Efficient evaluation of inside local-defect in pipeline with thick coating based on novel electromagnetic nondestructive testing technique

Siwei Fan[1], Jizhou Zhang[1], Shejuan Xie[1]

[1]School of Aerospace Engineering, Xi'an Jiaotong University, China

Effective evaluation of local defects inside pipelines with a thick coating is extremely challenging due to the supremely thick coating, small volume-ratio of local defects, and long distance of far-side detection manner. Although traditional electromagnetic nondestructive testing(NDT) techniques, like pulsed eddy current testing, have been investigated, the low signal-to-noise ratio of these techniques presents limited performance in the case of thick coating. Therefore, this study aims to improve the detection capacity of the transient electromagnetic NDT technique from the aspects of the excitation principle, sensor optimization, and signal processing. First, an adaptive spectrum-selection strategy is proposed to focus the electromagnetic energy in a desired range which may contain defects. A set of frequencies of eddy current can be calculated based on the skin depth. Then, the excitation signal is generated according to the inverse Fourier transformation of these eddy current excitation signals with various frequencies. Second, a novel focusing sensor is designed for the transient electromagnetic NDT technique, which comprises of electrical shielding structure, a magnetic shielding structure and detecting coils. This novel focusing sensor can significantly improve the detection capability of small volume-ratio defects. Subsequently, a hybrid signal processing method consisting of an adaptive denoising method and an efficient feature extraction method is proposed, which can effectively improve the signal-to-noise ratio of the acquired electromagnetic signal. Finally, transient electromagnetic NDT is validated experimentally, which presents a promising performance in the detection of local defects inside pipelines with a thick coating.