講演番号 063

文献番号 20225063

Development of 3-cylinder engine model using international standard language

- Engine multi physics analisys-

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KEY WORDS: EV whole vehicle model, MBD, VHDL-AMS, Model Exchange, IEC61691-6

The engine model in the international standard description language was announced at the Spring Convention (20155096) as a 4-cylinder engine model in 2015 [(1)]. This time, referring to this document, Toyota Motor's new engine M15A-FKS TNGA 3-cylinder engine model The specifications are shown in Table 1. This time, we will introduce the verification results of the model.

In order to support future model distribution, components such as sensors, actuators, and ECUs can be easily replaced by dividing them into functions like actual machines. The model was developed in accordance with the international standard (IEC61691-6) to guarantee reproducibility.

It was found that each component can be applied to practical use to some extent even if it is simply created from the data of the engine bench or the actual vehicle.

Table 1. Engine Specification

M15A-FKS	
Displaced volume	1490 [cc]
Stroke	97.6 [mm]
Bore	80.5[mm]
Connecting Rod	151 [mm]
Compression ratio	14
Number of Valves	3
Exhaust Valve Open EVO	23deg to 64deg BBDC
Exhaust Valve Close EVC	41deg to 0deg BTDC
Inlet Valve Open IVO	-35deg to 35deg BTDC
Inlet Valve Close IVC	115deg to 45deg ABDC
Throttle diameter $D_0throttle$	55 [mm]
Fuel heat	43.2 [MJ/Kg]
Ambient temperature	300 [K]
Ambient pressure	101325 [Pa]
molecular weight MW	0.028964 [kg/mol]
A/F	14.7
Maximum Power	88kW/6600rpm
Maximum Torque	145Nm/4800-5200rpm

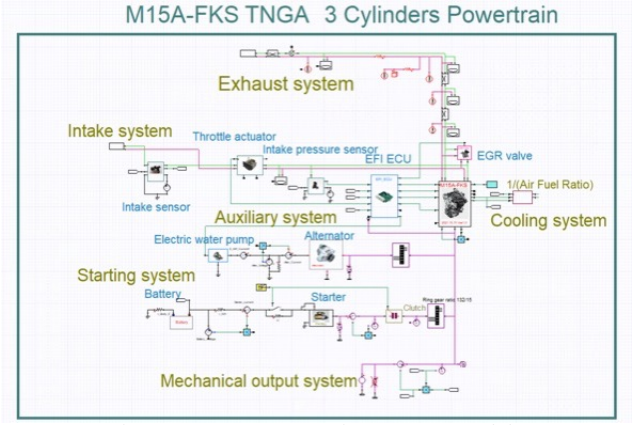

Fig.1 M15A-FKS Engine System model

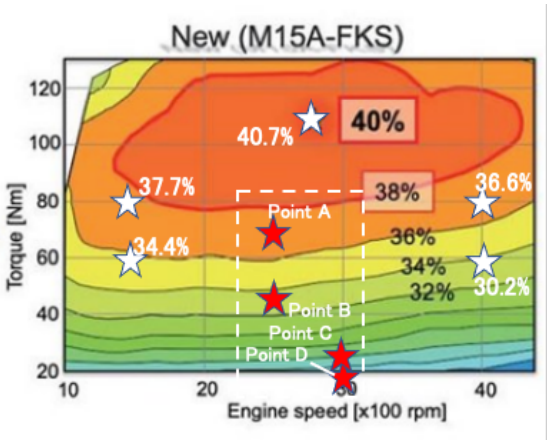

Fig.2 The Simulation Validated Result

The accuracy of the developed model is practical in all aspects such as combustion pressure, maximum combustion pressure crank angle, fuel consumption rate, intake pressure, intake flow rate, ignition timing, EGR flow rate, EGR opening command value, electric water pump rotation speed, etc. It is thought that the degree of perfection was guaranteed (Fig.2). By using the model, it is possible to estimate and visualize the behavior of parts that are actually difficult to measure. In addition, since it is based on the energy equilibrium law, it is a physical limit. Since it is suitable for handling points, it is highly possible that it can also be used for virtual adaptation.