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Analysis of Flame Propagation Behavior and Wall Heat Flux in Direct-Injection Hydrogen Motorcycle Engines

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It is important to evaluate cooling losses in hydrogen engines. However, because it is difficult to accurately estimate cooling losses in actual engines, evaluating them using CFD is an efficient method. To accurately predict in-cylinder combustion and wall heat transfer in CFD, it is necessary to understand the complex phenomena involved in combustion and compare and verify the results of CFD analyses. Therefore, it is important to capture various phenomena in actual engines. In this study, multiple heat flux sensors were placed on the cylinder head of a motorcycle direct-injection hydrogen engine. The instantaneous heat flux results obtained were used to analyze flame propagation behavior. Furthermore, CFD analysis and in-cylinder visualization results under identical conditions were compared to understand the cylinder flame propagation behavior dependent on the excess air ratio.

Figure 1 shows a comparison of the visualization and analysis results. The visualization results capture the process in which the flame is ignited by the spark plug, grows, and the illuminated area expands. The CFD analysis results for the 0.0005 mass fraction contour of the OH showed that the flame propagation pattern was similar to that observed in the visualization images.

Figure 2 shows a comparison of the heat flux between the experimental and simulation results at λ = 1.0. Comparison of the measured and simulated heat flux results shows that the difference in the time taken for the heat flux to reach its maximum value after ignition is approximately 1 degree, indicating that the tendency of the combustion flame to reach the combustion chamber wall has been accurately reproduced. However, the absolute values of the simulated heat flux trends were underestimated relative to the measured values. Therefore, it is necessary to compare the results with gas temperature measurements and verify the parameters contributing to the heat transfer coefficients.

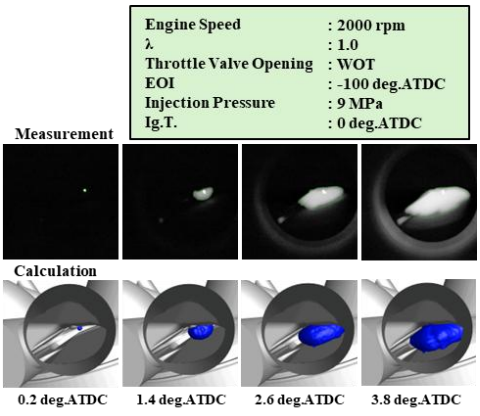

Fig. 1 Comparison of Visualization Results and Simulated Results

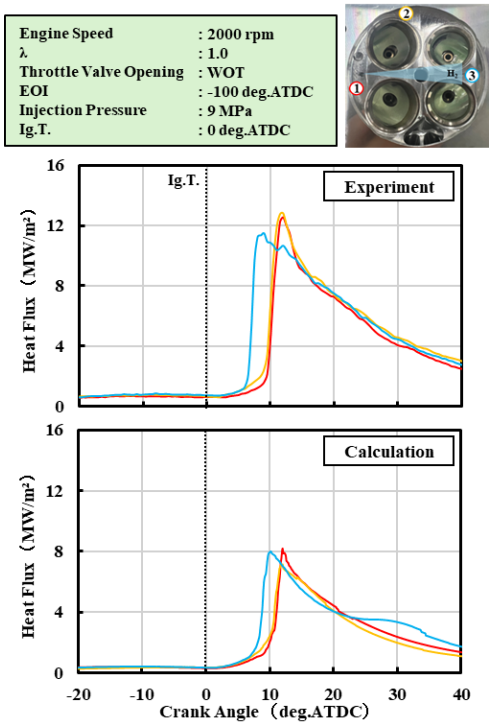

Fig. 2 Comparison of Heat Flux between Experiment and Simulation