

Construction of Online Co-Simulation Environment

- (7th report) Fundamental Investigation of MBD for OBD -

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As part of initiatives to realize a sustainable society and enhance human well-being, a widespread adoption of mobility solutions utilizing carbon-neutral energy is increasingly demanded. Mobility systems encompass a wide range of power unit (PU) options, including Battery Electric Vehicle (BEV), Fuel Cell Electric Vehicle (FCEV), Plug-in Hybrid Electric Vehicle (PHEV), Hybrid Electric Vehicle (HEV), and Internal Combustion Engine Vehicle (ICE). It is essential to provide optimal solutions in accordance with diverse market needs and regional infrastructure conditions. Furthermore, in order to continuously evolve PU and deliver mobility products to customers in a timely manner, the execution of highly efficient development processes with minimal rework is required.

Authors have defined the direction of a system model evolution as illustrated in Figure 1. By establishing a co-simulation environment based on the system model that integrates models with varying levels of granularity and across multiple physical domains, it is envisioned that the performance of an entire vehicle, including fuel economy, emissions, driving pleasure, power performance, vehicle dynamics, Automated Driving (AD), Advanced Driver Assistance Systems (ADAS), ride comfort, Noise and Vibration (NV), Electromagnetic Compatibility (EMC), reliability, and On-Board Diagnostics (OBD) can be predicted and effectively applied to product development.

As part of realizing the vision, the present study focused on the modeling of OBD. In particular, existing efforts on modeling Engine Off Natural Vacuum (EONV) have not taken into account the passive heat transfer mechanisms associated with residual vehicle waste heat, and thus have not extended to modeling the entire evaporative emission system. As a result, front-loading in the development process has been difficult to achieve.

Therefore, the objective of this study is to develop a model capable of predicting pressure behavior in the evaporative system under the premise of leak detection using EONV, and to clarify a MBD methodology for OBD utilizing the proposed model.

By constructing a plant model of the evaporative system, modeling the fuel vaporization characteristics using the Antoine equation, and considering heat input routes to the fuel such as waste heat from the fuel pump and heat transfer from components including the exhaust pipe to the fuel tank, it became possible to predict fuel tank internal pressure with accuracy equivalent to that of an actual vehicle, as shown in Figure 2. The proposed model enabled front-loading of OBD development through the application of MBD.



Fig.1 Vision for model evolution based on system model

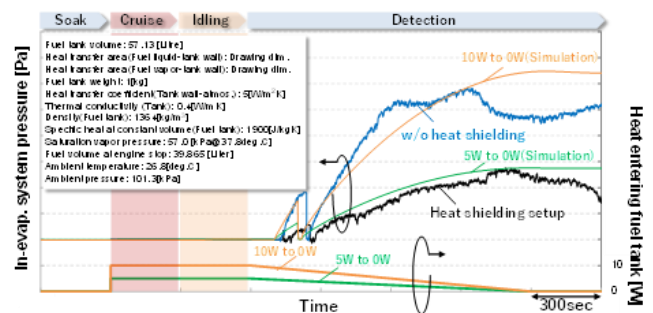


Fig.2 Model validation result