Road to Ultra-Low Viscosity 0W Oils: Quantifying Frictional Benefits for Crankshaft Bearings

CATEGORY OR KEYWORDS
Crankshaft journal bearings, 0W engine oils, ultra-low viscosity oils, lubricants

AUTHORS AND INSTITUTIONS
Priyanka S. Desai[a], Konstantinos Kalogiannis[b], Francesco Manieri[c], Tom Reddyhoff[c], Omar Mian[b] and Robert Mainwaring[d]

[a]Shell Global Solutions (US) Inc., [b]MAHLE Engine Systems (UK) Ltd., [c] Tribology Group, Department of Mechanical Engineering, Imperial College London,[d]Shell Global Solutions (UK) Inc.

INTRODUCTION
Shell and MAHLE have worked together to explore the frictional and engine fuel economy benefits offered by ultra-low viscosity oils within the SAE 0W grade envelope. Using the Journal Bearing Machine (JBM) at Imperial College [1] the impact of various prototype lubricants such as SAE 0W-20, SAE 0W-8 and 0W-4 on polymer coated journal bearings operated across a range of speeds, loads and temperatures has been evaluated. This talk reports the performance of these oil and bearing material combinations in terms of wear and seizure tolerance, highlighting the constraints on engine operation required to realise the economy benefits whilst maintaining an acceptable system robustness.

The JBM friction experiments indicate that a 0W-4 lubricant can reduce the frictional torque associated with the crankshaft assembly by up to 20% when compared to a 0W-20 lubricant. This corresponds to a 1% increase in engine output or a 1% improvement in fuel economy [2]. In addition, analysis of the resulting coefficient of friction (CoF) and Stribeck curves indicates a clear transition from hydrodynamic to boundary conditions as the temperature increases beyond 100°C. Accordingly, the frictional benefit of the 0W-4 lubricant is most strongly visible at modest temperatures, but disappears as the temperature reaches 120°C.

Durability studies have been carried out at MAHLE Engine Systems using bespoke test rigs called “Sapphire”, which can assess seizure and perform Start-Stop wear tests. In a seizure test, the load is increased linearly until seizure is detected by either rising bearing temperature or motor current, whilst the test cycle on the Start-Stop test controls variable speed and load in a way that transitions back and forth between mixed and hydrodynamic lubrication regimes. Seizure tests indicated that seizure resistance is not sensitive to oil viscosity but primarily to the material properties of the bearing surface.

Managing the engine temperature, bearing material and crankpin surface finish are the keys towards realizing the frictional savings offered by ultra-thin oils. Polymer overlays are quintessential to allow for a robust engine operation when low viscosity oils are used.

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REFERENCES
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