White etching crack (WEC) detection using electrostatic sensing techniques

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White etching crack (WEC) as a bearing failure mode has been investigated intensively over decades. While its drivers and formation mechanisms are still being contested, this study focuses on the detection of WECs using electrostatic sensing techniques, which have already shown to be effective for bearing monitoring. A range of tests has been conducted on a twin-roller machine while the oil lubricated contacts are subject to electrification and electrostatic sensors are used to monitor the rollers. The results have shown that the electrostatic sensors can detect charging-discharging events occurring at the roller contacts that are related to white etching cracking.

Keywords (from 3 to 5 max): White etching crack, bearing failure, electrification, electrostatic sensing, condition monitoring

1. Introduction

According to a survey on wind turbine gearbox reliability published in September 2015, about 76% of wind turbine gearbox failures are due to their bearing failures.[1] While the bearings have 20+ years of design life, the axial cracking of their inner ring due to white etching crack (WEC) is found to often shorten their life to 1 to 2 years.[2] While increasing efforts are made on elucidating the drivers and formation mechanisms of WECs, this study focuses on the detection of WECs using a novel sensing technique based on electrostatic charge sensors.

2. Methods

Oil lubricated rolling contact fatigue tests have been conducted on a TE74 Twin-roller machine under 2.5 GPa and a range of speed and oil temperature conditions, while electrostatic (ES) sensors are used to monitor the charges on the rollers. A DC voltage of 10 Volt is supplied to the contact to promote WEC formation. The voltage across the roller contact as well as the electric current through the contact are also monitored for comparison with the ES sensor outputs.

The rollers are made from through hardened AISI52100 bearing steel subjected to standard heat treatment procedure. A WEC critical lubricant is used during the testing. Roller surface roughness is changed to vary the lubrication regime and investigate the influence of lambda on WEC formation and its detection by ES sensors. Both ES and voltage signals are collected at 5 MHz rate to capture high frequency charge and voltage signals related to charging and discharging events occurring on the rollers and at the roller contact.

3. Results and Discussions

WECs have been found to form in the rollers when the contacts are under boundary/mixed lubrication conditions (see image shown in Fig. 1), which has been related to charging-discharging activities detected by the ES sensors for the WEC failed (Fig.2 upper) and non-failure tests (Fig. 2 lower).

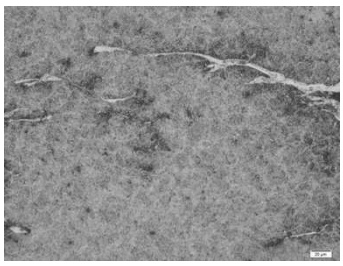

Fig.1. Subsurface optical image showing WECs created in a one of the TE74 rollers.

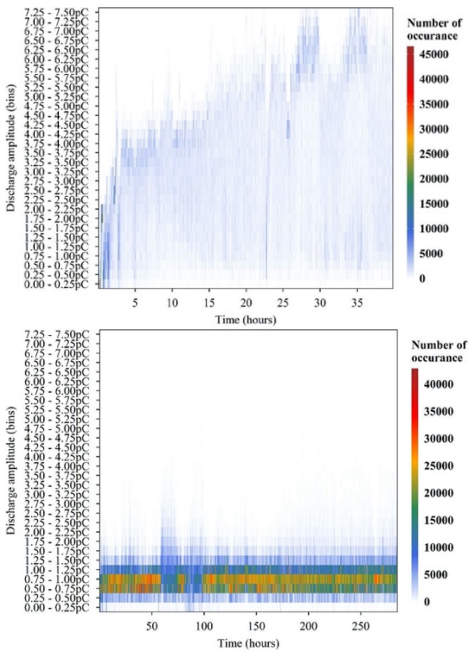

Fig.2. Charges detected by ES for a WEC failed test (upper) and non-failure test (lower).

4. References

[1] Office of Energy Efficiency & Renewable Energy (2015)

[2] Sharpley, N. (2014) Windpower Engineering & Development