EFFICACY OF COATINGS AND THERMOCHEMICAL TREATMENTS TO IMPROVE WEAR RESISTANCE OF AXIAL PISTON PUMPS

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Tribological performance evaluation and rating
Stainless steel; coating; nitriding; wear; axial piston pump;

ABSTRACT
A former study focused on wear mechanisms in helicopter axial piston pumps. It showed that the origin of wear in this system is the contact between piston shoes and swashplate, where the main wear mechanism is three-body abrasive wear due to coarse carbides removal. The resulting debris and particles are conveyed by the lubricating fluid and cause abrasive wear in the other contacts. In the literature, few studies report cases of wear due to carbides removal and hydraulic fluid pollution by hard debris. Moreover, these studies often characterize the origin of wear without suggesting solution to diminish it. This study consists in an experimental analysis of solutions to reduce wear between shoes and swashplate. Based on the former results, coatings, thermochemical treatment on stainless steel of swashplate (3S) have been proposed. The friction and wear tests have been performed on a rotative tribometer in order to simulate experimentally the shoes/swashplate motion. Wear mechanisms are analysed using Scanning Electron Microscopy (SEM) observations and Energy dispersive X-Ray (EDX) chemical analysis. The wear rates are quantified by using a 3D profilometry. Four different configurations are tested: ball-on-disk and pin-on-disk, both in dry and lubricated conditions. Ball-on-disk contact represents a first wear resistance test; it reproduces extreme conditions. Pin-on-disk contact reflects more accurately the friction between shoes and swashplate. The dry case is taken into account to model the most unfavourable case of limit lubrication regime. The observations and measurements reveal that the stainless steel of swashplate (3S) suffers carbides removal in the extreme cases, even with lubricant. Solid lubricant such as PTFE coating avoid carbide removal by diminishing the coefficient of friction but are less resistant in highly loaded contact. The nitriding treatment of 3S leads to further increasing of the wear resistance of the swashplate, but only under lubricated conditions. The DLC coating is the most efficient solution.
It minimizes the friction coefficient and wear rate under dry and lubrication conditions (figure 1 and 2). The latter configuration could be proposed as solution to increase the lifetime of axial piston pumps.

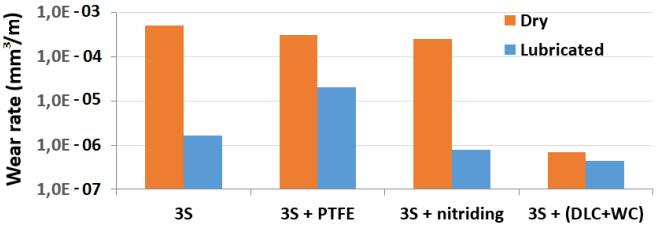

Figure 1: wear rate for each treatment on 3S: case of alumina ball on disks (40 N, 4000 seconds)

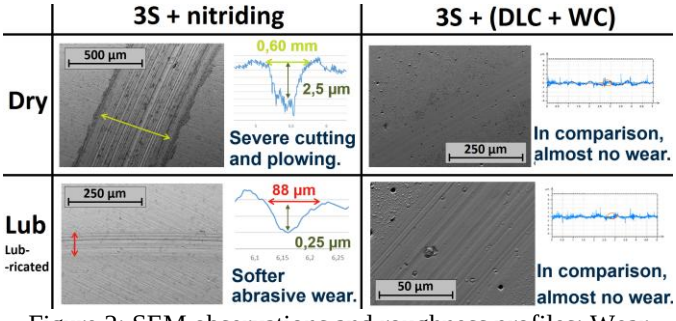

Figure 2: SEM observations and roughness profiles: Wear tracks in the case of alumina ball on disks (40 N, 4000 seconds)