POLYTETRAFLUOROETHYLENE LUBRICATION IN HIGHLY LOADED ROLLING CONTACTS – INFLUENCE OF OPERATIONAL CONDITIONS

Dr. Ankit Saxena [a], Prof. Dr.-Ing. G. Jacobs [a], Merle Reimers [a], Eleonor Carberry [a], Dr.-Ing. F. König [a*]
*florian.koenig@imse.rwth-aachen.de
[a] Institute for Machine Elements and Systems Engineering, RWTH Aachen University, Schinkelstr. 10, 52062 Aachen, Germany

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ABSTRACT
Highly loaded tribological contacts (p>1000 MPa) occur in many machine elements, such as rolling bearings or gears. To ensure low friction and wear rates, lubricants are used to separate the interacting surfaces in tribological contacts. Solid lubricants are used as alternative lubricants when the use of oil or grease is undesirable (e.g. in the food industry) or no longer possible (e.g. in vacuum, space). In the case of PTFE, lubricant supply through coatings or sintered materials is not suitable for highly loaded rolling contacts due to the high contact pressures. Therefore, the solid lubricant is applied in the form of transfer films in the vicinity of the rolling contact and transferred to the contact zone. The mechanisms of supply and lubrication in rolling contacts have not been sufficiently investigated. This paper describes the lubricant film formation in a highly loaded rolling contact supplied by PTFE relubrication.

Methods: A ball-on-disc tribometer is extended by a PTFE pin pressed onto the rotating disc. The sliding contact between the pin and the disc forms a PTFE transfer film on the disc, which lubricates the rolling contact between the disc and the ball. The film formation is analysed by in-situ microscopy and film thickness measurements using optical interferometry [1]. Simultaneously, the lubrication effect is evaluated by friction measurements in the PTFE lubricated rolling contact. This allows the effect of relubrication on film formation at different PTFE pin loads and its influence on the coefficient of friction to be determined, considering the operating conditions, i.e. loads, temperatures, surface roughness and slide-roll ratio.

Results: The results show that relubrication is necessary for effective PTFE lubrication in rolling contacts. Without relubrication, the initial film is quickly removed by shear and compressive stresses in the rolling contact, inducing high friction, which is in good agreement with the results of other authors. In contrast, a stable friction regime is established by continuously adding small amounts of PTFE to the rolling contact. In this way, the coefficient of friction can be reduced by up to 65% compared to the unlubricated conditions. This reduction in friction is correlated with the thickness of the PTFE film and the homogeneity of the film in the rolling contact. These results provide an advanced understanding of the physical mechanisms of PTFE lubrication in rolling contacts and demonstrate that permanent lubrication of highly loaded rolling contacts with PTFE is possible within a suitable corridor of PTFE pin loads and rolling contact operating conditions.

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REFERENCES
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