Experimental study on fretting wear of 42CrMo4 steel under wind turbine pitch bearing operating conditions

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Fretting wear and false Brinelling are two wear damages frequently occurring in wind turbine pitch bearings due to their unique operating conditions of small amplitude oscillations. Even though these damage modes have been widely investigated, typical experimental set-ups are far from an accurate representation of the actual contact condition that balls and raceways experience in pitch bearings, in which more than one fretting mode can occur simultaneously. For this reason, typical tangential fretting tests with a ball-on-flat configuration cannot represent the fretting behaviour in this application.

In this work, fretting wear damage in a bearing steel sample is studied using a downscaled ball-on-flat configuration, in which the ball is allowed to slide and rotate simultaneously, representing the two main fretting modes existing in pitch bearings. The study consists of testing the main parameters affecting fretting wear within an equivalent range of operating conditions of a full-size bearing. The studied parameters include oscillation amplitude, contact force, oscillation frequency and lubrication. The effect of these parameters on the coefficient of friction and wear damage evolution is investigated by employing an energy approach.

The results show that the variation of coefficient of friction with the studied parameters is not significant, and the contact surfaces are under gross sliding or reciprocating sliding. Grease lubrication reduces the coefficient of friction by 10% on average and makes fretting loops more stable. However, the application of grease lubrication can speed up the abrasion due to the debris trapped in the thickener leading to an increased wear damage, whereas in the unlubricated contact, debris can be ejected. Finally, the volume and local energy wear coefficient are derived from the tests under unlubricated and grease-lubricated contacts. These findings contribute to the development of a better understating of fretting wear in a more complex application such as pitch bearings and can be used to validate wear prediction models or support the development of large-scale tests.

Keywords: Fretting wear, Friction, Bearing steel, Grease lubrication, Wear energy approach.

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