Energetic investigation of lubricating grease thixotropy

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This paper deals with the partial thixotropic behavior of lubricating greases. A three-step experimental procedure was developed to stress a grease sample in a rheometer and to observe the reaction after reaching a stress less period. The typical behavior during the shear stress is discussed and the system reaction during the stress-free phase is treated from an energetic point of view. The driving force behind the entire process is the achievement of a stable state.

Keywords: lubricating grease, thixotropy, stability

1. Introduction

Friction is a non-equilibrium-process and as many publications show it is helpful to involve the irreversibility into the tribological investigations. More or less 100 years ago the so-called *thixotropy* was observed in special material by Freundlich et al. [1]. Many years later a partial thixotropic behavior of lubricating greases was detected and analyzed. The focus in this works was directed to the increase of viscosity after the stress period [2]. Several explanations were given by several researchers and the mechanisms that happen are described. The question of the driving forces behind thixotropic or partially thixotropic behavior appears interesting and will be treated in this paper

2. Experimental Methods

2.1. Test procedure for thixotropic experiments

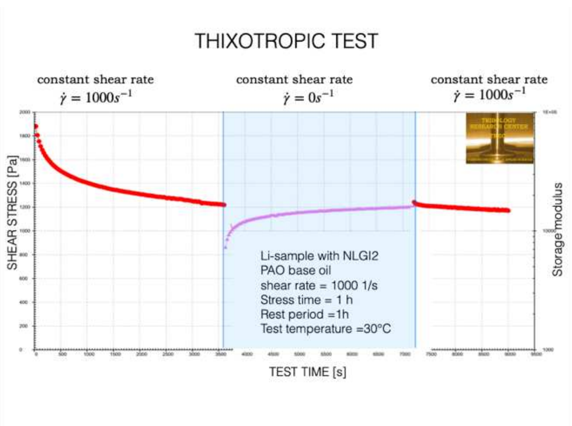

Fig.1: Example for the test procedure

We did rheometer test with different grease sample to observe the system reaction especially during the rest period. As can be seen in Fig.1 we measured the shear stress evolution during the stress periods and the storage modulus during the rest period. Temperature was hold constant during the whole test time, the shear rate was constant in the first and third period and the deformation was constant in the rest phase.

2.2. Observations from the tests

Strorage modulus during the rest period

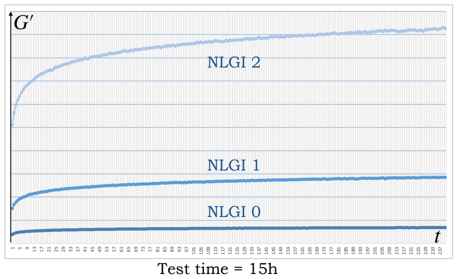

Fig.2: Evolution of the storage moduls for different grease samples during the rest period

As can be seen in Fig.2 the different content of solid material,expressed by the NLGI-class, here it is a lithium soap, ledas to a different process behaviour after stopping the fluid friction.

3. Analytical description

To get an idea of the effort of the system to become stable we check the stability criterion [3]

$$\frac{1}{2}\frac{\partial}{\partial t}(\delta^2 S) > 0 \qquad (1)$$

To find the probability for an intrinsic reaction.
In a first step two mechanisms were considered. That's the elastic deformation of the fibers and the coagulation of agglomerates caused by collisions.

$$\frac{dS_i}{dt} = \frac{\gamma^2_{elast} \cdot G' \cdot \psi}{T \cdot \cos\delta} + \frac{e_{kinA} - (e_{kinB} + e_{kindef})k_c}{T} \qquad (2)$$

4. Results

We see an influence of the content of solid materials (thickener) for the observed grease samples (Fig.2). The probability to become non-stable, what is a requirement for self-organization, is increasing with a decreasing content of solids (come from equ.2). This fact can be seen in interpreting Fig.2.

5. References

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[2] Czarny,R: Effect on changes in grease structure on sliding friction.*Industrial Lubrication and Tribology*47(1995)1
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