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Identification and Characterisation of Steel Corrosion using Passive High Frequency RFID Sensors

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Abstract — High frequency RFID sensors are attractive in diverse applications where sensor performance is required at a low cost and dimension restriction. An approach adapting commercial passive 13.56MHz RFID tags has been developed for sensing corrosion stage. This investigation includes balance of sensing and positioning of RFID sensors for corrosion detection by analysing real and imaginary parts of the complex impedance. With passive HF RFID sensors, real part and imaginary part of complex impedance have been extracted from the reader coil with VNA (vector network analyser) and delivering a unique capability for corrosion sensing with different atmospheric exposure time steel samples (1 month, 6 months, 10 months and 12 months). With different positioning (5mm to 25mm), features extraction based on the complex impedance with PCA (principal component analysis) has been designed for position-independent corrosion evaluation.

Keywords— Steel corrosion; Passive RFID; High frequency; Complex impedance; PCA.

I. INTRODUCTION

Steel corrosion is a serious problem facing engineers today as they maintain aging infrastructures [1]. Potentially, it is a very big market for those who develop the expertise to deal with corrosion detection [2]. The direct cost of corrosion in countries throughout the world is expected to be between 3% and 4% of the GDP (Gross Domestic Product) of each country [3]. Furthermore, corrosion detection is one of the foremost issues of corrosion control and prevention. A number of electrochemical test methods are available to measure corrosion in corrosive environments [4].

The simplest corrosion test is measurement of the mass loss. Variation of atmospheric corrosion over time (known as corrosion stage) can be characterized as a power function based on mass loss tests [5]. However, in practice the process time of these tests is expected to be very long. Therefore, it is not feasible for real-time measurement [6]. Furthermore, several electromagnetic Non-destructive test and evaluation (NDT&E) methods have been used to investigate characteristic changes for corrosion detection and monitoring [7]. These methods, including acoustic emission (AE) technique which based on the rapid release of energy within a material generating a transient elastic wave propagation, are employed for

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