Traction, Stribeck and scuffing characteristics of lubricants in rolling-sliding contacts using twin disc

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Rolling sliding contacts are integral to bearings, power transmission systems, rail-wheel interface and rolling mills are typically subjected to high contact pressures (1.5 to 4 GPa) and slip ratios (0 to 100%). Traction, Stribeck and scuffing characteristics of lubricants, governed by the base oil and additive chemistry respectively, directly affect the efficiency and durability of the machine elements. In this work, twin disc roller on roller with geometry representative of a line contact was used to measure the traction and scuffing performance of a commercial 20W50 oil. The tests were conducted at either room temperature or 100 °C using a heated lubricant recirculation system. Both friction at the contact and the vibration were measured during the test. For the traction test, the load was kept constant (1 to 2 GPa contact pressure) and the % slip varied between 0 and 40%. A peak in the coefficient of friction was observed with % slip indicating the limiting shear stress under EHD conditions. The lubricant temperature also increased at higher % slip denoting the influence of thermal effects due to EHD shearing. Stribeck tests were conducted with decreasing entrainment velocity at constant load. A transition from EHD to boundary lubrication was observed with the friction coefficient increasing from 0.05 to 0.15 representative of non-conformal contacts. During scuffing tests, two different motions were used (a) co-rotation with a finite lubricant entrainment velocity (b) counter-rotation with near zero lubricant entrainment velocity. The load was increased in steps till either a sharp increase in friction (COF > 0.2) and/or vibration were observed. Under co-rotation the coefficient of friction was constant upto loads of 5kN (~2.3 GPa peak contact pressure). With counter-rotation however, there was simultaneous increase in friction coefficient and vibration at ~ 3 kN (1.8 GP contact pressure) indicating scuffing. Microscopy of the disc surfaces post-test indicated severe material transfer and surface damage. Such test methods using twin disc can effectively and quickly screen different base oil and additive chemistries in a repeatable manner and enable development of lubricants for electric vehicles and high-speed railways.

Keywords: Scuffing, Traction, Vibration, % Slip, Line Contact, Entrainment Velocity

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