Experimental Investigation on the Effect of Liner Surface Properties on Wear, Friction and Surface Morphology in Non-Firing Engine Simulator

By

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Engine designers and tribology engineer are constantly challenged to produce products with lighter weight, lower friction, reduced wear, and longer life. The engine system must also meet increasing demanding emissions and fuel economy targets. Advance lubricants and surface coating are concurrently being developed worldwide to meet the needs of new engine material combinations. Because of the enormous cost and time associated with engine testing, attention is being focused on the development of representative and repeatable bench test for evaluation of materials and lubricants.

Several experimental studies have been conducted for evaluating coefficient of friction and wear in simulated engine conditions using Cameron-Plint wear tester, which uses a piston ring segment and a liner piece rubbing against each other in lubricated condition in reciprocating mode under varying load. This technique has a drawback that it does not test components. It is desirable to test component by maintaining the geometry, surface finish and microstructure.

In the present experimental investigation, a non-firing engine simulator has been developed in order to simulate engine conditions to a closer degree. This machine can operate at similar linear speed, stroke, load and can simulate almost similar engine operating conditions except firing pressures. Two cylinder liners with different surface properties have been used for experimentation and the wear and surface properties behaviour were evaluated at several locations in the liner. This machine can be used for comparing liners with different surface properties and the effects of surface texture on wear and oil consumption.

The performance of a combustion engine is closely related to the friction force between the cylinder liner and the piston rings. It is believed that this friction can be

significantly reduced by optimizing the surface topography of the cylinder liner. The surface of cylinder bore is typically machined in two steps. First, a rough honing step gives the right cylindericity, and engraves deep valley on the surface (up to 10μm deep). Secondly, a finish-honing step, also called plateau honing, gives a relatively smooth surface to the plateaux. The resulting surface is, therefore, composed of plateaux separated by deep valley. The plateaux play an important role with respect to force bearing and friction, whereas the valley serves as lubricant reservoirs and distribution circuits. Features of the surface changes during engine running are related to the wear caused by the piston ring on the bore surface. This action varies rapidly causes a "transitional topography", where the surface generated exhibits the influence of the piston ring. The transitional surface although modified, still retains significant characteristics of its initial machined state.

Plateau honing is a finishing process which attempts to impart a transitional topography which may be considered partially "run in" and hence provides a condition which is part way towards the fully run-in state.

The simulator was run at 1500 RPM for 60 Hours for two different liners. The rings were weighed initially and they were weighed after every 10 hours for the loss of material. Coefficient of friction between cylinder liner and piston ring was calculated for four different liner surface using Oscillation Friction Wear (SRV). Scanning electron microscopy (SEM) was also conducted for top ring and liner surfaces after a definite interval and whenever possible. Energy Dispersive Spectrometer (EDS) analysis of ring and liner was done for scuffing. The surface profile was done for liner and top ring surfaces initially and at the end of the experiments.