IMPROVEMENT IN MEASUREMENT ACCURACY OF OIL FILM DISTRIBUTIONS ON PISTON SKIRT USING SAPPHIRE GLASS CYLINDER

Yasuhiro Ishikawa [a,b*], Shiro Kume [a], Akemi Ito [a], Kenichi Yamashita [b]
*yasuhiro_ishikawa@isuzu.com
[a] Tokyo City University, Graduate School of Integrative Science and Engineering,
1-28-1 Tamazutsumi, Setagaya, Tokyo, 158-8557, Japan
[b] Isuzu Advanced Engineering Center Ltd,
Tsuchidana 8, Fujisawa, 252-0881, Kanagawa

KEYWORDS
Experiments in tribology; Hydrodynamic Lubrication; Friction; Oil Film Thickness

ABSTRACT
Oil film distributions on a piston skirt is one of essential information to comprehend the lubrication conditions of piston-cylinder interface. As the way to investigate the distributions, the induced fluorescence method using a sapphire glass cylinder liner is known [1],[2].

The purpose of this study was set to improve measurement accuracy. The effect of diffusibility of fluorescence on measurement accuracy was investigated.

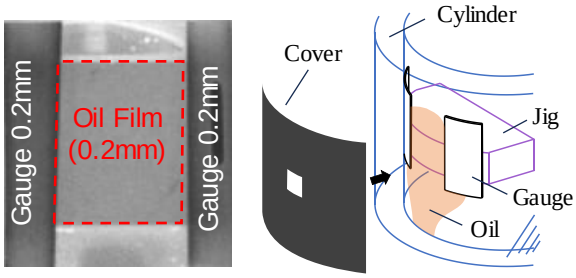
Fig.1(a) shows the jig which was attached to inner wall of a cylinder liner. There was a certain clearance between the jig and the cylinder bore, and the clearance was filled with oil containing fluorescence. The fluorescence intensity induced by UV ray was measured both with and without the cover shown in Fig.1(b). The cover had a window, and the effect of the opening area was also investigated.

Figure 2 illustrates the variation in fluorescence intensity relative to the opening area. Note that the evaluation area was 0.56 mm² at the center of the jig. This result suggests that the fluorescence emitted from the surrounding area of the evaluation point influences the intensity at that point. However, it can be negligible if the opening area is less than 4 mm^2 because the opening area was small enough.

Subsequently, the fluorescence intensity was measured both with and without the cover using a piston, revealing a strong correlation with a coefficient of determination of 0.98. The regression equation obtained is shown below. This result indicates that measurement error by the diffused light can correct using this equation.

$$F_{w\_Cover} = 0.72 * F_{w/o\_Cover} + 35.9$$

Finaly, the oil film distributions on the piston skirt were measured under the motoring conditions. This test revealed that without correction, the minimum oil film thickness (MOFT) was underestimated to be below 1μm. While, with correction, MOFT was 6μm, aligning closely with the theoretical analysis results.



(a) Jig without Cover (b) Cover

Fig.1 Jig for setting oil film thickness to 0.2mm

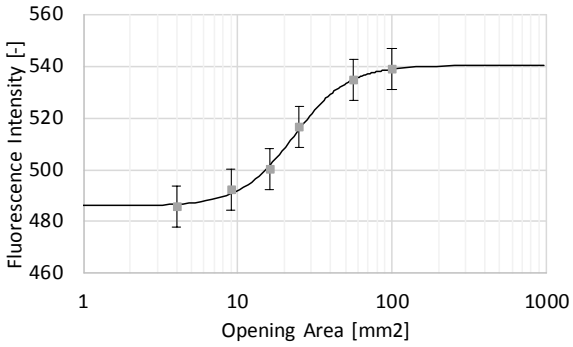


Fig.2 Influence on diffused Fluorescence

REFERENCES
[1] Inagaki, H., "Measurement of Oil Film Thickness Distribution on Piston Surface Using Fluorescence Method (Development of Measurement System)," Transactions of the JSME. Series B, Vol. 61 No.590, 3629-3635, 1995.
[2] Suzuki, H., "Analysis of Lubrication Characteristics in Piston Systems and Research on Friction Reduction" [Translated from Japanese.], Doctoral dissertation, 200