

Review

Giant Magnetoresistance Sensors: A Review on Structures and Non-Destructive Eddy Current Testing Applications

Damhuji Rifai ^{1,2,*}, Ahmed N. Abdalla ^{1,†}, Kharudin Ali ^{2,†} and Ramdan Razali ^{1,†}

¹ Faculty of Engineering Technology, Universiti Malaysia Pahang, Gambang, Pahang 26300, Malaysia; ahmed@ump.edu.my (A.N.A.); ramdan@ump.edu.my (R.R.)

² Faculty of Electrical & Automation Engineering Technology, TATI University College, Kemaman 26000, Terengganu, Malaysia; kharudin@tatiuc.edu.my

* Correspondence: damhuji@tatiuc.edu.my; Tel.: +60-98-601-000

† These authors contributed equally to this work.

Academic Editors: Subhas Mukhopadhyay and Chinthaka Pasan Gooneratne

Received: 10 January 2016; Accepted: 18 February 2016; Published: 26 February 2016

Abstract: Non-destructive eddy current testing (ECT) is widely used to examine structural defects in ferromagnetic pipe in the oil and gas industry. Implementation of giant magnetoresistance (GMR) sensors as magnetic field sensors to detect the changes of magnetic field continuity have increased the sensitivity of eddy current techniques in detecting the material defect profile. However, not many researchers have described in detail the structure and issues of GMR sensors and their application in eddy current techniques for nondestructive testing. This paper will describe the implementation of GMR sensors in non-destructive testing eddy current testing. The first part of this paper will describe the structure and principles of GMR sensors. The second part outlines the principles and types of eddy current testing probe that have been studied and developed by previous researchers. The influence of various parameters on the GMR measurement and a factor affecting in eddy current testing will be described in detail in the third part of this paper. Finally, this paper will discuss the limitations of coil probe and compensation techniques that researchers have applied in eddy current testing probes. A comprehensive review of previous studies on the application of GMR sensors in non-destructive eddy current testing also be given at the end of this paper.

Keywords: giant magnetoresistance; eddy current testing; non-destructive testing

1. Introduction

Non-destructive testing (NDT) is a quality control tool that is extremely important in heavy engineering sectors such as the petroleum and gas industry. It is the last test before a component, system or process are deemed safe to run. In the petroleum industry, non-destructive testing is widely used in detecting defects in the storage tanks and pipes that deliver oil and gas. Failure to detect and provide accurate information about the status of quality components, systems or processes may result in an accident that ends with the destruction of property and loss of life. Table 1 shows an overview of the major nondestructive testing techniques that are widely used in the oil and gas industry. With of the existing conventional NDT it is impossible to conduct inspections through the hundreds kilometers of a pipeline system used in the oil and gas industry. Thus, a simple and quick method to inspect the defects in large pipe systems is necessary.

Eddy current testing (ECT) techniques are a non-destructive evaluation method for defect inspection on conductive material. The main advantages of ECT are that a diversity of inspections can be done using this technique, including surface and subsurface material defect inspections,