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Effect of Lubricant Chemistry on the Camshaft Friction and Follower Rotation

RA. Mufti[1*], M. Khurram[1], F. Qureshi[2], R. Zahid[1], and J. Aslam[1]

1) School of Mechanical and Manufacturing Engineering, National University of Sciences and Technology, H-12 Islamabad, Pakistan
2) The Lubrizol Corporation, 29400 Lakeland Boulevard, Wickliffe, Ohio 44092, USA
*Corresponding author:riazmufti@smme.nust.edu.pk

1. Abstract

Lubricant technology is mainly driven by fuel economy, emissions and durability. Lubricant manufacturers and formulators are under constant pressure to develop products that would reduce fuel consumption and lower emissions while maintaining engine durability. This drive has resulted into the introduction of low viscosity lubricants [1] to reduce fluidfriction and has augmented the importance of friction modifiers to improve mixed to boundary lubrication friction.

It is well known that engine valve train is one of the most challenging components to lubricate effectively due to the high contact loading at the cam-tappet interface of the direct acting valve train configuration. The contribution of frictional losses from the valve train is relatively low at low temperatures and high speeds but a significant impact on fuel economy can be seen at low speeds and high temperatures [2]. Lubricant viscosity has a major impact on the valve train performance. Lowering the viscosity increases the friction at the cam/tappet interface whereas the tappet-bore friction decreases as shear friction is more dominant in this region. The cam-tappet-bore friction has an impact on the rotation of the tappets and tappet rotation has an effect on the tappet wear and thus durability. With the introduction of low viscosity lubricants, maintaining the valve train component durability is one of the key challenges faced by automotive OEMs.

Along with viscosity,friction modifiers also influence the cam/tappet friction. Friction modifiers reduce the boundary friction at the cam/tappet interface buttheir impact on tappet rotation needs to be investigated. In adirect acting cam/tappet configuration, the tappets are slightly offset from the cam and in some cases conical cam/dome tappets are used to facilitate rotation. Tappet rotation is important as it plays a vital role in reducing sliding friction but more importantly it encourages uniformwear. If for some reasons the tappets stop rotating catastrophic component failure can take please due to fatigue or sliding wear.

To study the impact of lubricant rheology and chemistry on the valve train friction and tappet rotation, Mercedes Benz OM646engine head is instrumented for simultaneous measurement of these parameters(Fig1).The tappet rotation speed is measured using magnetic gradiometer chip, a recently developed technique that allows the measurement of tappet rotation without the need to drill holes in the engine block for sensor installation.The engine valve train friction is measured using the online torque tube method previously implemented on heavy duty diesel engines [3] and now applied on the passenger car engine. The instrumentation of the engine head is carried out in such a way that components under investigation operate in original environment so that realistic behavior can be observed. With the use of advanced data acquisition system simultaneous measurement of friction and tappet rotation was made possible, providing an insight into the tappet friction and rotation relationship. Friction reduction improves fuel economy but it also reduces the traction required for tappet rotation. Tests carried out under different operating conditions clearly show the influence of lubricant chemistry on the engine valve train performance.

Fig1. Instrumented engine for camshaft friction and tappet rotation measurement.

2. References

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