Recent Development On Corrosion Sensor Based On Electromechnical Impedance Instrumented Piezoelectric-Metal Transducer

Weijie LI, Zhishun LIU, Xuefeng ZHAO

Corrosion of steel leads to the thickness loss of steel structures, which is responsible for most of the structural failures across multiple industries, especially the oil and gas pipeline industry. In our previous research, a novel corrosion sensor, consists of a metal plate bonded with a lead-zirconate-titanate (PZT) patch, was proposed based on the electromechanical impedance (EMI) instrumented piezoelectric-metal transducer. The corrosion sensing principle of the sensor is that under the EMI harmonic excitation, the PZT patch contracts and extends, inducing bending vibration of the piezoelectric-metal transducer. Thickness loss of the metal plate reduces the bending rigidity as well as bending resonant frequencies. Our previous work has showed that the peak frequency in the conductance signatures is linearly proportion to the thickness loss of the metal plate. In this paper, the response characteristics and performance of this corrosion sensor were investigated using finite element method and experimental investigation. Parametric analysis of the effects of structural dimensions, materials properties on the performance of the sensor were performed numerically and validated by experiments. To eliminate the influence of external loading or disturbance, a special outer casing was designed and the effects of waterproofing filling materials were investigated. The results presented in this paper serve as a valuable guideline for practical application of the proposed corrosion sensor.