46th Leeds-Lyon Symposium on Tribology - September 2-4, 2019, Lyon, France

FILM FORMATION AND TEMPERATURE DEVELOPMENT IN TEXTURED RECTANGULAR FACE SEALS

D. Bulut [a*], G. Poll [a]
*bulut@imkt.uni-hannover.de
[a] Institute of Machine Design and Tribology(IMKT), Leibniz Universitaet Hannover, Welfengarten 1A 30167 Hannover, Germany

KEYWORDS

Texturation; friction; film thickness, hydrodynamic lubrication, rectangular face seals

ABSTRACT

Rotary connections are used, inter alia, in automatic transmissions to transfer pressurized oil into actuators. For a proper function, sealing components are important in rotary connections. These usually seal axially. For this purpose, rectangular seal rings, which are a special type of face seal, are particularly suitable since they provide low leakage and high durability. Rectangular seal rings operate at high pressures and together with high speeds, significant friction losses occur, which also lead to a high thermal stress on seal and lubricant. Therefore, optimization of the seal rings in term of friction is particularly important to increase the efficiency in transmissions. One of the optimization methods of the seals is the reduction of the resulting normal contact force via hydrostatic or hydrodynamic load reduction. While the pressurized area on the seal contact surface can be decreased for hydrostatic load reduction, macro structures are used to enhance lubricant film formation in hydrodynamic load reduction [1]. The current project investigates rectangular face seals with pockets (hydrostatic load reduction) and macro structures (hydrodynamic load reduction) in terms of film formation and temperature development in the sealing contact. For this reason, friction torque and mean contact temperatures of a group of seals were measured. For detailed investigation, film thickness in the sealing contact was determined with fluorescence method and temperature development in the contact area was monitored via thermal camera.

To measure film thickness with fluoroscence method, an optical test rig, which was developed in previous works [2], is used [Fig. 1]. The visualization of the sealing contact area is realized with a counterface made of sapphire. The sapphire counterface provides high thermal conductivity and a similar surface roughness to an actual run-in steel counterface, therefore replicating the conditions of the real tribosystem more realistically compared to a glass counterface. An appropriate fluorescent dye dissolved in the lubricant emits fluorescence radiation when excited by light. By means of a microscope, the emitted light is forwarded to a CCD camera. Since both the excitation and emission wavelengths of the dye are known, optical filters are used to pass on the desired wavelength, so that the fluorescence is captured selectively. The emitted light is a measure of the dye concentration present in the sealing area and thus also the amount of lubricant. Thus, the lubricant film thickness distribution is obtained from fluorescence intensity. In addition, the contact temperature is also determined by replacing the microscope with a thermal camera. Experiments are carried out at different pressure and speeds.

Fluorescence method is described and film formation in rectangular seal rings is analyzed depending on macro and micro surface structure. The behavior of the seals with pockets to generate hydrostatic effects seems to be dominated by surface roughness effects and is thus stochastically distributed on the load carrying surface. The film formation and thermal behavior of the structured seals dominated by concentrating cavitation and pressure generation.

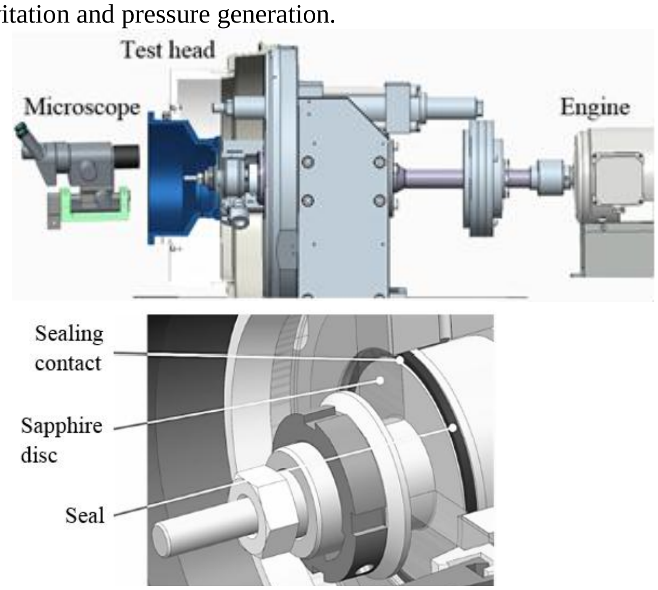

Fig. 1: Experimental set-up and the detailed view of the test head from [1]

REFERENCES

[1] Gronitzki; M., Poll; G. (2007) Optimization of the Tribological Performance of Rectangular Seals in Automotive Transmissions., Proceedings of the Institution of Mechanical Engineers, Part J: Journal of Engineering Tribology

[2] Schüller, M. (2016) Optimierung und Reibungsreduzierung von Drehdurchführungen, FVA Report 678 I