

Oil Film Distribution and Skirt Friction Loss in Concave Created by Piston Skirt Profile or Pattern Coating

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To improve fuel efficiency and reduce CO₂ emissions in automotive engines, minimizing friction loss in the piston skirt is a key technology. A modified piston skirt profile and patterned coating on the piston skirt are effective solutions for reducing friction loss by improving oil lubrication. In this study, both the modified piston skirt profile and the patterned coating were tested to evaluate their effects on oil film distribution.

Figure 1 shows two types of pistons to provide concave on the skirt sliding surface. The concave areas are shown in white. The design target for the depth of the concave was 10 μm . Type A has concave directly formed in the skirt profile, while Type B has concave produced by pattern coating.

The oil film on the piston skirt was visualized under firing conditions using the laser-induced fluorescence (LIF) method. Figure 2 shows the results of oil film thickness. Oil failed to completely fill by the concave region for both piston types. The oil mainly

accumulated on the rear side of the concave region relative to the sliding direction. The amount and distribution of oil inside the concave differed between the expansion and exhaust strokes. The oil film distribution in the concave changes depending on the piston sliding direction and operating stroke.

Figure 3 shows the results of FMEP calculations carried out using the experimentally obtained oil film distribution. Three conditions were compared based on the visualization results: a fully oil-filled in concave region, a concave region with no oil, and a partially oil-filled in concave region. Both Type A and Type B showed lower FMEP than the standard piston without a concave, even when the concaves were only partially filled with oil.

The following conclusions were drawn from oil film visualization and FMEP calculations using a piston with a concave feature on a portion of the skirt profile. While oil does not completely fill the concave region, an oil film forms toward the rear in the sliding direction. Even a partial oil film in the concave resulted in a greater FMEP reduction compared to the STD piston case.

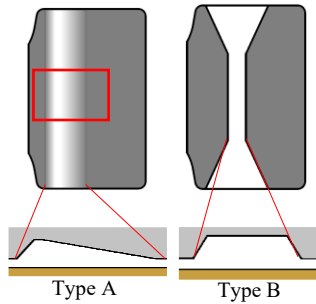


Fig. 1 Concave Type of Test Piston on Skirt Bearing Area

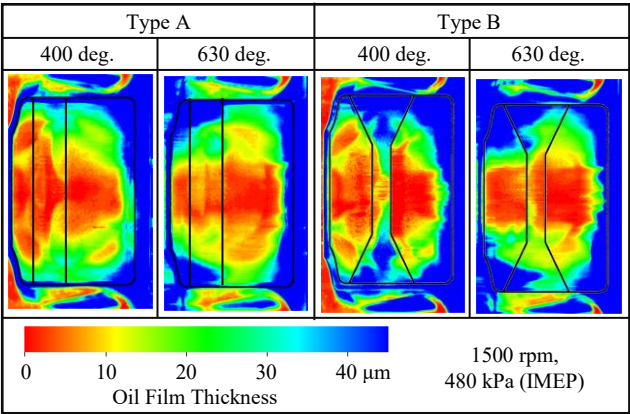


Fig. 2 Oil Film Distribution on the Skirt

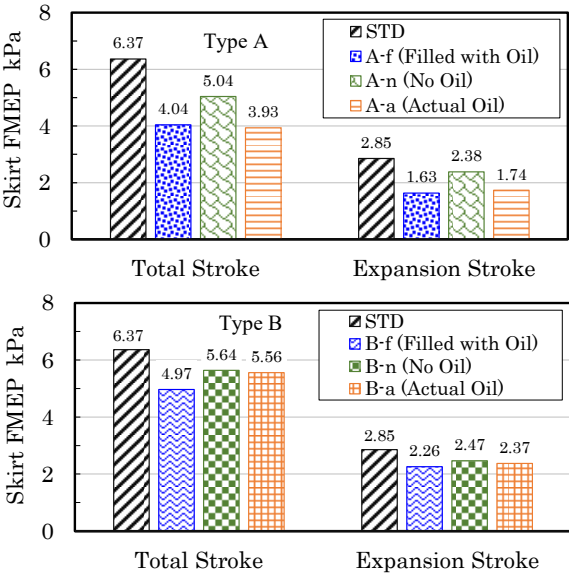


Fig. 3 Calculation Results for Various Oil Film Distribution at Concave Area (1500 rpm, IMEP: 480 kPa)