Lubrication with Liquid Crystal:
Minimization of Friction at Various Speeds Using Autonomous Control of Its Viscosity

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Abstract
To demonstrate the concept of the smart lubrication system using liquid crystal (LC) lubricant proposed by Nakano (Tribol. Lett. 14, 17–24, 2003), the following three types of tests were performed: (1) film thickness measurements in pure rolling contacts, (2) friction coefficient measurements in rolling–sliding contacts, and (3) molecular orientation measurements in stationary cells. In all of these types of tests, a nematic LC (4-pentyl-4'-cyanobiphenyl (5CB)) and a carboxylic acid (hexadecanoic acid (HDA)) were used as the base fluid and the additive, respectively. The results of these tests confirm the following mechanism. First, surface films of the HDA additive that spontaneously adsorb onto contact surfaces induce surface anchoring, which has the effect of making 5CB molecules align themselves perpendicular to the surfaces, competing with the flow alignment of 5CB molecules and inducing an increase in the apparent viscosity of 5CB with decreasing entrainment speed. This increase in the apparent viscosity generates a constant friction coefficient region in the Stribeck curve on the left side of the minimum friction coefficient point, resulting in the minimization of friction at various speeds.

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