

Practical Use of 1D Engine Model to Improve Powertrain Development Efficiency (First Report)

- Modeling process for high accuracy 1D engine simulation -

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Recently, many manufacturers are promoting MBD-V-process which is a combination of V-process and Model-Based Development (MBD) to improve the efficiency of development. V-process is a layered design and verification structures. It is the method improved development efficiency by using models at each layer. This process has been applied to engine plant models for ECUs (Engine Control Units) development.

Figure 1 shows the goal to engine development process. We have determined that the application of 1D simulation is effective for engine control, performance design and structure design study. In order to utilize a 1D model, both of them are important the highly accuracy model and the modeling process for it such as prepared before starting development and model management system. Previously, the 1D model has improved to predicted high accuracy intake air mass by tuning valve tappet clearance and wall heat transfer coefficient (HTC) based on the measurement results. However, previous modeling process has the problem occur that model prediction can not be guaranteed when we can not get the measurement results before prepared modeling. In this study, we decided the modeling process for high accuracy 1D engine simulation for using performance design and structure design study for judgment of drawings.

Figure 2 shows the root mean square percentage error (RMSPE) of the intake air mass obtained by the previous and the this study. In previous study, the RMSPE is 9.5% at the engine oil temperature of 90 degC. However, it increase to 13.9% when the engine oil temperature decreases to 40 degC. This means that the accuracy deteriorates as the calculation conditions deviate from the correlation region. In this study, it is from 8.5% to 9.6% when the engine oil temperature is from 90 degC to 40 degC by modeling the physical characteristics. We can make the 1D model for high accuracy engine simulation, case of environmental condition without warm-up.

In this study, we can prepare the high accuracy 1D engine performance model of the intake air amount under a wide range of operating conditions before starting development. Therefore, it has become possible to seamlessly connect to the determination of engine hardware specifications such as performance design and structure design. Furthermore, RT(Real Time) modeling was performed by reduction this model, and it became possible to carry out control studies and powertrain system development in advance. In conclusion, we contributed to the realization of "The goal to engine development process".

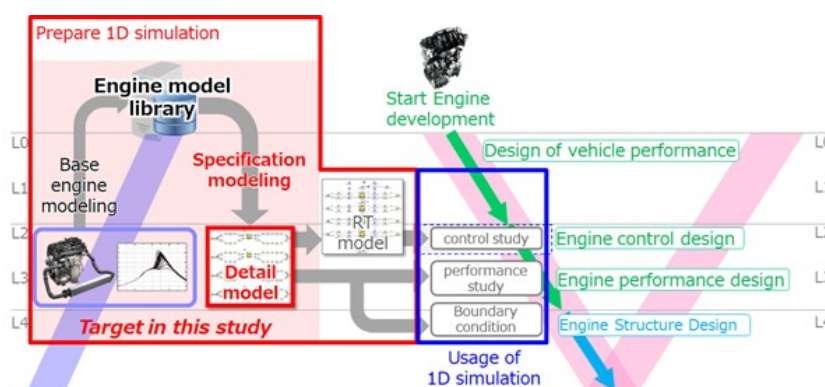


Fig.1 Goal to engine development process

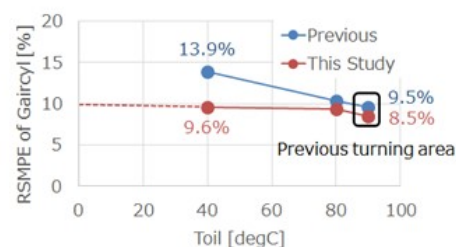


Fig.2 Intake air mass difference of Toil