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A system engineering approach to reduce soot wear

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Soot contaminates engine oils over time and causes an increase in friction and wear. In this study, the effect of soot was simulated adding carbon black (CB) to fully formulated engine oils, then tested in a Four Ball Tester. The effect of CB was evaluated on steel surfaces and in the presence of W-DLC coating.

Keywords (from 3 to 5 max): engine oil, soot, wear, DLC, glycerol monooleate

1. Introduction

Engine oil lubricants contaminated with carbonaceous matter like soot has increased friction and wear of engine components. Over a decade of research has helped us to identify the soot wear mechanism, the solutions to soot wear problem has to be developed, however. In this study, we have proposed a solution that includes modification to the steel surface and lubricant chemistry- a system engineering approach.

2. Methods

Four Ball Tester (FBT-3) was used to determine in situ friction and temperature of fully formulated semi-synthetic lubricant i.e. 10W40 and 10W40 with 1 % wt carbon black (a model for engine soot), at 0.7 GPa and 75 °C. Profilometer was used to measure the surface topography and wear volume of the test balls.

3. Discussion

Results showed that carbon black increased the friction and lubricant temperature (poor thermal stability). Surface topography study on the steel balls tested in 10W40 showed a thick adsorbed film on the surface however they were ruptured due to carbon black. We added an organic friction modifier to the 10W40 with 1 % wt carbon black, and tested this formulation in FBT-3. It reduced the friction and also improved the thermal stability of the contaminated oil. Also the friction modifier helped in rebuilding the protective film on the steel surface. Furthermore, the steel balls were coated with tungsten doped diamond like carbon (W-DLC). It further reduced the friction, improved the lubricant thermal stability and there was no wear due to carbon black in 10W40. A lubricant system comprising of W-DLC coating and organic friction modifier can improve retention of protective surface film, and resist abrasive nature of carbon black due to increase in surface hardness of steel surface.