Case Study

Automotive | High Sensitivity | Low Thermal Resistance | Flexibility

Measurement of Heat Dissipation/ Reception around the Engine

References: Measurement of engine surface heat dissipation by a thin and highly sensitive heat flux sensor
Automotive Engineering Society 2015 Autumn Meeting

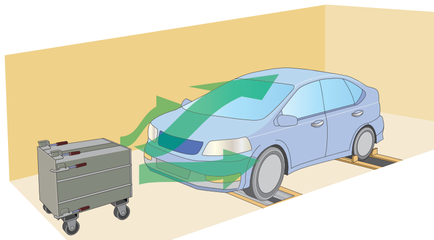
Goal

① Examine the heat dissipation situation around the engine and apply it to the heat loss evaluation data.

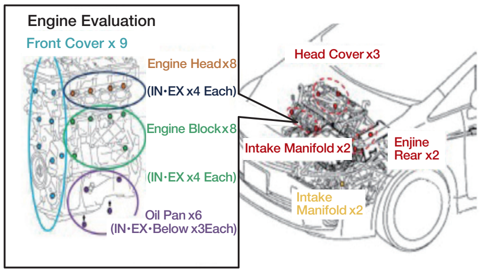
② Examine the part with a large heat reception around the engine and apply it to evaluation data of thermal damage to electrical parts.

Measurement Method

By mounting heat flux sensors on the engine surface, a survey was implemented in order to investigate how engine surface heat dissipation changes under running conditions during a vehicle test. Using the chassis dynamometer, we applied air through the blower to simulate wind conditions according to vehicle speed. The running resistance was reproduced by the chassis roller. Moreover, the test was carried out using covers and so on inside the engine compartment. 40 heat flux sensors were mounted in specific positions as below: engine front and rear parts – 10 sensors, engine block – 8 sensors, front cover – 9 sensors, head cover – 3 sensors, oil pan – 6 sensors, intake manifold – 2 sensors and transaxle (build in on HV motor) – 2 sensors. Furthermore, heat resistant adhesive (until 120℃) was used for installation. Since DENSO Heat Flux Sensor has a thickness of 0.25mm and can be bent at will, it can also be mounted on engine curved surfaces.

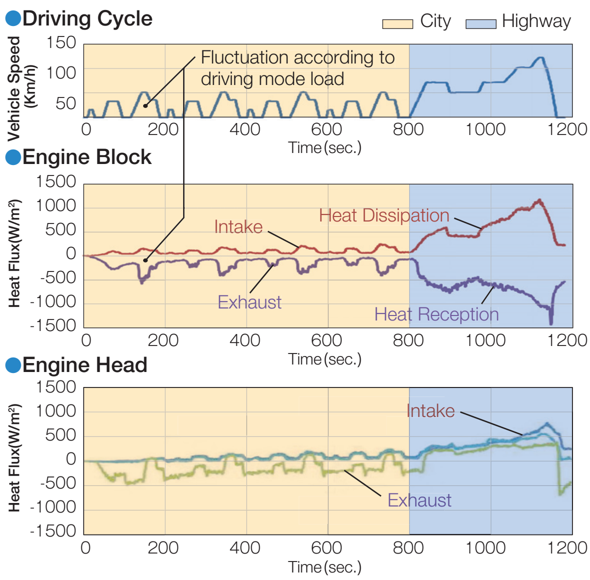


Appearance of Vehicle Test



Results

It was clearly noticed that the surface heat radiation behavior of each part increases and decreases following the vehicle speed of the driving cycle (EUDC). It was confirmed that the part where the heat release amount is large is the engine block intake side, the front cover and oil pan where 1000W/m² at was exceeded at high speed. In addition, there is a clear behavior of the surface radiation heat being negative on the engine head and engine block exhaust side. This shows that they are receiving heat from the exhaust pipe. Furthermore, this heat receiving behavior is different between the engine head and engine block. In the engine block, the amount of heat received increases or decreases according to the increase or decrease in vehicle speed. However, it was observed that the engine head receives heat at a vehicle speed of about 30km/h but dissipates heat at higher vehicle speeds. We can infer that this is because the flow velocity and the wind direction in the vicinity of the surface with respect to the vehicle speed are different between the engine heat positioned in the upper part of the exhaust pipe and the engine block positioned in the lower part. Also, the exhaust pipe located downstream of the flowing wind differs depending on vehicle speed.



Considerations

The heat flux (radiation/reception) of each part of the engine surface can be quantified using the heat flux sensor as a result of heat flux vs. time measurements at the respective engine surface position. During driving in the new EC mode, the heat flux in each part follows the vehicle speed as well. We also confirmed that the heat flux sensor has a fast enough response time to recognize the increasing/decreasing behavior. Based on this fact, we are confident the sensor can be utilized as a useful tool to improve the heat flux inside the engine compartment and future heat management development.

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