

# Development of a new cross-sectional shape of 2-piece oil control ring by CFD analysis

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Reducing the oil consumption is important for the environmental impact of diesel engines. In general, increasing the surface pressure of sliding area of the 2-piece oil control ring is one of the methods reducing the oil consumption. However, as a trade-off, worsening friction is a concern. Therefore, the cross-sectional shape of a 2-piece oil control ring was improved to reduce oil consumption without increasing the surface pressure of the sliding area by using oil flow analysis.

The 2-piece oil control ring have a space between the upper and lower rails to reserve the oil scraped from the bore. In this study, we focused on the oil flow from the oil reservoir space to the back of the ring through the oil drain slots, and determined the cross-sectional shape by simulation. The effect of the cross-sectional shape was verified by the visualization test and the engine test. In the simulation, the cross-sectional shape of the 2-piece oil control ring is converted to 3D-model, and the shape between the rails is extracted. And two-phase flow analysis of air and oil was performed within the shape. The analysis conditions were a crank angle of 0 ° to 180 ° (downward stroke), and a rotation speed of 4000 r/min. In addition, we optimized the shape based on the Design of Experiments (Table1, Fig.1). In the visualization test, the oil amount between rails was measured by laser induced fluorescent. And testing machine was configured single-cylinder with a glass cylinder liner and a supercharger. The operating conditions were a cylinder pressure of 6MPa and a rotation speed of 2000, 3000, 4000 r/min. In the engine test, the oil consumption was measured using a 4-cylinders, 2.8L diesel engine. The operating condition was a rotation speed of 3600 r/min (Full Load). 2 types 2-piece oil control ring, which the conventional cross-sectional shape and the new cross-sectional shape, applied to the visualization test and the engine test.

As a result of the simulation, the oil flow was improved up to 90% compared to the conventional cross-sectional shape due to shorten a length of pillar formed between the oil drain slots and the upper and lower rail. The new shape which apply the analysis results to the latest cross-sectional shape has also improved the oil flow about 60% (Fig.2, Fig.3). As a result of the visualization test, it was confirmed that the new cross-sectional shape reduces the oil amount between rails about 20% (Fig.4). Furthermore, in the engine test, the oil consumption of the new cross-sectional shape was reduced about 20% (Fig.5).

By shortening the length of pillar formed between the oil drain slots and the rails, the oil flow was facilitated. And it was also found that oil consumption can be reduced by making the oil flow facilitation. In this study, we were able to develop the new cross-sectional shape of 2-piece oil control ring optimized by simulation which can reduce oil consumption.

Table.1 Level of shape parameters

	Case		
B3[mm]	1.2	1.35	1.5
$\alpha$ [°]	10	15	20
a4[mm]	0.5	0.7	0.9
c1[mm]	0.4	0.5	0.6

  : Parameters of the conventional cross-sectional shape

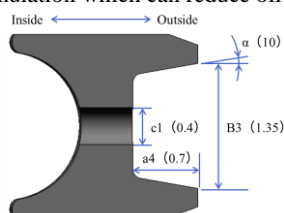


Fig.1 Shape parameters configured between the rails of 2-piece oil control ring

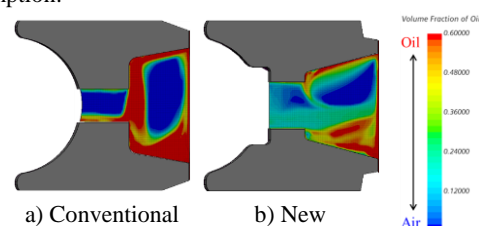


Fig.2 Oil flow distribution

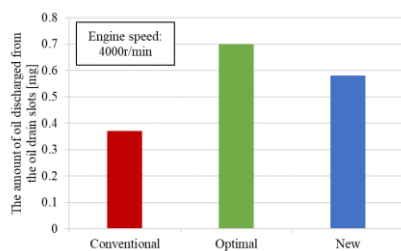


Fig.3 Simulation results

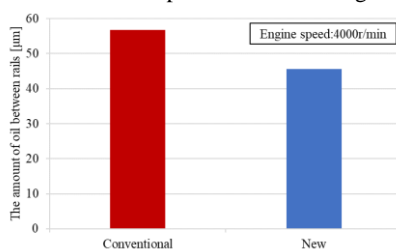


Fig.4 Visualization test results

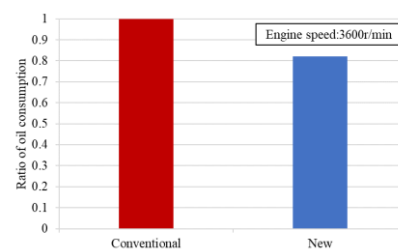


Fig.5 Engine test results