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ANALYSIS ON THE ROLE OF ENGINE COOLANT TEMPERATURE SENSOR IN GASOLINE ENGINE

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ABSTRACT

A gasoline motor engine using electronic control system has several sensors and actuators driven by a computer. This paper aims to reveal the role of an engine temperature sensor mounted on a gasoline engine motor. The testing data shows that there is a connectivity between the temperature data obtained from the coolant temperature sensor with the fuel injection time and the exhaust gas emission content.

Keywords: sensor performance analysis, engine coolant temperature sensor, injection time, vehicle exhaust emissions.

INTRODUCTION

Electronic control system on a vehicle engine aims to optimize engine performance so that it can save fuel, has bigger power performance and inflicted emission can be pressed. To achieve it, a good synergy between sensor, actuator and its control center are needed.

Sensor roles as a collector of information mounted in the engine. Whereas control center acts as the data receiver which comes from the sensor, and then process it into specified control logic. So that it can produce “value” which then given to actuator. This actuator acts to realize a desired situation based on the amount of “value” resulted from the control center.

When the engine is cooler (lower temperature) especially in the morning, combustion chambers need to be conditioned, therefore the ideal engine heat can be reached sooner. Engine coolant temperature sensor is one of sensors which information becoming the reference as the condition determinant. This conditioning multiplies fuel injection to the combustion chambers.

This study is going to expose the role of engine coolant temperature sensor by analyzing the connectivity between the data of engine coolant temperature, time injection, and exhaust gas emission produced by the engine.

The beginning of fuel injection into the combustion chambers method started from 1970 up to 1980 where the system of fuel injection into the combustion chambers using carburetor system. This system intermingles the air and the fuel inside the carburetor. Along with exhaust gas emission regulation, air intermingling process between air and fuel experiences an increase on its setting pattern. Starting from the year 1970s, air mingling system and fuel establishes one generation of new setting pattern namely Electronic Fuel Injection (EFI) (TTA: 2010).

Electronic Fuel Injection (EFI)

Gasoline injection system with more well-known electronic control is called Electronic Fuel Injection (EFI), fuel injection volume is controlled electronically. The basis of this system has been going through many developments and been implemented by various vehicle brands, not only European made vehicles but also Japanese and American ones. The working of fuel injection injector is set by a Electronic Control Unit (ECU) which is known as ECM (Electronic Control Module) (Daihatsu: 2010).

Engine Coolant Temperature Sensor

Engine coolant temperature (WTS/ECT: engine cooling temperature) is made from thermistor, a resistor variable influenced by temperature. The working performance of ECT and IAT is similar, the difference is only on the sensor function. ECT functions to detect engine coolant temperature as ECM input in order to correct the amount of fuel injection on the injector.

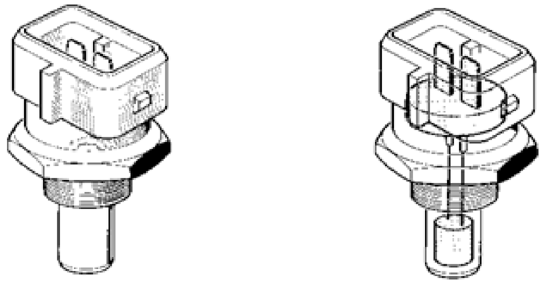

Fig 1. Coolant Temperature Sensor

ECT also functions as engine coolant temperature control toward the driver through temperature gauge mounted on instrument panel. Engine coolant temperature sensor is variabel resistance with NTC (Negative Temperature Coeffecient) sensing element which functions to provide information to ECU on engine cooling temperature. By having this sensing element thus: Cooling temperature is low, sensor resistance value is high. Conversely, coolant temperature is high, sensor resistance is low.

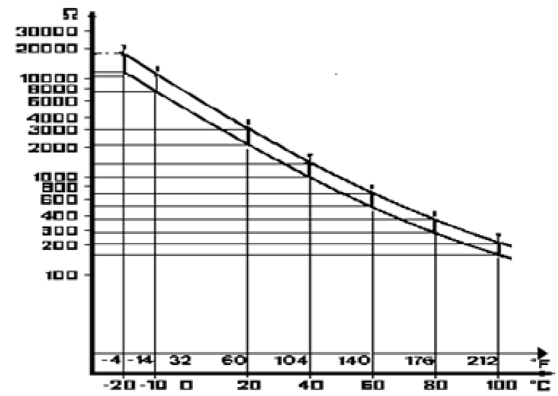

Fig 2. Graphic of Coolant Temperature Sensor Characteristic

Vehicle Exhaust Emission

Gasoline exhaust gas is hazardous compare to diesel engine. Commonly, gasoline exhaust gas is invisble, how ever it is dangerous for human life.

1) Gasoline engine is dominantly with CO, HC, and Pb.
2) Diesel engine is dominant with SO2 and Carbon elements causing exhaust smoke opacity.

The effort in reducing the emission negative effect is proven can be done by adding O2 sensor (D Sudarno Putra dkk, 2015).

Carbon Monoxide (CO)

Carbon monoxide (CO) emission from the combustion engine can be controlled particularly by air/ fuel ratio. The maximum CO is produced at the time the engine operates mixed with oil, like when the engine is started in cool condition or when it accelerates. CO (Carbon monoxide) is colorless and odorless. This gas occured when the fuel and C element does not receive sufficient bond with O2 , which means the air that flows into the cylinder chamber is lesser or excessive fuel supply.

Hydrocarbon (HC)

The composing of hydrocarbon (HC) emission is influenced by the original components of its fuel, combustion chambers geometry and engine operational parameter. If HC emission is entering the atmosphere, several of them are carsinogenic sensing elements which can cause cancer. HC (Hydrocarbon) is blackish, and aromatic. This gas occured when the combustion process on the combustion chambers does not work well or excessive fuel supply. The breakdown in ignition system is the major symptom. This gas can cause eyes irritation, nose and throat (ISPA) and eventually causing serious deseases.

Carbon Dioxide (CO_2)

The higher the CO2 substance in the exaust gas identifies that the more combustion occured inside the engine. Otherwise, the lower the CO2 level in the exhaust gas shows that the combustion efficiency is not good and in accordance with the engine performance. Another effect is : the level of CO and HC increase and so does fuel consumption. CO 2 level is measured in % volume unit. The average of CO2 level on four-stroke engine in a normal condition: engine with carburetor: 12-15 % vol, engine with EFI: 12-16 % vol, EFI engine with catalic converter: 12-17 %.

RESEARCH METHOD

This study uses descriptive research design. It is conducted in order to describe the role of engine coolant temperature sensor by analyzing the obtained data during the testing. More over, it utilizes Toyota Avanza engine year 2011 with thermocouple digital, engine scan tool, and engine emission analyzer as the data collector instruments.

The testing is conducted in the morning time when the engine is still in cool condition. The data collection is taken by using the data collection scheme as seen in Figure 3.

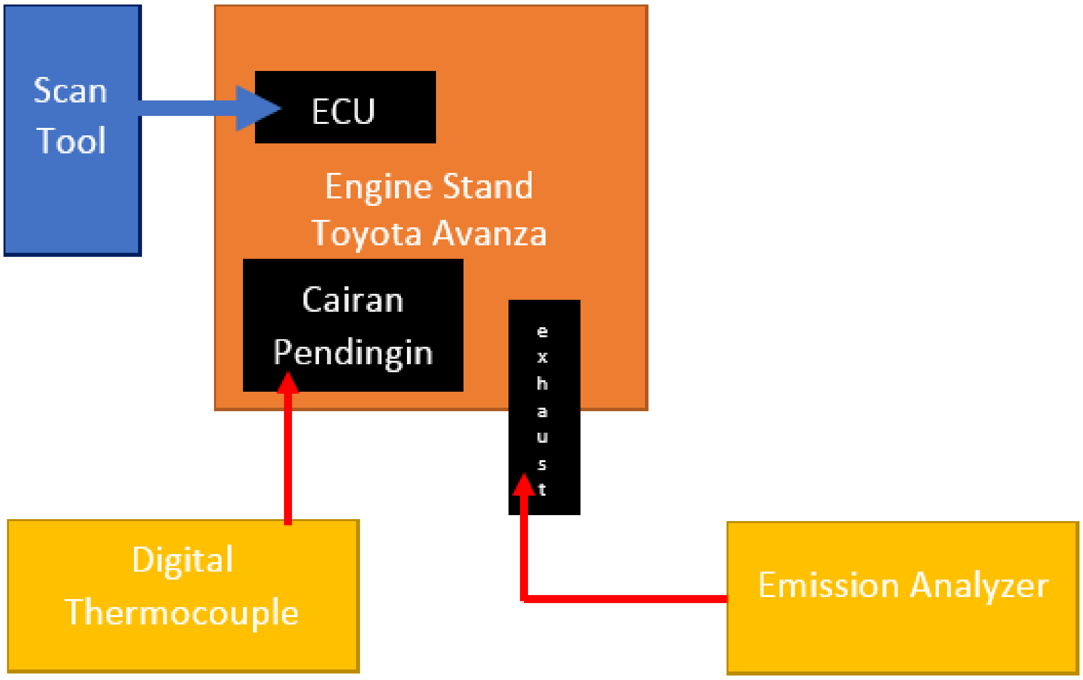

Fig 3. Data Collection Scheme

RESULT AND DISCUSSION

Result

The obtained data then undergoes tabulation into Table 1.

Table 1. Testing result on Stand Toyota Avanza Engine

Cooling Water Temperature (^{0}C)	Injection Time (μs)	Exhaust Gas Emission Contents	
		CO	HC
		%	ppm
40	2.048	0.05	296
45	2.176	0.02	62
50	2.048	0.01	34
55	2.048	0	21
60	1.920	0	18
65	1.920	0	14
70	1.792	0	13
75	1.792	0.01	0
80	1.792	0.01	0
85	1.792	0.01	0
90	1.664	0.02	0
95	1.664	0.02	0

Discussion

Cooling temperature and Injection time

Furthermore, the data taken from Table 1 then is generated to become a connectiviy graphic between cooling temperature and injection time, as presented in Figure 4.

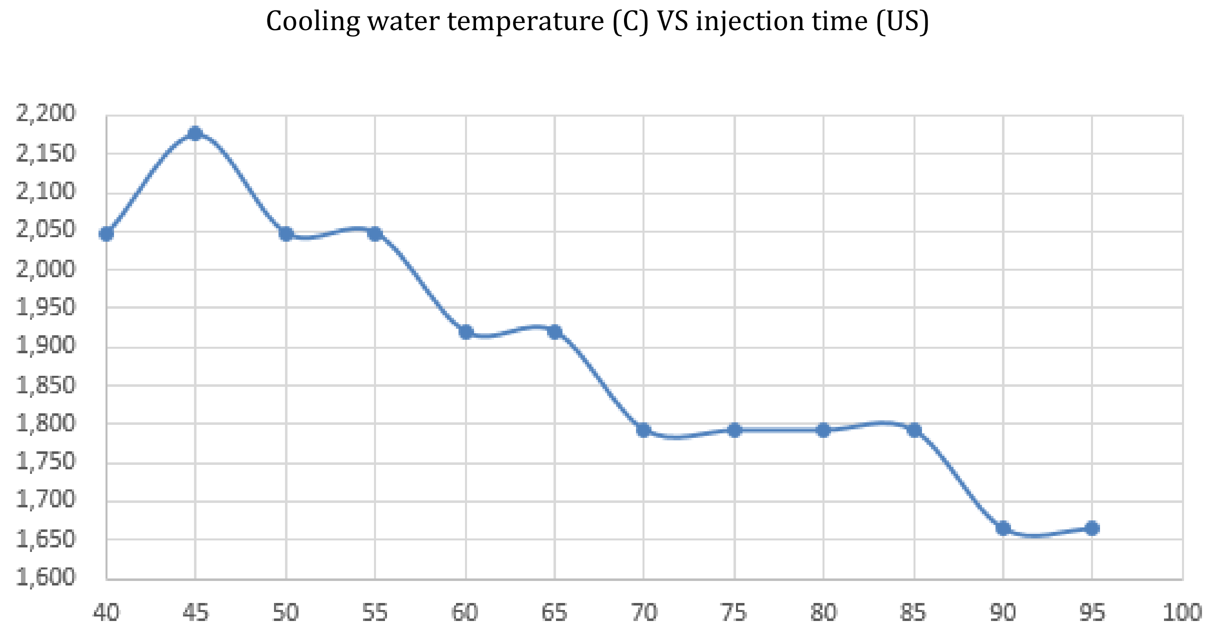

Fig 4. Graphic of Cooling Temperature vs Injection time

In Figure 4, it can be seen that there is connectivity tendency between cooling temperature and injection time. The tendency is the more increase the cooling temperature, the shortest the injection time.

Cooling temperature and exhaust gas emission content

The data taken from Table 1 is then generated to become a connectivity graphic between cooling temperature and emission content which resulted the graphic as viewed in Figure 5 and 6.

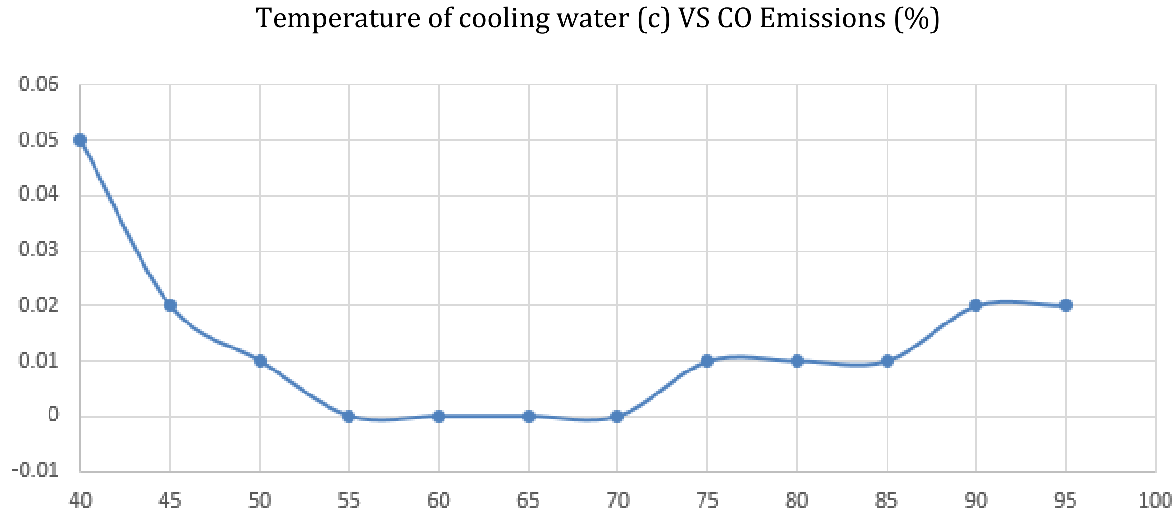

Fig 5. Graphic of Cooling Temperature vs CO Emission

In Figure 5, it can be seen that there is a connectivity tendency between cooling temperature and CO contents on exhaust gas. The occuring tendency is at the beginning of engine heating or before the engine heats, where the CO contents is relatively high.

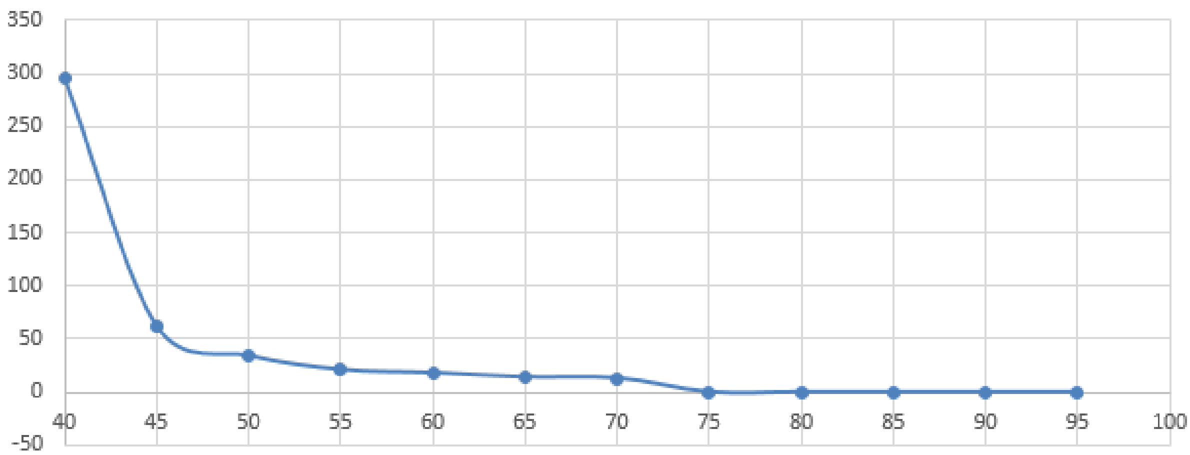

Fig 6. Graphic of Cooling Temperature vs HC Emission

In Figure 6, it can be stated that there is a connectivity tendency between cooling temperature and HC content on exhaust gas emission. The occuring tendency is the more increase the cooling temperature, the lower the HC content.

CONCLUSION

The result of this study proves that engine heat detected through coolant temperature sensor has connectivity with injection time. This injection time influences the combustion process where the longer the injection time, the more amount of fuel needed. So that the exhaust gas emission is then influenced as well. Demonstrably, the longer the injection time causes the tendency of exhaust gas emission becoming worse.

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