco Pirola Pipe in-line inspection by "intelligent" pigs is a fundamental oil and gas industry practice but still considered as an exceptional operation. In fact, the instrumented pigs addressing such a purpose are expensive and delicate tools with non-negligible operating risks, thus making their deployment rather infrequent (typically, once every several years). In eni we have started a number of R&D initiatives targeted to making pipeline inspection easier and more frequent by significantly reducing the operating risk faced when deploying inspection pigs. In this context, we present a new, low-cost and low-risk plastic pig with inspection capabilities analogous to those of a multichannel caliper pig (i.e. able to detect, locate and size inner diameter changes and deformations) together with additional features allowing to detect internal roughness changes (e.g. due to corrosion) and perform some pH / salinity determinations, also useful for corrosion assessment purposes. One implementation of the new tool makes use of a foam pig "body", providing the required push with a good capability to negotiate restrictions, equipped with specialized sensors and modules for acquisition and storage. Another implementation, targeted to gas lines and called "skeleton caliper pig", deploys the light plastic system without any foam pig carrier, pushed by the gas velocity alone, and is suitable to prevent the massive displacement of condensates from gas lines. The paper describes the design, construction and field testing of this new low-risk caliper pig, together with some comparisons with the information gathered adopting a conventional tool.

The paper titled "Survey Operations – Pipeline Inspection "Kevin Donald, HydroFest 16th April 2014" Introducing a fundamental step change in the training and qualification of Pipeline Construction Inspectors as a means of improving the construction quality of projects. Improving the overall quality of work performed by Pipeline Construction Inspectors within the industry.

The paper titled "The long and winding road: identifying pig domestication through molar size and shape by Allowen Evin a,b,*, Thomas Cucchi a, b, Andrea Cardini c,d,e, Una Strand Vidarsdottir f, Greger Larson g, Keith Dobney a says The ability to document the effects of domestication from archaeological remains of animals and plants is essential for reconstructing the history of one of the most important transitions in human prehistory e the shift from hunting and gathering to farming. In mammals, teeth are well preserved in archaeological remains and are known to be taxonomically informative. In this study, we compare three sets of dental morphometric descriptors in wild and domestic pigs' maximum length, size and shape variables from 2D geometric morphometrics e in order to assess which of the three provides the best ability to correctly distinguish current wild and domestic West Palaearctic pigs. For this purpose, we used predictive linear discriminant analysis with cross-validation taking into account potential bias due to heterogeneous sample sizes and important number of predictors. Classification accuracy of wild and domestic status ranged between 77.3 and 93% depending of the tooth and the descriptor analysed. However, individual posterior probabilities of correct classification were appreciably smaller when using tooth length and centroid size compared to shape variables. Size appeared to be a poor indicator of wild and domestic status, contrary to shape which in addition provides a high degree of confidence in the wild versus domestic predictions. Our results indicate that geometric morphometrics offers an extremely powerful alternative to more traditional biometric approaches of length and width measurements to capture the elusive morphological changes induced by the domestication process in archaeological remains.

The paper titled "Hydraulic Transients Induced by Pigging Operation in Pipeline with a Long Slope "Tao Deng,1 Jing Gong,1 HaihaoWu,1 Yu Zhang, 2 Siqi Zhang,1 Qi Lin,1 and Huishu Liu1, Received 14 July 2013; Revised 22 August 2013; Accepted 9 September 2013" Pigging in pipelines basically performs operations for five reasons including cleaning the pipe interior, batching or separating dissimilar products, displacement, measurement, and internal inspection. A model has been proposed for the dynamic simulation of the pigging process after water pressure testing in a long slope pipeline.

The paper titled "Advanced Assessment of Pipeline Integrity Using ILI Data by Dr. Ted L. Anderson Daniel J. Revelle Improvements in in-line inspection (ILI) and computing technology, coupled with the emergence of fitness-for-service standards, have created an opportunity to advance pipeline integrity assessment. This paper describes innovative approaches for assessing cracks, wall loss and dents in pipelines using data from ILI tools. Crack detection ILI tools that rely on shear wave UT have improved significantly in both detection probability and sizing accuracy. Quest Integrity Group uses realistic fracture mechanics models that utilize 3D elastic-plastic finite element analysis. The combination of advanced modeling and reliable in-line inspection provides a superior alternative to hydrostatic testing for ensuring pipeline integrity. Inline inspection tools that measure wall loss with compression wave UT provide superior results compared to other methodologies. The former outputs a digital map of individual thickness readings, which is ideally suited to effective area assessment methods such as RSTRENG and the API 579 Level 2 Remaining Strength Factor (RSF) calculation. Quest has developed software that can rapidly process large quantities of ILI wall loss data and evaluate the maximum allowable operation pressure (MAOP) at discrete locations. The ranking of these MAOP values serves as a rational and rapid means for prioritizing the severity of corrosion throughout the line. Traditional dent assessments are based on a simplistic characterization of the dent (e.g. the ratio of the dent depth to the pipe diameter), combined with a simple empirical equation. Quest Integrity has developed an advanced dent assessment that combines a detailed mapping of the dent from ILI data (either UT or a caliper pig) with 3D elastic-plastic finite element analysis. This advanced methodology can be applied to interacting anomalies such as dent/gouge and dent/crack combinations.

The paper titled "PIGGING SYSTEM "Mr.Sc. Halima Hadziahmetovic, Prof. Dr.Sc. Ejub Dzaferovic, September 2010" Pigging in the maintenance of pipelines refers to the practice of using pipeline inspection gauges or 'pigs' to perform various operations on a pipeline without stopping the flow of the product in the pipeline. The pipeline is normally segmented into sections, and a pig trap is fitted at the start and end of each section. The pig trap is similar to an air lock or a torpedo launch tube. It is isolated from the pipeline by a valve, so it can be depressurized to load the pig. Once loaded, the trap door is closed, and the trap is pressurized.

The paper titled" "DIGITAL PIGGING" AS A BASIS FOR IMPROVED PIPELINE STRUCTURAL INTEGRITY EVALUATIONS by James D. Hart, Nasir Zulfiqar, David H. Moore, Greg R. Swank This paper describes the application of “digital pigging” procedures for converting field measurements of pipeline geometry (e.g., top of pipe survey profiles), results from geometry pig surveys, or analytically generated pipeline centerline profiles into corresponding profiles of pipeline curvature and bending strain. Application of digital pigging procedures to pipeline elevation and/or inclination profiles developed from accelerometer-based geometry pigs provides a basis for performing the additional calculations required to develop bending strain profiles which may not be a part of the geometry survey deliverable but are required for pipeline structural integrity evaluations. This paper presents examples of digital pig runs over analytical pipe centerline profiles to illustrate the important effects of feature length, pig length and curvature gage length. Comparisons of the results from digital pig runs over actual geometry pig data profiles and digital pig runs over the corresponding known analytical profiles will illustrate how basic pattern recognition concepts can be used as a basis for improved synthesis of real pig data signatures. This paper also presents examples of digital pigging calculations performed on geometry pig survey data that show how low pass filtering can be used to reduce the effects of noise in the survey data as well as the influence of curvature gage length on the computed curvature/bending strain profiles.

The paper titled” Combined In-Line Inspection of Pipelines for Metal Loss and Cracks by M. BELLER, A. BARBIAN, NDT Systems& Services, Stutensee, Germany D. STRACK, Deutsche Transalpine Oelleitung, Kösching, Germany. As pipelines grow in age it is of ever-growing importance to provide operators with precise and reliable inspection data in order to perform advanced integrity assessment calculation and optimize maintenance processes. Until recently the inspection of a pipeline regarding metal loss and cracks not only constituted the need for two separate inspection runs but also the use of two separate tools. This paper will introduce a range of advanced in-line inspection tools that incorporate the ability to be used for quantitative metal loss and wall thickness- as well as crack inspections. These tools, utilizing ultrasound technology, make use of a new generation of electronics and an entirely new design of sensor carrier to enable metal loss- and crack inspection surveys to be performed with a single tool in a single run. The paper will explain the physical principle used, introduce the tool technology, introduce a case study and present the operational advantages to the operator.

REMOVAL OF SCALE FROM THE TOTAL DUNBAR 16” MULTI-PHASE PIPELINE by Jon Hawes the 16” Dunbar Pipeline, operated by Total E&P UK PLC, transports raw multi-phase fluids 22km from the Dunbar platform to the North Alwyn Bravo platform in the North Sea. The pipeline was commissioned in 1994 and successfully intelligently pigged in 1997. Video inspections of the pipeline conducted in recent years indicated a significant deposition of scale on the topside and riser pipework at the Dunbar platform. Scale throughout the length of the pipeline was also suspected. In 2003, a program of work was initiated to clean the pipeline of scale and to enable an intelligent pig inspection. This consisted of a three-phased approach, performing a detailed study into options for safe removal of the scale, carrying out a comprehensive assessment of the scale quantities in the pipeline, executing modifications to the platform topsides, and culminating in the final pipeline de-scaling operations in 2004. The detailed study was carried out over the second half of 2003 and looked at a number of possible techniques for removal of the scale. Prior to completion of this de-scaling study, a contract was awarded to assess the scale quantities, and shortly afterwards a second contract was awarded to clean and intelligently pig the pipeline. The subject of the assessment of the scale quantities was covered in separate paper in 2005 [1]. This paper presents an outline of the options considered during the study phase of the work and looks at the subsequent platform modifications and descaling work program undertaken, as well as summarising the results of the inspection runs which measured the effectiveness of the scale removal during autumn 2004.This paper describes the technical challenges, which resulted in the successful removal of barium sulphate scale from a strategically important pipeline.

The paper titled “PIGGING IN PIPELINE PRE-COMMISSIONING “David Russell, Weatherford Pipeline & Specialty Services UK, Copyright © 2005, Pigging Products and Services Association.” Pipeline pigging has a significant role to play in meeting these conditions, and pigs are met with in several guises during pre-commissioning operations. This paper is intended to provide an overview of the uses of pigs in these operations and provide some basic information on train design and pig selection. Some examples are drawn from a range of types of construction and pre-commissioning projects in order to give a feel for the practicalities of the operations described.

The paper titled “Development of the Caliper System for a Geometry PIG Based on Magnetic Field Analysis paper introduces the development of the caliper system for a geometry PIG (Pipeline Inspection Gauge). The objective of the caliper system is to detect and measure dents, wrinkles, and ovalities affect the pipe structural integrity. The developed caliper system consists of a finger arm, an anisotropic permanent magnet, a back yoke, pins, pinholes and a linear hall effect sensor. The angle displacement of the finger arm is measured by the change of the magnetic field in sensing module. Therefore, the sensitivity of the caliper system mainly depends on the magnitude of the magnetic field inside the sensing module. In this research, the ring shaped anisotropic permanent magnet and linear hall effect sensors were used to produce and measure the magnetic field. The structure of the permanent magnet, the back yoke and pinhole positions were optimized that the magnitude of the magnetic field range between a high of 0.1020 Tesla and a low of zero by using three-dimensional nonlinear finite element methods. A simulator was fabricated to prove the effectiveness of the developed caliper system and the computational scheme using the finite element method. The experimental results show that the developed caliper system is quite efficient for the geometry PIG with good performance.

The paper titled “Observations on the Application of Smart Pigging on Transmission Pipelines”byRichard B. Kuprewicz President, Accufacts Inc September 5, 2005A Focus on OPS’s Inline Inspection Public Meeting of 8/11/05 Smart pigs, also known as inline inspection (“ILI”) tools or intelligent pigs, are electronic devices designed to flow on the inside of a transmission pipeline, usually while the line is in service, to inspect a pipeline for various types of anomalies that can increase the risks of pipeline failure.1 This paper comments on observations pertaining to the Office of Pipeline Safety’s (“OPS”) public meeting of August 11, 2005 in Houston, Texas.2 Approximately 400 industry, pigging vendors, and regulatory representatives attended this meeting, dramatically underscoring the gravity of this important subject. This author concurs with the public meeting announcement and fully supports and is committed to assisting OPS’s effort, and many in the industry, to advance the prudent application of ILI in gas and liquid transmission pipeline systems. OPS has a long history of encouraging technical development to improve pipeline safety. Smart pigging has taken on an even more critical role with the promulgation of integrity management rule making in the last several years.3 In some situations pigging is not the best or preferred inspection method for various reasons, especially if the technology is misapplied, oversold, or the pigging process and information mishandled. It is extremely important to recognize those situations where smart pigging technologies have not advanced sufficiently, or where the pigging process is incomplete such that it interferes with inspection quality. In such misapplications, ILI may not be effective or warranted. It is crucial to properly communicate to the industry and the public the appropriate limits of this important technology, especially those tools still in development. This white paper briefly describes various smart pig technologies, outlines several new industry standards (including the just released API 1163),4 that should advance the proper utilization of smart pigs, comments on the 8/11/05 public meeting, and identifies areas where further pigging research, development, and advancement are necessary. Smart pigging, when properly applied, can serve as a superior inspection tool for many risks of concern over other integrity inspection methods. A proper smart pigging program can play a vital role in integrity management ("IM"). This author advises that OPS "stay the course" in ILI efforts, but continue its oversight of the inspection repairs and IM process to assure continual improvement. It is expected that the new standards discussed in this report will play a significant role in this continual improvement. An Advisory Bulletin alerting industry, regulators, and the public on the new standards, and OPS's critical observations and expectations onthe ILI process, should be issued.

III. CONCLUSION

This may result in improper pigging programs and/or the use of the wrong type of pig and h s could have an adverse effect on the pipeline's operating and maintenance costs. It is therefore important to clearly define the reasons at the very beginning and the following will provide some guidance in this respect. Therefore the sensitivity of the caliper system mainly depends on the magnitude of the magnetic field inside the sensing module. In this research, the ring shaped anisotropic permanent magnet and linear hall effect sensors were used to produce and measure the magnetic field. The structure of the permanent magnet, the back yoke and pinhole positions were optimized that the magnitude of the magnetic field range between a high of 0.1020 Tesla and a low of zero by using three dimensional nonlinear finite element methods. A simulator was fabricated to prove the effectiveness of the developed caliper system and the computational scheme using the finite element method. The experimental results show that the developed caliper system is quite efficient for the geometry PIG with good performance.

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