

Development of an Electromagnetic Imaging System for Well Bore Integrity Inspection

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State-of-the-art imaging technologies for monitoring the integrity of oil and gas well bores are typically limited to inspection of metal casings and cement bond interfaces close to the first casing region. The objective of this study is to develop a novel well-integrity inspection system that is capable of providing enhanced information about the flaw structure and topology of hydrocarbon producing well bores. In order to achieve this, we propose the development of a multi-element electromagnetic (EM) inspection tool that can provide information about material loss in the first and second casing structure as well as information about eccentricity between multiple casing strings. Furthermore, the information gathered from the EM inspection tool will be combined with other imaging modalities (e.g. data from an x-ray backscatter imaging device). The independently acquired data are then fused to achieve enhanced accuracy compared to the sum of individual acquired data.

A test rig composed of several concentric pipes was assembled and various defect structures in the metal casings were imaged. Initial test results were obtained with a scanning system that includes a transmitting coil and several receiving coils that are mounted on a single rod. A mechanical linear translation stage was used to move the EM sensors in the axial direction during data acquisition. For simplicity, a single sensor and repetitive scans were employed to simulate performance of a sensor array system. The resulting electromagnetic images enable the detection of metal defects that previously have been introduced into the steel pipes. Responses from several sensors were used to assess position and amount of material loss in the first and second metal pipe as well as magnitude of eccentricities between the two pipes. The results from EM measurements and x-ray backscatter simulations demonstrate that data fusion from several sensing modalities can provide an enhanced assessment of flaw structures in producing well bores and potentially allow for early detection of anomalies that if undetected might lead to catastrophic failures.