DESIGNATION OF DEFECT AREAS USING ADAPTIVE SEGMENTATION ON EDDY CURRENT RESPONSE SIGNAL

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Abstract

Signal processing in the material testing and application of new processing and analysis tools belongs among the priorities in the manufacturing industry. This article discusses innovative evaluation of eddy current response signals and the data sorting using adaptive segmentation in order to increase efficiency of the material testing.

1 Introduction to Eddy Current Testing

Non-destructive testing (NDT) is a way of verifying the quality of materials in the production and post production process or during its use. The tested material is not damaged and in case of successful completion of the controls can be further used. It is necessary to test the materials and the products used in various fields of industry before their final application and also during the use to maintain their proper functioning and usability in the specific applications. The materials may contain defects and to avoid any undesirable consequence, it necessary to find them and also to identify them in order to be assessed their severity.

Various materials required for accurate control different methods. Control method has to be appropriate for this specific material type and necessary range of the inspection. One of the methods for the testing and the evaluation of the conductive materials is the eddy current method (ECT).

Eddy current method is contactless electromagnetic method which uses the phenomenon of electromagnetic induction. Eddy current probe induces eddy currents in a conductive material that generate secondary field acting against the primary field of the probe, according to Lenz's law. The interaction of the electromagnetic fields and its influence on the probe impedance produces response signal. [1,2]

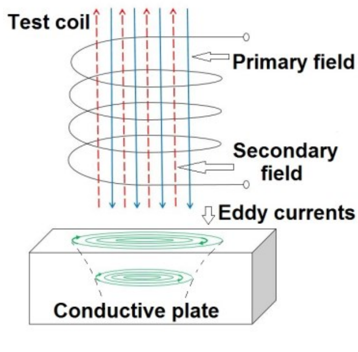

Figure 1: Principle of eddy current method

The disruption of the eddy currents flow by the presence of the defect causes a change in the response signal, since the EC signal dependents on the secondary field influence. Changes in the response signal obtained in this way allows an indication of defects and a detailed examination of the defect allows to evaluate his properties and thus determine its severity. ECT belongs to a differential methods, therefore it is necessary except the response of the material to obtain also reference response typical for the material without defects. The difference of these signals defined by Eq. (1) represents the real response of the eddy current control. [1,3]

$$\Delta B = B_{material} - B_{ref} \tag{1}$$

The reference signal may be obtained in several ways: individual scan of the material without defects, scan of the same material at positions without indications of the defects, using the differential probes, use of signal database, etc.

2 Data Sgmentation and Results

The need of several scans of the material, the use of complex probe or browsing the database can be expensive and time consuming. Another option is to use digital tools. In our work, we use MATLAB environment [4] for processing eddy current response signal using adaptive segmentation.

Methods of adaptive segmentation are based on sliding the movable window over the signal. The signal can be analyzed upon completion of the scan, or some methods of the segmentation allow to analyze signal already during the scan. Online scan analysis enables significant time savings. The user could see the results of the scan in a user-friendly form shortly after completion of the control test. In this article we focus on the evaluation of offline signal in the time domain by using the simple test methods,[5]. As the test material we use stainless steel 316L with the predefined 9 mm deep defect. A control is performed as surface scan and Rohmann absolute pencil probe KA 2-1 is used. The obtained signal response of scan is presented in Figure 2.

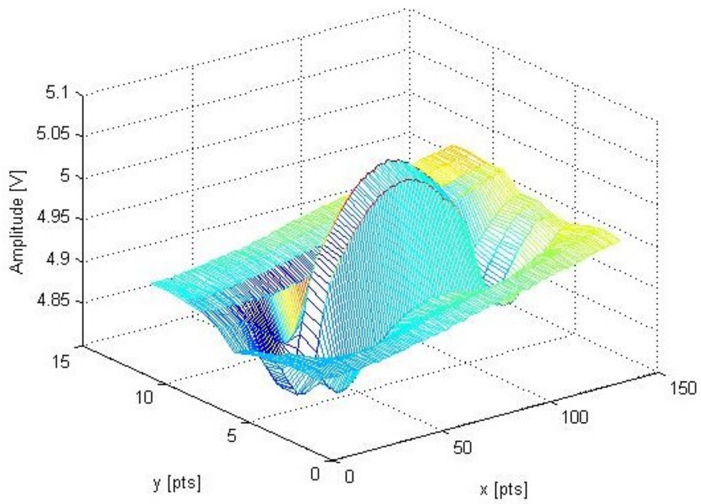

Figure 2: Principle of eddy current method

A simple test method assumes determination of reference value from the first window. After moving window at the second position, the next obtained value is subtracted from reference. The resulting value is compared with a threshold value and a change in the signal is determined. If the change in the signal occurs, the new reference value and margin of tolerance is set. The incoming signal will be compared with these adapted values. The reference value will adapt to incoming signal and detects changes in it until the last window comes.

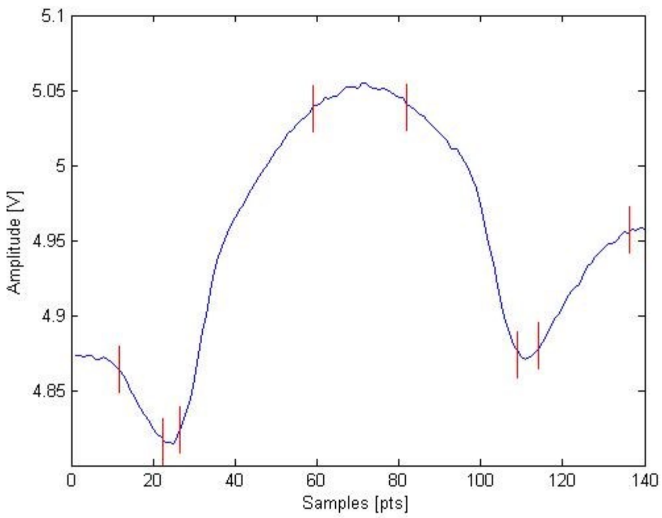

Figure 3: Creating response signal segments

Designated positions in response signal are the margins of unknown segments and represent an indication of defect. Consequently, it is possible to create a color map of the surface with an expected probability of occurrence of the defect. For the control of larger areas are obtained positions of areas on the surface destined for further control.

3 Conclusion

This method for signal segmentation is primarily intended to control large areas where the standard investigation took relative long. The signal processing outputs are designated positions of areas of investigated conductive material with defect indication. These areas are then examined and present defects evaluated. This work focused on the primary defect identification on controlled materials with low time requirements. The next step of the work will be to detect and display defect indications by measuring in real time.

References

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