

Research on a Small Two-Stroke Uniflow-Scavenged Opposed-Piston Engine

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In recent years, the automotive industry has been influenced by decarbonization initiatives, leading to the increased adoption of battery electric vehicles (BEVs). However, issues such as driving range, charging time, and charging infrastructure remain. At the same time, internal combustion engines have received renewed attention, and highly efficient engines with designs different from conventional engines are expected to be developed. Therefore, this study focuses on a small two-stroke uniflow-scavenged opposed-piston engine for application as a power-generation engine in hybrid vehicles.

The opposed-piston engine used in this study was constructed by arranging two YAMABIKO PB770 engines facing each other and connecting them with an attachment that forms the combustion chamber. The engine speed was varied from 1000 to 3000 rpm in increments of 500 rpm, and the ignition timing was varied from 30 to 50 degrees BTDC in increments of 5 degrees. Gasoline was used as the fuel and supplied by injection. The effective compression ratio was 6.5, the throttle opening was maintained at 100%, the excess air ratio was 1, and the delivery ratio was 0.60. The effects of engine speed and ignition timing on torque and misfire were investigated. The torque increased with increasing engine speed at all ignition timings, reached a maximum at 2500 rpm, and then decreased at 3000 rpm. The optimum ignition timing generally tended to shift toward advanced timing as the engine speed increased. In addition, torque tended to decrease as the misfire rate increased, while the lowest misfire rate was observed at 2500 rpm.

The higher misfire frequency at 3000 rpm may have contributed to the reduction in torque. The shift of the optimum ignition timing toward advanced timing with increasing engine speed is considered to be related to the increase in piston speed. As the piston speed increases, the crank angle at which Pmax occurs is delayed at the same ignition timing. Therefore, earlier ignition is required to obtain the maximum torque after top dead center. The occurrence of misfire was considered to be affected by the ignition timing and the relationship among engine speed, ignition position, and in-cylinder flow. In particular, the favorable combustion condition at 2500 rpm may have resulted from an appropriate relationship between these factors.

The effects of engine speed and ignition timing on the characteristics of a small two-stroke uniflow-scavenged opposed-piston engine were investigated. The torque increased with increasing engine speed, reached a maximum at 2500 rpm, and decreased at 3000 rpm. The decrease in torque at 3000 rpm was considered to be caused by misfire. The optimum ignition timing tended to shift toward advanced timing as engine speed increased. Furthermore, an increase in the misfire rate resulted in a decrease in torque, and the lowest misfire rate was observed at 2500 rpm. These results indicate that engine speed, ignition timing and in-cylinder flow affect the performance and combustion stability of the opposed-piston engine.

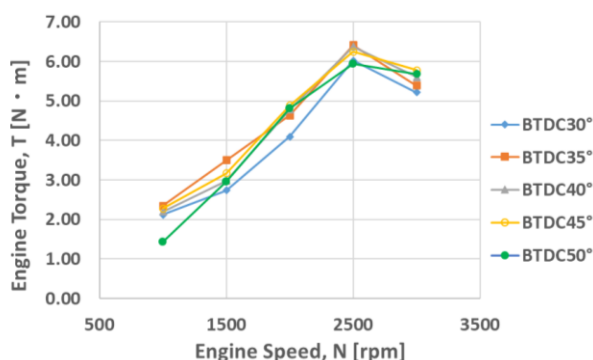


Fig. 1 Torque and Engine Speed

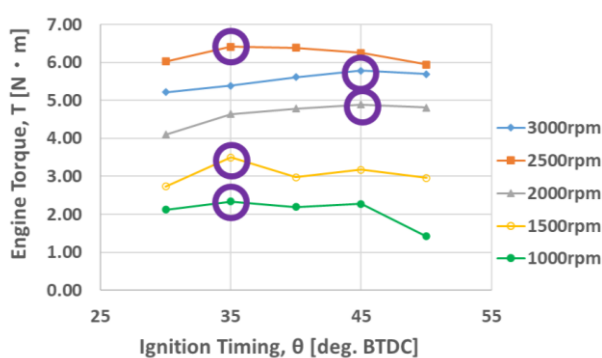


Fig. 2 Torque and Ignition Timing