

TRIBOLOGICAL INVESTIGATION ON FRICTION BEHAVIOR OF PISTON RING-CYLINDER LINER UNDER THE EFFECT OF AMMONIA-DISPERSED ENGINE OIL

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KEYWORDS

Friction; wear; mixed lubrication; ammonia-dispersed engine oil

ABSTRACT

With the efforts to lower carbon emissions from automotive industry, alternative fuels, such as ammonia, have gained attention as carbon-free fuel. However, due to ammonia's corrosive and acidic/base nature, additional research is necessary to understand its effect on the friction phenomenon.

For this, tribological experiments took place using fresh and ammonia-dispersed engine, referred as *Old*, oils (SAE 10W-40), where the lubricant was supplied dropwise to the sliding surface. Steel piston ring (Nippon Piston Ring), and conventional cast iron cylinder liner (FC250) were selected as the tribological pair. Linear reciprocating friction/wear tester (Heidon, Type 38) was used, where experimental conditions were set to sliding speeds of 1000, 3000, 4500, 6000 mm/min, normal load 5N and 10N, engine oil at 26°C and sliding distance of 10m under each speed. All test surfaces were created with wire-EDM (base), whereas smooth surfaces were created with addition of lapping process.

Figure 1 depicts the coefficient of friction (COF) with respect to the dimensionless bearing characteristic number, S_b . The bearing characteristic number was calculated by the viscosity of the lubricant η (Pa·s), the sliding speed V (m/s), and the load per unit area P_m (N/m).

$$S_b = \frac{\eta V}{P_m}$$

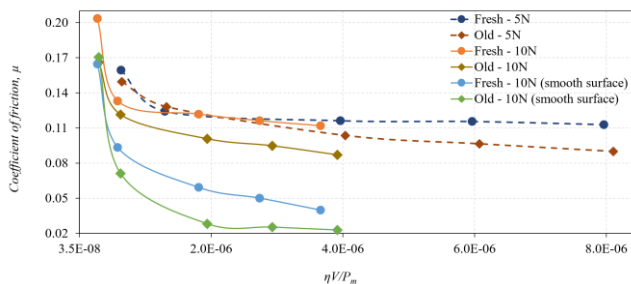


Fig.1 Stribeck curve using fresh and ammonia-contaminated engine oils under various loads & surface roughness.

From Fig. 1, it can be seen that old oil showed smaller COF values under all conditions. Chemical analysis showed that old oil had lowered viscosity, which is thought to be the reason why the COF was lowered under faster sliding speeds. It was calculated for base specimens under 5N load, on average COF was 10% lower in old oil. Whereas, under 10N load, base and smooth specimen differences were 17% and 32%, respectively.

Table 1 shows the measured Ra values before and after the experiments under normal load of 10N, for base and smooth liner specimens. It was found that smoother specimens showed lowered Ra values after the tribological experiments, whereas base specimens showed elevated values. As the smooth surfaces had lower asperities, the wear phenomenon, where surface gets even smoother was observed. However, for the base case this phenomenon was not observed. As the next step, sliding distances along with normal load and lubricant temperature will be increased in the following experiments.

Table 1 Change in surface roughness, Ra , for liner specimens.

Ra [μm]	Before	After	Difference
Fresh – 10N	0.448	0.556	24.1%
Old – 10N	0.614	0.690	12.4%
Fresh – 10N (smooth surface)	0.129	0.111	-13.9%
Old – 10N (smooth surface)	0.113	0.108	-4.4%

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