DEFORMATION OF PLASTIC DISPERSE SYSTEMS (PDS) AT LOW SHEAR RATES

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ABSTRACT
Integrated study results involving the analysis of rheological and electrical properties of greases having various nature are reported. Thixotropic properties of greases are estimated with reference to their performance in low-speed rolling bearings.

The region of low shear rates is very critical for many technological applications of PDS. This paper discusses this problem with reference to typical PDS, i.e. greases of various nature obtained by thickening mineral oils with lithium, sodium, barium and aluminium soaps of individual saturated carboxylic acids.

The rheological analysis was performed in rotary plastic flow viscosimeter with rifled measuring surface having the uniformity of stressing within 94%. Dynamometers of various rigidity were used. Fig. 1 shows flow curves for the two PDS (industrial grease samples) when the shear rate decreased below critical values for tested grease samples it was impossible to reach stable flow conditions. In the shear rate region below critical values (the latter being close to $\dot{\gamma} = 0.252$ sec$^{-1}$ and $\dot{\gamma} = 0.035$ sec$^{-1}$ for sodium and lithium greases, respectively) shear stress alterations are observed which become higher with further decrease of shear rate. At $\dot{\gamma} > 0.252$ sec$^{-1}$...
and $\dot{\gamma} > 0.035$ sec$^{-1}$ the conditions of stable flow can be reached, which is described by the smooth curves of $\tau = f(\dot{\gamma})$. The critical rate value for the stable flow conditions was found to be determined by the grease nature. According to experimental findings obtained for reference PDS the critical shear rate was found to change by more than two orders of magnitude depending on the soap cation (from 75.6 sec$^{-1}$ for lithium and 0.12 sec$^{-1}$ for aluminium soaps). At shear rates below critical values the shear stress was found to change with time, the time-stress curve having serrated pattern. Apart from grease nature the critical shear rate depend up on the dynamometer rigidity as well. However, even using very rigid dynamometers stable flow conditions cannot be reached at shear rate values below critical.

The fact that at low and very low shear rates stable flow conditions cannot be achieved both with PDS in general, and greases, in particular is determined by the rheological properties of these materials, i.e. the frittleness of their structural skeleton and its ability to thixotropic restoration. Electrical conductivity of various nature greases were made to study the above regularities under dynamic conditions. The grease nature was understood as being determined by grease interphase conductivity connected both with the integrity of its structural skeleton and the electrical parameters at the interface. The measurements were performed in rotary plastic flow condenser-viscosimeter; the results obtained are shown

Fig. 1. Shear stress vs deformation rate; 1) Na-grease, 2) Li-grease.