Simulation and experimental study of magnetic anomalies of defects in high-energy beam electron welds

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Abstract

In view of the current situation in which the existing nondestructive testing (NDT) technology can hardly meet the demand of aluminum alloy electron beam weld defect detection, a weak magnetic NDT technology for aluminum alloy electron beam weld defects based on the geomagnetic field is proposed. Using the finite element analysis method, a simulation model of cracked aluminum alloy electron beam weld defects is established, the distribution characteristics of the magnetic field of cracked weld defects are determined, and the relationship between the defect size and the number of magnetic anomaly characteristics is analyzed. On this basis, a weak magnetic detection test was conducted on cracked aluminum alloy electron beam welds. First, the magnetic anomaly signal at the cracked weld was accurately extracted from the complex original magnetic induction intensity signal by using wavelet transform, and second, the least squares method was used to fit the curve to the crack depth h and the magnetic anomaly amplitude [?]B at the crack. The test results show that the magnetic induction intensity signal at the crack has obvious characteristics, and the wavelet transform can effectively extract and judge the weld crack signal from the weak magnetic detection signal and improve the defect identification rate. The crack amplitude [?]B is approximately positively correlated with the depth h in a certain range, consistent with the simulation analysis results. The feasibility of weak magnetic detection of cracks in aluminum alloy electron beam welds is verified by simulation and experimental analysis.

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