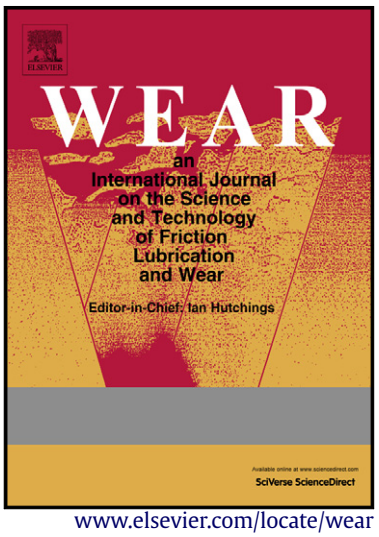

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Ionic liquids as an additive in fully formulated wind turbine gearbox oils

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Abstract

This work presents the friction and wear behaviour of two fully formulated (polyalphaolefin- and mineral-based) wind turbine gearbox oils separately additivated with two ionic liquids ([Choline][NTf_2] and [BMP][NTf_2]) at 5 wt% concentration. A tribometer using a ball-on-plate reciprocating configuration is adopted for friction and wear experiments. Friction is measured during tests and the worn surface is measured and analysed by confocal microscopy, SEM, EDS and XPS. The friction and wear results show that both ionic liquids used as an additive have a slight friction modifier character but a strong wear reducing performance, with [BMP][NTf_2] performing better than [Choline][NTf_2]. In addition, EDS and XPS analysis demonstrated the temperature-related chemical interactions and their influence on tribological behaviour.

Keywords: ionic liquids, additives, lubrication, wind turbines gearbox, friction, wear.

1. Introduction

Wind energy is an important and strategic subject because of its relation with reduction of CO_2 emissions and climate change; and wind turbines are broadly used in renewable electricity generation. The low rotating speed of the main shaft within a wind turbine requires the use of a turbine gearbox (multiple stages gear train) in order to multiply the speed of the secondary shaft until the correct angular velocity values used for the generator are reached [1]. The gearbox, more than any other component in a wind turbine, has the higher repair costs and greater downtimes because of failures. This fact has led to the manufacturing of direct drive wind turbines, but the comparison in terms of reliability between this new type and the geared drive still requires consideration. One of the most important problems of wind turbines is the fact that the optimum viscosity and anti-scuffing properties of oils are reached at temperatures above 80ºC. At temperatures lower than 60ºC, the anti-scuffing protection diminishes resulting in higher wear. On the other hand, above 80ºC is difficult to maintain an effective lubricant film and that is why the utilization of synthetic oil in this situation is employed [2]. Friction between meshing teeth is the highest source of energy loss in the gearbox. However, the rolling bearing friction represents