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Examination of Ionic Liquids Exposed to Voltage

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Every year around 23% of the global energy consumption is caused by friction and wear. Especially in time periods, where bearings and gearboxes are more and more exposed to occurring electrical currents, lubricants have to fulfill advanced qualities to prevent the components from the novel damage mechanism causing in increased friction and wear. Using Ionic Liquids is a commonly used approach to raise the conductivity of standard oils or greases, to deviate these electrical currents. But exposing these chemical components to electrical currents may lead to destroying mechanism not jet taken into account.

Keywords: lubricants, ionic liquids, electric conductivity, IR-spectroscopy, rheology

1. Introduction

Lubricants used in industrial applications consisting of baseoils and additive packages are mostly insulators and therefore not suitable to lead off electrical currents from e.g. friction bearings in cars.
Adding conductive additives as ionic liquids has already been used in industrial applications [1]. But until now it is not clarified what will happen to the chemical structures exposed to these electrical currents.
In this applied joint research approach [2] different ionic liquids with different conductivities where exposed to well defined electrical currents using a new constructed equipment to examine the impacts of different voltages and exposing times using IR spectroscopy, rheology and conductivity measurements of the liquids.

2. Methods

The ionic liquids were exposed to the shown current feed equipment (test chamber and oven). In the apparatus voltages from 0 to 25V are possible with different selectable polarization. The test chamber may be heated and the occurring conductivity can be metered.

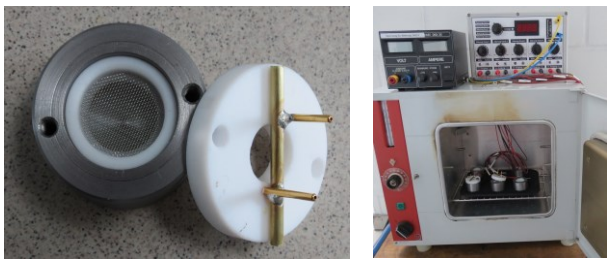

Figure 1: Test chamber and current feed apparatus.

2.1. Infrared spectroscopy: The current fed samples were analyzed by using this spectroscopical method to characterize rearrangement and decomposition processes.

2.2. Rheology: Measuring the changes in viscosity to determine the degradation progress have been performed.

2.3. Conductivity: Identifying the changes during the current feed operation was mapped.

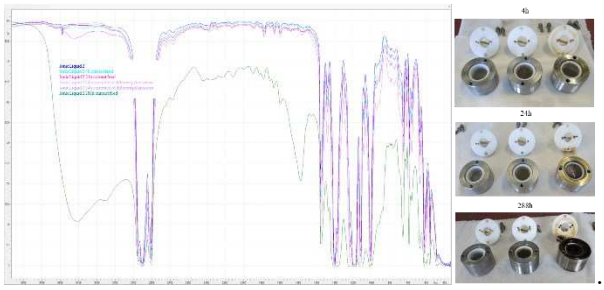

Figure 2: IR example spectra of a current fed ionic liquid and pictures of the current fed test chambers after 4 hrs, 24 hrs and 288 hrs.

3. Discussion

The examined ionic liquids, chemically described as molten salts with no measurable vapor pressure are electrically conductive. Depending on their own conductivity they react on the applied voltage by degradation of their chemical structure and attacking the steel sample chambers depending on the composition of the used steel parts, even the PTFE distance ring can be affected. The conductivity decreases during the process as well as the measured viscosity afterwards leading to the assumption that the ionic liquids have been degraded by the voltage. These results should be taken into account using an ionic liquid as conductive additive in lubricating oils or greases.

4. References

[1] Khazalpour, S.et al., “Applications of phosphonium-based ionic liquids in chemical processes,” Journal of the Iranian Chemical Society, Review, Springer, 2020

[2] Joint research project EPiG: Development of electrically conductive lubricants and adapted nanocomposites for sliding bearings by use of ionic liquids and graphene. BMBF support code 03XP0220A. Duration 01.05.2019 to 31.10.2021