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Experimental Study of Heat Flow through the Cooling System of the Internal Combustion Engine in a Hybrid Vehicle WIPH

Wojciech Danek[a], Rafal Lawniczek[b]

[1]Silesian University of Technology, Faculty of Mechanical Engineering, Department of Theoretical and Applied Mechanics, 44-100 Gliwice, Konarskiego 18A, Poland

[a]Wojciech.Danek@polsl.pl, [b]Rafal.Lawniczek@polsl.pl*

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Abstract: In this paper authors present results of experimental studies of heat flow through the cooling system of the internal combustion VM MOTORI engine, which is used in the newly projected multi-purpose engineering hybrid vehicle (abbreviated as WIPH).

In order to determine the temperatures in each section of the cooling system, the temperature measurement was carried out in the engine control unit (ECU), via the contact sensor (RTD) and contactless (infrared FLIR camera).

Introduction

The study was conducted in the OBRUM Research Department in Gliwice. The study aimed to verify the operation of the internal combustion engine cooling system under different load on the developed test bench which included the following elements:

- VM MOTORI combustion engine with accessories,
- Cooler for an internal combustion engine VM MOTORI,
- Intercooler for an internal combustion engine VM MOTORI
- Radial fan driven by a hydraulic motor,
- The stand to testing and control of the engine,
- The measurement systems (HYDAC and FLIR infrared camera)
- Dynamometer.

Constructed stand and elements necessary for the test is shown in the picture below (Fig. 1).

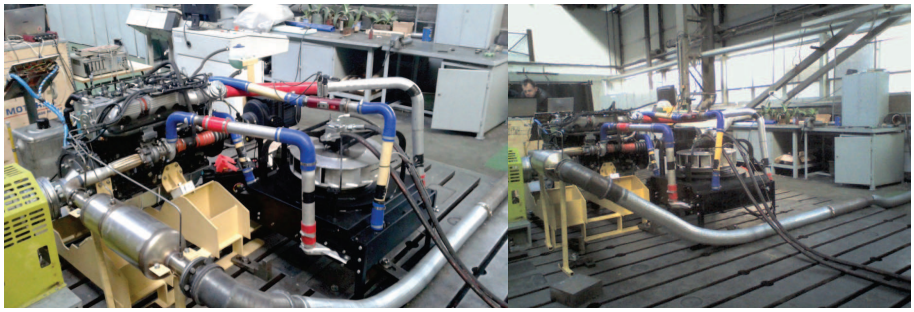

Fig. 1: Test stand

Experimental studies

The test stand described in the previous section was subjected to a series of tests to verify proper operation of the cooling system. Description of the tests and variations of engine parameters that were used is given in Table 1.

Changes of six parameters were recorded during each test, using a diagnostic interface of ECU.

The measured values were used to verify the correct operation of the cooling system and to verify the operation of the engine itself. The recorded parameters are shown in Table 2.

Tab. 1: Values of parameters during tests

No.	Engine speed [rpm]	Load of dynamometer [Nm]	Power supply of fan motor [l/min]*
1.	1500	400	16
2.	1500	400	32
3.	1500	400	48
4.	3000	330	64
5.	2300	400	70

*Fan motor was powered by hydraulic motor.

Tab. 2: Recorded parameters

No.	Parameter	Unit
1.	Engine speed	[rpm]
2.	Fuel consumption	[l/h]
3.	Engine coolant temperature	[°C]
4.	Engine load factor	[%]
5.	Torque of drive train	[Nm]
6.	Fuel rail pressure	[bar]

Results

The temperature measured during the test is shown in Fig. 3. However, to verify the changes in temperature of the cooling system authors used FLIR infrared camera. Sample images taken by the infrared camera are presented in Fig. 2.

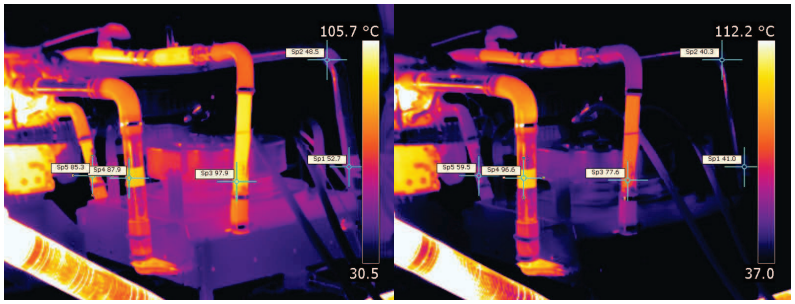

Fig. 2: Images taken by FLIR infrared camera

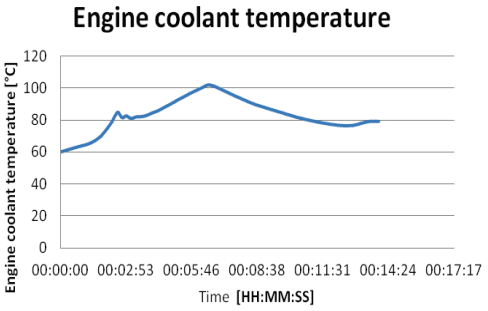

Fig. 3: Results from ECU

Summary

The effect of the variable and inflicted load on the combustion engine was studied. Results of the study were used to maximize the efficiency of the internal cooling system of the engine.

The measured data show that the necessary condition for proper operation of the system is to increase efficiency of the supply of hydraulic radial motor of the radiator fan.

When the flow rate was set at 70 l/min, the temperature ranged from 82 to 84 °C.

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