

Observation of Land Oil Distribution to Elucidate Upward Oil Transport Pathways

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The reductions of engine oil viscosity and piston ring tension have been adopted to improve fuel economy and reduce CO₂ emissions in automotive engines. These approaches may increase oil consumption due to upward oil transport through the piston rings. In this study, the oil distribution on the piston lands area was visualized to clarify the upward oil transport pathways and the factors affecting oil transport.

A test engine with a transparent sapphire cylinder was used for visualization. The oil film distribution around the piston rings was measured using Laser Induced Fluorescence (LIF). Different top ring end gaps (0.2 mm and 0.4 mm) and oil ring types (2-piece and 3-piece) were tested.

Figure 1 shows the upward oil transport from the top ring end gap under the motoring condition with the throttle fully closed. The figure has results of small ring gap (left hand side) and that of large one (right hand side). Although the smaller top ring end gap showed a larger amount of upward oil transport, this was mainly caused by the difference in the amount of accumulated oil on the 2nd land. The amount of upward oil transport through the top ring end gap did not have a clear relationship with the piston ring specifications.

The upward oil transport pathways were also investigated by observing the oil film distribution around the piston lands area. Figure 2 shows the upward oil transport with 2-piece type oil ring and 3-piece one. The oil in the second land subsequently passed through the top ring end gap. Although upward oil transport from the upper surface of the top ring groove, as indicated by the black square marker, was occasionally observed, the flow through the ring gap was the dominant pathway.

The influence of oil ring types were also investigated by Fig. 2. No systematic differences in upward oil transport were observed by the oil ring types. The 3-piece oil ring is expected to suppress upward oil transport by its two rail structure, while the larger oil storage volume in the oil ring groove may increase oil accumulation. The 2-piece oil ring may also provide sealing performance due to ring flutter. These factors are considered to affect the upward oil flow behavior.

From these results, the following conclusions were obtained. No clear relationship was found between the amount of upward oil transport and both of the top ring end gap and the piston ring specifications. The dominant upward oil transport pathway was from the ring gap to the ring gap, although upward oil transport from the ring groove surface was also observed occasionally. A larger amount of accumulated oil on the piston lands area resulted in a larger amount of upward oil transport through the top ring end gap.

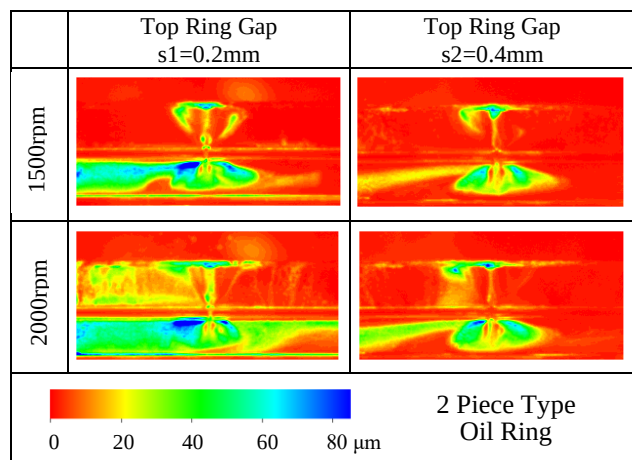


Fig1. Upward oil transport through the Top Ring Gap

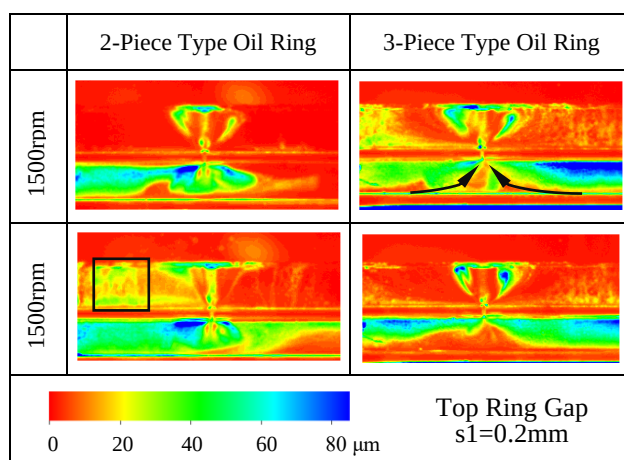


Fig2. Upward oil transport through the Top Ring Gap