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Practice of Inline Pipeline Inspection with MDSCAN Intelligent Pigs

Dmitry SLESAREV, Dmitry SUKHORUKOV,
Electrodnaja 11, b.1, "Intron Plus", Moscow, Russia
E-mail: info@intron.ru
Evgenij VASIN
"Diascan", Lukhovitsy, Russia

Abstract

MFL intelligent pigs are widely applied for pipeline inline inspection because of possibility of complete pipe and weld coverage. Such types of pipeline defects as pitting corrosion and transverse weld seams cracks can be detected and estimated only y MFL pigs. At the same time MFL remains an indirect method of defects estimation with a lot of influence factors, which obviously decrease estimation accuracy. Nevertheless using of a priori information of typical defects and sections particularities enables appreciable increasing of estimations reliability. Introduced subclasses of metal loss defects enable to increase accuracy of field inverse problem solution within limited training sample. At the same time it proves to be possible to apply achieved training results to the pipes with a wide variety of their diameters and wall thickness. Some other problem concerns evaluation of real corrosion agglomeration especially within automated inspection data processing.

Keywords: MFL, pipeline inspection

Pipeline inline inspection plays now a key role in ensuring reliability of oil and gas pipelines. This is connected with two main factors – first, possibility of inline inspection without disturbing of normal oil/gas pipage, second, possibility of nearly 100% coverage of pipeline surface and detection of different types of defects. The last aspect is very important. There are different types of inspection tools – ultrasonic (WM and CD), geometric, MFL, which are specialized for concrete type of defects. Application of different types of tools increases inspection reliability. So it is important to make possible detection of critical defects with different types of instrument. The most prevalent type of defects is corrosion caused metal loss. Practically over 95% of all pipeline defects belong to this type. Most dangerous is the case, if metal loss locates in the place of tension concentration. Especially it concerns combination of different defects, in particular dents with notches. So it is important to identify such combination. Another class of dangerous defects consists of weld cracks, both girth and longitudinal welds. Several years of operating

MDSCAN MFL-pigs developed by Intron Plus and Diascan allow us to make some generalizations about detection and estimation of pipe defects and anomalies with help of MFL technique.

MFL-tools are most applicable, because it possess such advantages as 100% coverage of pipeline surface (sediments are not so critical as for ultrasonic), it enables detection of different kinds of defects including pitting corrosion and weld cracks, which can not be detected with ultrasonic tools. Furthermore inspection operators have a big insipience of interpreting MFL-data, this is very important in practice. Herewith magnetic flux leakage remains an indirect method of measuring of defects parameters. It is based on solution of inverse electromagnetic problem and there are many influence factors, decreases accuracy and reliability of defect parameters estimation.

Defect classification underlies accurate parameters estimation. It is known one can find two defects of different classes, producing nearly the same MFL-signal [1]. Therefore correct defect classification plays very important role. In fact we need to use specific signal features for defect classification, different from those used for parameters estimation and additionally to use information about pipeline section as a whole. It is important to know what kind of pipe is it (forthright welded, spiral welded, weldless), if the defect locates near the weld, if it belongs to some defects agglomeration and some other. In real survey MFL-data is affected by sensor movement path, non-homogeneity of pipe material and other factors. Moreover, some data can be corrupted because of faults of measurement system. In this case classification problem can be solved only with help of additional (a-priory) information as mentioned above. So we introduced some special types of defects for example corrosion agglomeration and metal loss on dent. Calculation of depth, length and width of these defects differs from those of normal metal losses. This is reasonable. Figure 1 shows MFL-signal of some notch of about 0.25 T depth on a dent, T means here wall thickness. Figure 2 shows MFL-signal of approximately same notch but without dent. Difference in signal magnitude of normal notch and the same on dent reaches nearly 50%. So we have to use some special algorithms to calculate parameters of such defects.

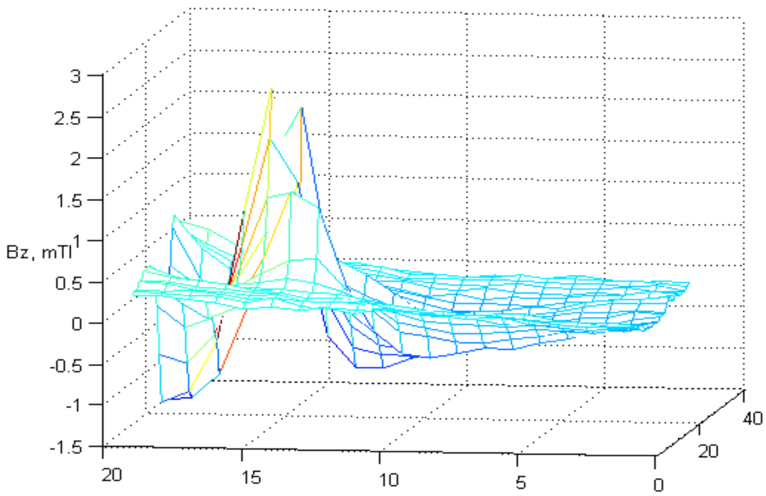

Fig. 1

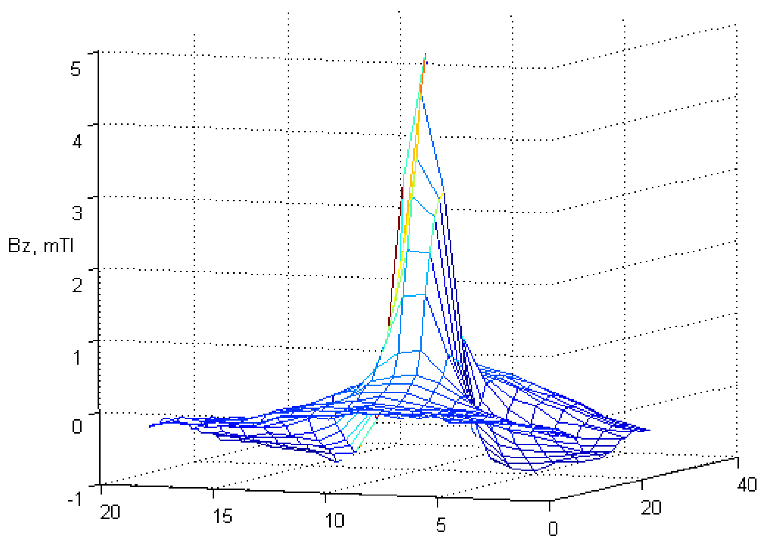

Fig. 2

Another problem concerns interference of MFL-signals in corrosion agglomerations. Figure 3 depicts C-scan of typical case of corrosion. Distinct defects locate very near at each other, so that there MFL-signals have apparent interference, as shown in Figure 4. This means, that we can not apply classical model of single metal loss to calculate parameters of such defects. Some special models are to be used in this case. So extended defect classification helps us to increase accuracy of parameter estimation. This applies to defects located near welds also.

Other reason for extension of defects classes consists in the possibility to limit training sample for parameter estimation algorithms. Too wide training samples leads to instability of inverse problem solution.

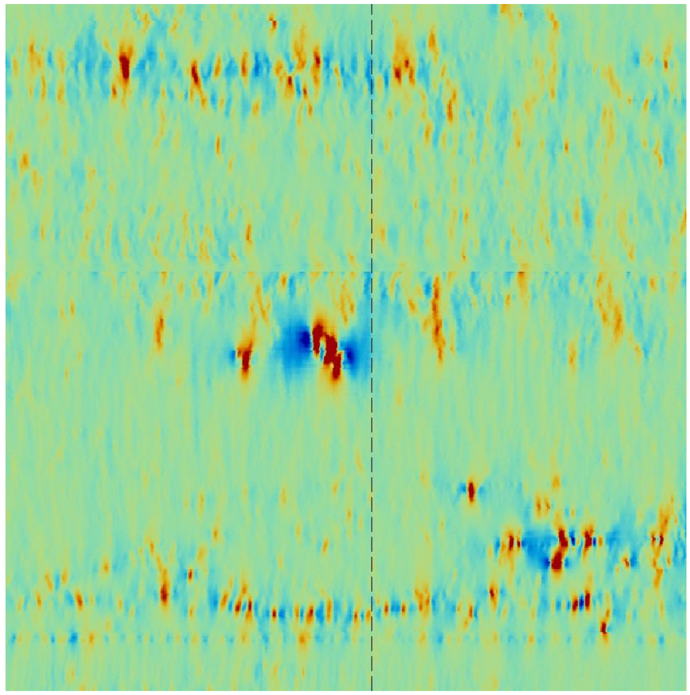

Fig. 3

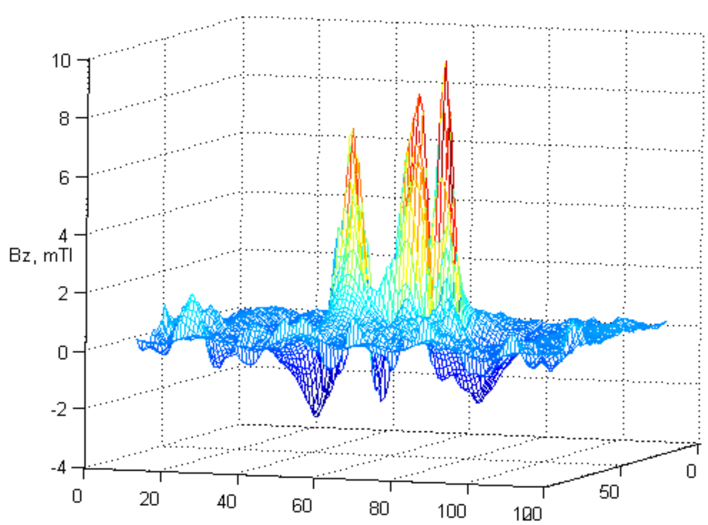

Fig. 4

Generally processing of inspection data consists of two main steps – working out of pipebook, and defects analysis. These steps underlie structure of the software, used in inspection data processing [2]. Firstly the program calculates pipebook, which has to be corrected by operator. In fact the automatically calculated pipebook is up to 98% correct. The main defect analysis module includes follows analysis stages:

1. Data preprocessing

2. Defects localization
3. Defects classification
4. Calculation of defect parameters
5. Posprocessing.

Results of automatic data processing should be checked by operator. Every processing stage has its control parameters, which influence results of the calculation. Herewith parameters of stages 1, 2 and 5 should be fitted for every inspection. It allows to achieve better quality of data processing and to reduce expenses of inspection data processing, which depend on the amount of missed defects on one hand and amount of false defects on other hand. In order to increase reliability of data analysis and to reduce expenses of data processing we have realized an automated training based adaptation of processing stage parameters in the Software for MDSCAN-pigs. It enables to simplify and improve significantly the procedure of control parameters adjustment.

References

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