Proceedings IRF2018: 6th International Conference Integrity-Reliability-Failure
Lisbon/Portugal 22-26 July 2018. Editors J.F. Silva Gomes and S.A. Meguid
Publ. INEGI/FEUP (2018); ISBN: 978-989-20-8313-1

PAPER REF: 7076

STRUCTURAL DEGRADATION OF LUBRICATING GREASES. AN ENERGY DRIVEN PROCESS

E. Kuhn[(*)]
MuT Institut of Eng.Des and Prod.,Hamburg University of Appl. Sciences, Germany
[(*)]*Email*: erik.kuhn@haw-hamburg.de

ABSTRACT

Greases are visco-elastical lubricants. The application of a friction stress leads to a structural degradation and a change of the friction and wear behaviour. An analytical description is developed to investigate the possibility for self-organisation inside the grease film. Some experimental work supported the described idea.

Keywords: lubricating grease, structural degradation, entropy production, self-optimization.

INTRODUCTION

If a grease is stressed in a tribological process (shear process) a degradation of the thickener structure can be observed. These structural change is the response of the greases to the new energetic situation.

Starting a friction process leads to a shift of the system out of the thermodynamic equilibrium. Placed in this situation a restoring force emerges. Continuing the friction process opens up the possibility of a stationary non-equilibrium. A further step could result in an instability. Instability is the requirement to start a process of self-optimization and under certain conditions the creation of dissipative structures are possible.

It is assumed in this paper that the formation of dissipative structures are possible for greases too.

RESULTS AND CONCLUSIONS

Start point is the criterion for stability with [1]

$$\frac{1}{2}\frac{\partial}{\partial t}(\delta^2) \geq 0 \tag{1}$$

Working some microgeometrical parameter:

- ψ describes the soap content
- ξ describes the temporary state of the grease structure

It follows

$$\frac{1}{2}\frac{\partial}{\partial t}(\delta^2) = \frac{V_0}{T}\frac{\partial \tau}{\partial \xi}\frac{\partial \dot{\gamma}}{\partial \xi}(\partial\gamma)^2 \dot{} \geq 0 \tag{2}$$

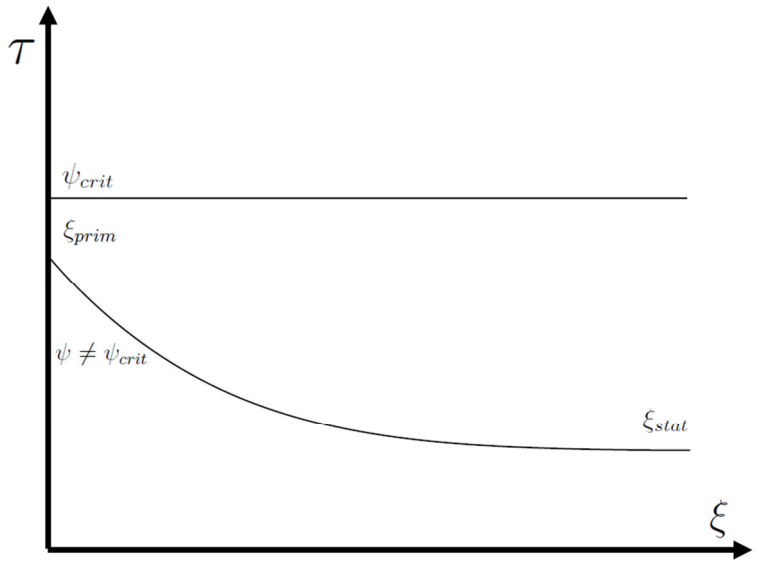

Fig. 1 - Illustration of the transition between stable and non-stable process and interpretation of Eq. (2).

Next step is to make an analytical analysis of the effects of a dissipative structure inside the greases film. According to [2] it is obtained

$$\gamma_D = \gamma_{D0} - \frac{(\tau\dot{\gamma})^2}{\lambda T(grad\phi)^2} \tag{3}$$

The assumption that γ_D is correlated with the structural degradation leads to a decreasing degradation process with an increasing stress.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the funding by Ministry of Education and Research of Germany.

REFERENCES

[1] Nosonovsky, M.: Self-organization at frictional interface for green tribology. Phil.Trans.R.Soc. A 2010, DOI: 10.1098/rsta.2010.0179.

[2] Kozyrev, Y.P.; Sedakova, E.B.: Application of a thermodynamical model for analysis of weear resistance of materials. J.Machinery Manuf. Reliability.2008, 37, 60 62.