The Effect of Lubricating Oil Condition on the Friction and Wear of Piston Ring and Cylinder Liner Materials in a Reciprocating Bench Test*

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A test method has been developed to evaluate the friction and wear behavior of candidate piston ring and cylinder liner materials for heavy duty diesel engine applications. The test uses actual piston ring segments sliding on flat specimens of liner material to simplify alignment and to multiply the stress to the level normally seen in engine operation. Reciprocating tests were conducted at 10 Hz and 10 mm stroke at 100° C. Test oils consisted of fully formulated lubricating oils that were conditioned in ASTM standard engine tests. The point contact between the ring segment and flat counter-face, the applied load and elevated temperature all result in boundary lubrication, which simulates the environment near top-ring-reversal. The oil condition was defined by such variables as spectroscopic elemental concentrations, soot level, oxidation and nitration, and contaminant particle concentration. Compared with engine-measured wear rates, ring wear was increased by at least an order of magnitude and the liner by about 1.5 to 2 orders of magnitude as needed for an accelerated test. The iron content of the engine-conditioned oil was a good predictor of the relative wear rates of the liner specimens in the bench test. The soot concentration also had a strong effect on liner wear but no effect on ring wear. This corresponds to engine experience in which it has been observed that soot can interfere with the formation of antiwear films on the liner surface. The oil viscosity has a mild effect on the friction at high load in boundary lubrication conditions. The viscosity of the conditioned oils was related to the soot content rather than the oxidation levels.

Key words: Piston ring, cylinder liner, oil condition

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