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A basic study on drivetrain lubricants with fuel economy for electric vehicles by applying oil film forming lubricant additive

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Lubricants play important roles for e-Axles, which are the drivetrain of electric vehicles (EV). It was confirmed that the lowering lubricant viscosity had the effect of improving the efficiency in mild operating conditions that hydrodynamic lubrication was assumed. On the other hand, the lowering lubricant viscosity caused to reduce the efficiency in severe conditions that mixed lubrication was assumed. Therefore, while achieving efficiency improvement under mild conditions by lowering lubricant viscosity, friction reduction technology that prevents losses from increasing in the severe conditions is required. In this paper, we report our newly developed additive, so called friction modifier (FM), for fuel saving EV fluids by improving the efficiency for the reduction gear, especially under severe condition.

We evaluated three samples, which are genuine oil, ultra-low viscosity commercial oil (Sample base) and sample base with the developed FM, for the efficiency of a reducition gear. As a result of validation, “the sample base” and “the sample base with the developed FM” improved efficiency by the lowering lubricant viscosity under the high rotation speed. The sample base with the developed FM also improved efficiency by the reducing fricition under the low rotation speed. The efficiency improved by +1.1%, at the indicated low rotation speed (Fig. 1).

Next, we studied the effect of reducing friction in the mixed lubrication on the durability performance of major components such as bearings and gears. As the results of the study by the bearing durability tester, the torque was lowered and the durability of the bearing was improved by the developed FM (Fig. 2). The sample base is considered to have a sufficient fatigue life in the market. So it was suggested that the further lowering lubricant viscosity is possible by applying the developed FM.

In order to investigate the working mechanism of the developed FM, we evaluated contact electrical resistance and oil film thickness during sliding test. We also analyzed the surface of the test parts. As the results of the validation, we confirmed that the friction reduction in the mixed lubrication was due to the prevention of metal contact between parts accompanying the improvement of the oil film thickness. Since this improvement in oil film thickness cannot occur in the single-layer adsorption of the developed FM, we assume that the multilayer adsorption of the developed FM is occurring (Fig. 3).

In the future, we will proceed with the study toward the practical application of the developed FM for fuel saving EV fluids. We are also planning to confirm the behavior of multilayer adsorption.

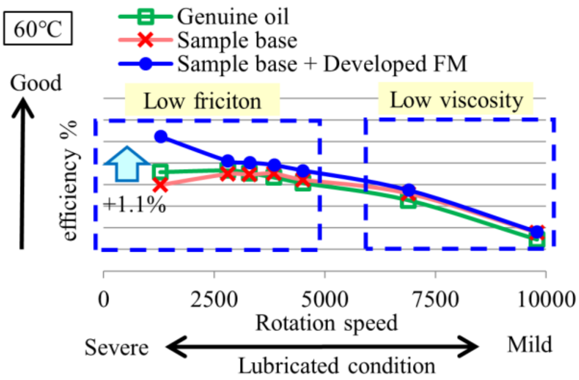

Fig.1 Result of reduction gear efficiency test

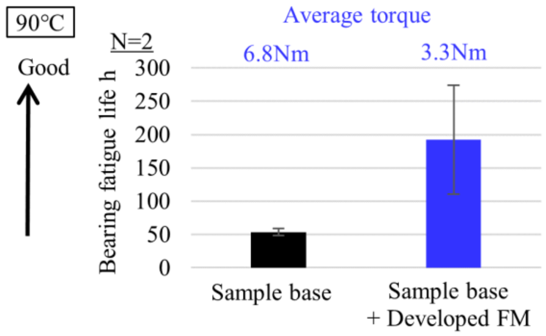

Fig.2 Result of bearing durability test

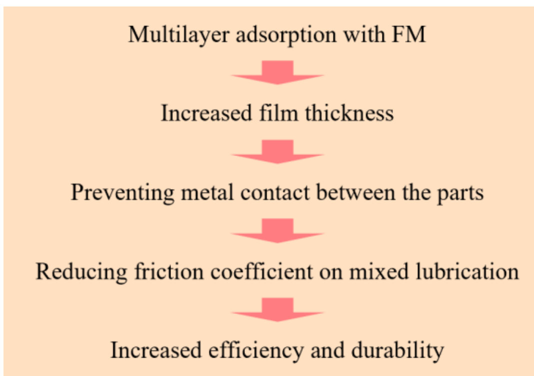

Fig.3 Plausible working mechanism of developed FM

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