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CONDITION MONITORING OF A WIND TURBINE DOUBLY-FED INDUCTION GENERATOR

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This paper presents the results of work to analyse the power output of a wind turbine generator to detect eccentricities in the rotor/stator electrical field resulting from generator shaft misalignment. The power output has been analysed using a wavelet and the magnitude of the wavelet component at twice slip frequency tracked in time. This magnitude is shown to increase significantly during periods of field eccentricity as verified under controlled conditions in a lab test. The technique was then applied to two operational turbines and showed positive indications of shaft misalignment or bearing distress which were subsequently confirmed by maintenance.

With the move to offshore, the requirement for predictive and proactive maintenance of wind turbines has become ever more important. Misalignment of the generator drive shaft which may result in generator bearing failure is known to be one of the more frequent sources of failure in wind turbines and is a candidate for condition monitoring. Proximity sensors and vibration monitoring equipment can be used to detect bearing and shaft problems, but this type of equipment is expensive and may itself be prone to failure. In addition, installation of such equipment may require drilling and tapping of components within the drive train which could cause warranty or mechanical integrity problems. A simpler non-intrusive approach is to monitor the power output of the generator itself. This does not require any further equipment, merely, the averaging of data at a higher frequency than the SCADA standard of ten minutes. This paper presents the results of research using wavelets to analyse the power output of a doubly-fed induction generator sampled at 60Hz. In particular, the magnitude of the twice slip frequency component (2sf) is tracked in time as an indicator of eccentricity in the rotor/stator electromagnetic field which may indicate shaft misalignment and/or bearing wear. The technique was validated on a scale test rig under controlled conditions and its use was then demonstrated on two operational wind turbines of 1.5-2 MW in size. The results showed that shaft misalignment, which in one case resulted in bearing failure, were detectable up to two months in advance of the failure occurring. The results of the measurements were confirmed by subsequent maintenance action. The methodology described could easily be incorporated into a new or existing condition monitoring package for a wind turbine.