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An extraction method of welding crack acoustic emission signal using harmonic analysis

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ABSTRACT

The actual collected welding crack acoustic emission (AE) signal has the characteristics of multi-sources coexistence and weak feature. An extraction method using harmonic analysis is proposed for separation of welding crack AE signal from the multi-sources ones. The collected AE signal from welding process is synthesized to be the high order reconstruction matrix, the valid harmonic layers are obtained by Singular Value Decomposition (SVD) that decompose and judge the reconstruction matrix. The Fast Fourier Transform (FFT) is adopted to extract the valid harmonic of signal, of which the welding crack AE signals are recombined. Combined with the welding AE signal test experiment, the proposed extraction method is applied to separate the crack AE signal in the welding heating and cooling process respectively. The results indicate that the proposed method can effectively achieve separation and extraction of the welding crack AE signal, which provides a method for the structure crack detection in the welding process.

Keywords: Welding crack AE signal; harmonic analysis; extraction; SVD; FFT

1 Introduction

Acoustic emission (AE) testing technology is a valid method for the structure crack detection in welding process. AE signal is the elastic wave released by the energy within the material, which can characterize the physical phenomena essence of the welding crack generation and expansion [1-3]. The actual collected welding crack AE signal has the characteristics of multi-sources coexistence and weak feature due to the interference of the friction from specimen connection with fixture and the arc shock [4-7]. In order to achieve AE detection of the structure crack in the welding process, it is necessary to extract the welding structure crack AE signal from the multi-sources ones efficiently. Therefore, it is key to achieve AE detection of the welding structure crack by conducting the separation and extraction of the structure crack AE signal from the multi-sources

ones, which provides the theory and method for the structure crack detection in the welding process.

The existing extraction methods of signal mainly include wavelet analysis theory, Empirical Mode Decomposition (EMD), Local Mean Decomposition (LMD), etc [8-11], which can achieve the signal components extraction from high frequency to low frequency. The valid signal can be restructured from the valid signal components. Zhang Xiaofeng et al [12] applied the wavelet analysis to extract the fault diagnostic signals specific frequency band. Kuanfang He et al [13] studied AE signal feature extraction in rotor crack fault diagnosis using the wavelet transform and EMD. Xuejun Li et al [14] presented a method combining lifting wavelet with EMD to solve the problem of difficult to extract fault features from the early weak AE signal. Kuanfang He et al [15] studied feature extraction for estimation of welding arc energy characteristics related to the

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