Residual Fatigue Life Prediction of Ball Bearings Based on Paris law and RMS

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Abstract: Paris law can reflect the failure mechanism of materials and is usually used to be a method to predict fatigue life or residual fatigue life. But the variable which can represent the health of machine is hardly measured on line. To a degree, the difficulty of on-line application restricts the scope of application of Paris law. The relationship between characteristic values of vibration signals and the variable in the Paris equation which can describe the health of machine is investigated by taking ball bearings as investigative objects. Based on 6205 deep groove ball bearings as a living example, historical lives and vibration signals are analyzed. The feasibility of describing that variable in the Paris equation by the characteristic value of vibration signals is inspected. After that vibration signals decomposed by empirical mode decomposition(EMD), root mean square(RMS) of intrinsic mode function(IMF) involving fault characteristic frequency has a consistent trend with the diameter of flaws. Based on the trend, two improved Paris models are proposed and the scope of application of them is inspected. These two Paris Models are validated by fatigue residual life data from tests of rolling element bearings and vibration signals monitored in the process of operation of rolling element bearings. It shows that the first improved Paris Model is simple and plain and it can be easily applied in actual conditions. The trend of the fatigue residual life predicted by the second improved Paris Model is close to the actual conditions and the result of the prediction is slightly greater than the truth. In conclusion, after the appearance of detectable faults, these improved models based on RMS can predict residual fatigue life on line and a new approach to predict residual fatigue life of ball bearings on line without disturbing the machine running is provided.

Key words: residual fatigue life, Paris law, prediction model, intrinsic mode function(IMF), root mean square(RMS)

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