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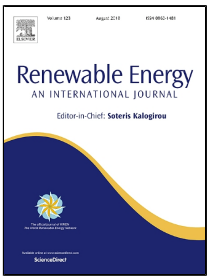

A prediction method for the real-time remaining useful life of wind turbine bearings based on the Wiener process

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A prediction method for the real-time remaining useful life of wind turbine bearings based on the Wiener process

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Abstract **—** A performance degradation model and a real-time remaining useful life (RUL) prediction method are proposed on the basis of temperature characteristic parameters to determine the RUL of wind turbine bearings. First, using the moving average method, the relative temperature data of wind turbine bearings are smoothed, and the temperature trend data are obtained on the basis of the uncertainty of wind speed and wind direction that causes the temperature of wind turbine bearings to vary widely. Second, given that the degradation speed of bearings changes with operational time and uncertain external factors, the performance degradation model is established with the Wiener process. The parameters of this model are obtained through the maximum likelihood estimation method. Third, according to the failure principle of the first temperature monitoring value beyond the first warning threshold, the RUL prediction model for wind turbine bearings is established on the basis of an inverse Gaussian distribution. Finally, the performance degradation process and real-time RUL prediction are demonstrated by predicting the RUL of a practical rear bearing of a wind turbine generator. The comparison of the predicted RUL and actual RUL shows that the proposed model and prediction method are correct and effective.

Keywords: Wind turbine bearings, performance degradation, Wiener process, RUL prediction

1 Introduction

At present, the premature failure rates, restoration times, and operation and maintenance (O&M) costs of wind power are higher than desirable[1]. The operational unavailability of wind turbines reaches 3% of wind turbine lifetime. The O&M costs can account for 10%–20% of the total energy cost for a wind turbine project, and this percentage can reach 35% for a wind turbine at the end of its lifetime [2]. Wind turbines are unmanned remote power plants. Unlike conventional power stations, wind turbines are exposed to highly variable and harsh weather conditions, including calm to severe winds, tropical heat, lightning, arctic cold, hail, and snow. Wind turbines undergo constantly changing loads because of these external