Research and Application of Acoustic Emission Condition Monitoring and Fault Diagnosis Technology for Low-Speed Heavy-Load Rolling Bearings

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Low speed heavy-duty rolling bearings have been widely used in amusement facilities and passenger ropeways. As an important load-bearing component, their failure can cause accidents and casualties. Due to their difficult disassembly, there is an urgent need to develop an effective operation condition monitoring and fault diagnosis technology to ensure the safe operation of the equipment. Acoustic emission technology not only meets this requirement, but also has the potential to predict early faults. Therefore, the acoustic emission source characteristics of low-speed rolling bearings in different operating states (normal and faulty) were studied, and diagnostic methods for different faults were proposed. This study first conducted long-term acoustic emission monitoring on a new defect free rolling bearing operating at low speeds. The statistical parameter changes and typical periodic signal characteristics of the acoustic emission signals were analyzed. It was found that the operation of the bearing went through three stages from running in to stable operation, accompanied by the appearance and disappearance of RMS peak signals. The signal characteristics of the stable stage reflected the acoustic emission source characteristics of the defect free bearing. Secondly, acoustic emission tests were conducted on rolling element faults and inner ring faults separately, and the parameters and spectral characteristics of the obtained signals were analyzed. It was found that bearing faults significantly increased high-frequency signals, and their RMS history maps had peak characteristics, with different peak intervals between the two types of faults. Thirdly, by observing the statistical parameter changes in acoustic emission signals of bearings without defects, rolling element faults, and inner ring faults, effective feature parameters (RMS) for identifying faults were extracted. The distribution range and fluctuation amplitude of feature parameters were analyzed for bearings without defects and faults, and a diagnostic method for bearing faults was proposed. Finally, multiple large-scale amusement facilities and passenger ropeways were subjected to on-site acoustic emission testing and monitoring applications multiple times to diagnose the health status of the bearings.