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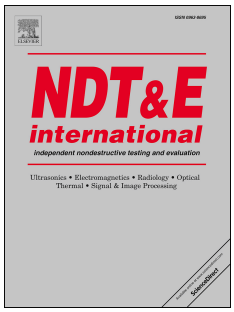


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# Multiple Type Defect Detection in Pipe by Helmholtz Electromagnetic Array Probe

Jiuhao Ge; Wei Li[1]; Guoming Chen; Xiaokang Yin; Xinan Yuan; Weichao Yang; Jian Liu; Yuxi Chen;
(Centre for Offshore Engineering and Safety Technology, China University of Petroleum, Qingdao, China)

**Abstract:** Non-destructive testing plays a key role in the detection of pipe. In this paper, a Helmholtz electromagnetic array probe, with the advantages of multiple type defect detection, quantification, non-contacting and good applicability on ferromagnetic pipe, is presented. A designed structure, containing a high precision tunnel magneto-resistive (TMR) array sensor, is used to scan the full circumference of pipe in a single pass. In the experiments, multiple types of detects, e.g. hole, axial crack and circumferential crack are detected through the probe. The profile of the defects can be inferred approximately. Moreover, the pipe of different radius are inspected showing that the radius of pipe has little effect on the detection sensitivity if the Helmholtz Probe proposed in this paper is used.

**Keywords:** Helmholtz coil; Array Probe; Multiple Type Defect Detection; Pipe; Electromagnetic method;

## 1 introduction

Ferromagnetic pipe such as oil well tubing, drill pipes and risers *et al*. are widely used in the oil industry [1]. Subjected to variable loads and complex environment, pipe frequently suffers from stress corrosion crack, fatigue crack, corrosion and deformation, all of which will give rise to catastrophic accident [2]. Pipe can be inspected, using Magnetic Flux Leakage (MFL), Ultrasound Test (UT), Magnetic Particle Inspection (MPI) and Eddy Current (EC) methods [3-4]. The MFL technique has been proved to be an effective way to detect cracks on pipe through in-line inspections. However, the inspected pipe have to achieve complete magnetic saturation condition and the direction of magnetization should be varied depending on the types of metal loss [5-7]. Alternating

Flux Leakage testing was proposed to achieve fast detection [7-8]. However, the detection of axial narrow and long defects is still restricted [9]. The MPI technique is also a preferred technique for crack detection historically. However, due to its requirement for the surface cleaning before the inspection, its field use is costly when one considers the standby time of other trades when the MPI inspection and documentation is in progress [2].

In the case of UT, liquid couplant is usually needed between the device and the pipe surface through the traditional UT devices [3,10-12]. Moreover, manual operation requires careful attention by experienced technicians and it is difficult to locate the position and invert the sizes of defects [11-12]. In recent years, Electromagnetic Acoustic Transducer (EMAT) is becoming increasingly popular due to its non-contact nature [13-14]. Generating ultrasonic waves directly into the testing piece instead of coupling through the transducer, EMAT can be applied where surface contact is not possible or desirable [15-16]. However, EMAT transducers typically produce raw signals of lower power than piezoelectric transducers. As a result, more sophisticated signal processing techniques are needed to isolate signals from noise [17]. Guided Wave Testing (GWT) employs the ultrasonic guided by the inspected structure and offers the possibility of rapid screening over long lengths of the pipelines for the detection of corrosion and other defect [18-19]. Thus, it has attracted much attention in pipelines corrosion monitoring during the past few decades

[1] Corresponding author: Wei Li
Email: ronald8044@163.com, Address: No.66 Changjiang road, Huangdao, Qingdao, China