CRAWLER CONTROL PROCEDURE

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Abstract: The following paper discusses the advantages of using an electromagnetic signalling system in comparison with an isotopic system for a crawler control system. The description of the electromagnetic crawler control system is as follows:-

Introduction: There are thousands of kilometres of pipeline worldwide which are in production or under construction. It is essential that these pipelines are built to the highest standards as any pipeline failure could result in ecological disaster. One of the most common reasons for pipeline failure is flaws in the welded joint between two pipes.

Therefore periodical inspections of production pipelines are required and any pipeline under construction must have 100% inspection of welded joints.

As more and more pipelines are built and older pipelines start to deteriorate the risk of accidents gets higher, and the need to inspect pipelines in a safe and cost effective way takes on prime importance, hence the development of automated pipeline diagnostic systems. The information obtained using this modern equipment enables the inspector to reliably evaluate the condition of the pipeline and to predict its residual lifetime.

To provide the NDT examination of the weld joints in the process of pipeline construction in most common use are special devices called crawlers, and on most crawlers panoramic X-ray tubes are mounted. This guarantees high examination productivity. All crawlers are self-propelled chassis travelling inside the pipeline. Besides the X-ray tube the system comprises built-in power supply block, one or more motors, electronic module and signal detector. The Signal detector registers the signals generated by operator to initiate commands and transmit registered signal to the electronic module in which the information is decoded and the start signal for the specific command is generated and power is applied to the motor or x-ray tube as appropriate. During this procedure, the command should guarantee high accuracy of crawler positioning relative to examined welded joint as this is one of the most important conditions to obtaining a high quality X-ray image.

Traditional methods of crawler control are based on use of ionising radiation detectors. This makes it possible for operators to send signal commands to the crawler with the help of an isotope through the pipe wall. This method is very reliable and use of special containers for isotopes provides satisfactory accuracy of the crawler positioning and consequently obtaining a good quality x-ray image of welded joint. But at the same time use of isotopes creates a number of problems. One of them is the safety issues that accompany ionising radiation. The other problem is connected with the difficulties of transportation. In the world there are a lot of countries in which the import of radioactive materials is forbidden.

All these problems force the crawler manufacturers to look for alternative, in comparison with isotope, control methods.

In the world there are a number of companies manufacturing crawlers. Company "JME Ltd." is one of the leading companies acting in this area. Three basic models of crawlers are manufactured by the company. These three models cover practically the whole range of pipes that are subject to NDT. These are: 6" JME crawler that provides examination of pipelines with diameter from 135 to 356 mm; 10/60" JME crawler – covers range of 240 – 1500 mm and 24" JME crawler for examination of pipelines with diameters 558 – 1829 mm. All the above crawlers can be equipped with X-ray tubes operating from the following voltages: 160, 180, 200, 250 and 300 kV. They provide the examination of some 120 welded joints and travel back to start point on a single battery charge.

But until recently, the crawlers proposed by "JME Ltd." company had, in common with other manufacturers, the disadvantages associated with isotopic control systems. This company made a lot of effort to find alternative control methods.

Some attempts were made to use the radio signals for equipment control. But this approach requires access of the operator at least to one opened end of the pipeline. Besides the developers faced difficulties connected with the radio signal transmitting to long distances inside the pipeline. The other weak point was in the difficulty to provide accurate positioning of the crawler in certain point as the operator was not able to see the crawler position relative to welded joint. In such a way the proposed method was not the best for crawler control.

Results: In 1997 “JME Ltd.” And JSC “MSIA “Spectrum”, long term business partners, started common research works with a goal to develop an ecologically safe crawler control system. An analysis of various control technique was performed and finally they decided to concentrate their efforts in the direction of the use of the electromagnetic method.

The newly developed method made it possible to abandon isotopes as control element. Such an approach helps to avoid negative impact of radioactive radiation on operator as well as remove the problems relevant to radioactive isotopes transportation both within the country and abroad.

Discussion: The Electromagnetic control system comprises two main modules: electromagnetic detector installed on the crawler operating inside the pipeline and control module named “magnetope”, placed outside the pipe and handled by the operator. The Magnetope is battery powered with a 24 hour capability prior to recharge.

Outside of the pipe the magnetope generates a powerful electromagnetic signal and this signal is registered by detector on the crawler inside the pipe, where the signal is picked up and processed.

The detector is equipped with two sensors of electromagnetic field, aligned coaxial with the direction of magnetope displacement.Such scheme provides detection of magnetop motion.

The shape and size of magnetizing coil used in the Magnetope helps to form the electromagnetic field with strength enough to signal the electromagnetic detector through the metal with thickness more than 20 mm. The coils in the detector block have a core lengthened in the direction perpendicular to the pipe axis that increases the working area of the detector. A feature of the detector’s design makes it possible to eliminate the necessity to place magnetope accurately over the detectors sensors. A certain degree of alignment error is acceptable and does not affect the operability of the system.

The electromagnetic control system does not leave residual stresses of pipe magnetization that make it possible to carry out several exposures of the same weld.

Simultaneously with such a radical change in the procedure of crawler control, all standard control commands remain unchanged and additional training of the operator performing work on site is not required. The scheme of connection of detector module and crawler were kept the same as well and this provides fast replacement of detectors during equipment up-grade.