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EDDY CURRENT APPROACH FOR METALLURGICALLY CLAD PIPE INSPECTION

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ABSTRACT

Orthogonal eddy current sensors operating in differential mode was applied to evaluate fatigue cracks in clad pipelines circumferential weld. A dedicated electronic hardware was developed to drive the sensors and measure the electrical impedance. In the preliminary experiments, an automated inspection was performed with the goal to evaluate sensors detectability and different scanning speed was tested to reproduce in service situation. The results have shown that the presented eddy current transducer is a potential solution for a fatigue crack detection on a clad circumferential weld bead.

Keywords: clad material, Eddy current testing, fatigue crack.

INTRODUCTION

The application of cladding material to subsea pipelines has been gaining ground in deep water oil exploration. Its bimetallic configuration presents an attractive combination of mechanical strength and corrosion resistance, ensuring the safety and integrity of pipelines that connect the reservoir to oil rig. The clad material for oil exploration consists of a base material, usually carbon steel, inner coated with a thin layer of corrosion resistance alloy (CRA), turning into an attractive economical solution for deep water exploration since only a small portion of the noble anti-corrosive alloy is required.

The potential for fatigue cracks to occur in pipeline structures due to cycling loads inherent of offshore oil production, such as, tide variation, waves, etc., makes necessary have an inspection tool to carry out periodic NDT. In case of clad material, it is crucial to detect fatigue crack on its initial stage because if the crack propagates through the layer of the CRA and reaches the carbon steel a strong galvanic couple is completed accelerating exponentially the fatigue corrosion process. The most critical point of pipeline structures is the circumferential weld and demands special attention during inspection. Figure 1 presents a section of clad pipeline with a base material of carbon steel API X65 coated with Inconel 625 and highlighted the inspection region with the crack position.

This scenario, detection of fatigue crack in Inconel, encouraged the development of an eddy current (EC) system with the goal to inner inspection of clad pipelines. The main challenges are the circumferential weld geometry and the fact that the tool must operate in a speed around one meter per second. The orthogonal eddy current transducer was applied to detect the crack in the weld bead root. An electronic hardware was built to drive the transducer and evaluate the testing coils electrical impedance by the means of Goertzel algorithm [1].

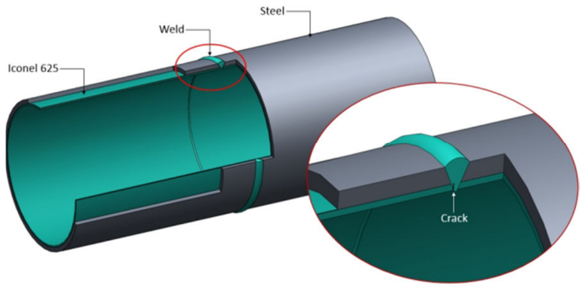
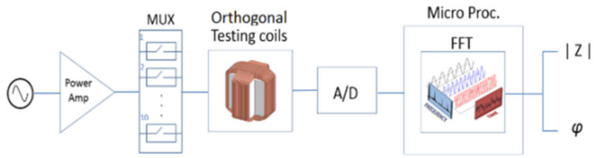


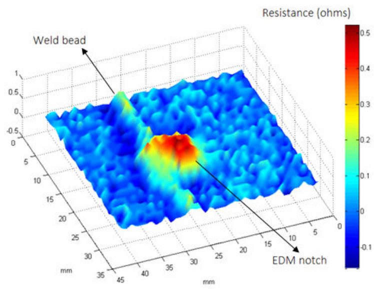
Fig. 1 - Clad pipe with the inspection region highlighted.

Figure 2 presents the block scheme of the measuring system, the automated tests with EC array on a clad pipe sample and the inspection results with the notch besides the weld bead. One can observe that the defect indication was clearly separated with a SNR of 14 dB.



(a)

(b)



(c)

Fig. 2 - (a) Block scheme of the electronic hardware; (b) automated inspection of a clad sample; (c) inspection result of the clad sample with the circumferential weld bead.

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