A Study on Non Destructive Evaluation of Materials Defects by Eddy Current Methods


Abstract—Non-Destructive Techniques are used widely in the metal industry in order to control the quality of materials. Eddy current testing is one of the most extensively used non-destructive techniques for inspecting electrically conductive materials at very high speeds that does not require any contact between the test piece and the sensor. This paper includes an overview of the fundamentals and main variables of eddy current testing. It also describes the determination of coating thickness and identification of materials defects. The experiments were conducted with reference block by eddy current testing, and also found that defects identification on the block, plastic coating thickness was measured. Recent advances in complex models towards solving defects-sensor interaction, developments in instrumentation, and the evolution of data processing suggest that eddy current testing systems will be increasingly used in the future.

Keywords—Defects, Eddy Current, Non-Destructive Testing, Probe.

I. INTRODUCTION

Non-Destructive Testing (NDT) is a wide group of analysis techniques used in science and industry to evaluate the properties of a material, component or system without causing damage [1]. The common NDT methods include ultrasonic, magnetic-particle, liquid penetrant, radiographic, remote visual inspection (RVI), eddy-current testing. Based on particular nature the choosing the right method and techniques is an important thing of the performance of NDT. NDT is a highly-valuable technique that can save both money and time in evaluation of materials, evaluation of product, evolution of products that have been put into services, and research[2]. Coating thickness measurement in metals and inspection of weld scan having limitation with ultrasonic testing, fluorescent dye penetrate testing and magnetic particle testing. Easy and faster way of measurements carried out by Eddy current testing.

The objective of NDT may be simply expressed as the detection and complete specification of defects and flows. The eddy current test was used for internal defect detection and coating thickness measurements.

II. WORKING PRINCIPLE OF EDDY CURRENT TESTING

In eddy current testing, electrical currents (eddy currents) are generated in a conductive material by a changing magnetic field shown in Fig 1. The strength of these eddy currents can be measured [5]. Material defects cause interruptions in the flow of the eddy currents. Interruption of flow alerts the inspector to the presence of a defect or other change in the material.

III. EXPERIMENTAL EQUIPMENTS

GE Phasec3d Eddy current flow detector shown in Fig 2, it has dual frequency inspection capability. It is light weight portable and user friendly. Eddy current flow detector suitable wide range of application like aerospace, automotive, petrochemical, power generation and rail. Its used for, general crack detection, sub surface cracking and corrosion, conductivity measurement, coating thickness measurement. The general specifications of eddy current instrument as shown in Table 1. Different factors will affect the eddy current response. To minimize the effects, need to control the following factors namely material conductivity, permeability, frequency, geometry etc [3]. Practical testing of eddy current will need the following, A suitable probe should select based on application and geometry of the product to be inspected. An instrument equipped with the necessary capabilities like, light weight ,portable ,user friendly, interference with computer large memory and reporting software . Need to find the nature of defects size , location and type of flaws etc.
Important thing in eddy current testing is setup the equipments with suitable test standards. Skilled and expertise technician needed for interpret the results.

### TABLE 1
**GENERAL SPECIFICATION**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
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<tbody>
<tr>
<td>Frequency</td>
<td>10 Hz to 10 MHz</td>
</tr>
<tr>
<td>Probe mode</td>
<td>Absolute, locator, bridge and reflection</td>
</tr>
<tr>
<td>Mix gain</td>
<td>x/y -60 to 60 dB</td>
</tr>
<tr>
<td>Mix phase</td>
<td>0 to 359.9° in 0.1 Step</td>
</tr>
</tbody>
</table>

After setting the all parameters in the instruments [6] like (frequency, probe mode gain, phase etc), Coating thickness is measured by comparing the signal from the reference standards 31A00B shown in Fig 4. Signal from reference standards were individually scanned using the broadband testing probe shown in Table 2. The plastic coated test block shown in Fig 6. Correlated with reference value and signal obtained from test block shows the coating thickness. It’s observed the coating thickness of plastic was 1.541mm.

### TABLE 2
**CALIBRATION STANDARD REFERENCE**

<table>
<thead>
<tr>
<th>Reference Standard with plastic slots(0.5 mm each)</th>
<th>Signal values</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.5 mm</td>
<td>19</td>
</tr>
<tr>
<td>1.0 mm</td>
<td>32</td>
</tr>
<tr>
<td>1.5 mm</td>
<td>38</td>
</tr>
<tr>
<td>2.0 mm</td>
<td>44</td>
</tr>
</tbody>
</table>

Fig. 5 and Fig 7 show typical screenshots taken from the inspection system screen of reference standard and coated plastic respectively.
B. Flaw detection

After setting all the parameters in the instruments like (frequency, probe mode gain, phase etc), Calibrate the equipment using a test block of similar materials to that under examination. Record the signal obtained from the calibration block. The weld scan probe has placed the parent material scanned fully shown in Fig 9 and also founded the horizontal flaw detected by eddy current testing and liquid penetrate testing (LP) shown in Fig 10, and Fig 11 respectively.

V. CONCLUSION

The expected goals for this research were studied. Non-destructive evaluation of materials defects has been found by eddy current testing. Adequate signal values were successfully obtained calibration reference standards. Coating thickness of plastic was measured 1.541 mm and materials defects were found by both eddy current testing and liquid penetration testing. The operating performance of the inspecting system was demonstrated for laboratory conditions.

Acknowledgment

This work is being conducted at the Al Musanna College of Technology, Sultanate of Oman.

REFERENCES


P. Sivaprakasam was born in Tieuvannamalai, Tamil Nadu, India, on May 5th in 1983. Earned a Bachelor degree, Industrial Engineering at Anna University, Chennai, India (2005) then earned his Masters Computer Integrated Manufacturing engineering from Anna University in 2008. He worked at Regency International clothing Pvt Ltd as an Industrial Engineer from 2005 to 2006. Then lecturer in Tagore Engineering College in Chennai from 2008 to 2010. At present working as Faculty in Al Musanna college of Technology in Oman.