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Experimental Studies of Heat Flow Through the Radiator of Electric Motor in a Multi-Purpose Hybrid Vehicle (WIPH)

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Abstract: This article presents research process of the heat flow through the radiator of an electric motor in cooling system, which is used in the newly designed multi-purpose hybrid vehicle. Motivation of the research is to verify that the selected components included in the cooling system provide optimum working condition for the engine. For this purpose, a specialized test stand was designed for simulation of the actual conditions of the running.

In order to ensure the most accurate determination of temperatures occurring in each section of the cooling system the temperature was read both via contact sensors (RTD) and contactless (infrared camera).

Introduction

The proper temperature of the coolant circulating in the cooling system has a high importance for smooth operation of the engine. The hybrid vehicle WIPH is driven by two electric motors with a capacity of125kW each with efficiency at approx.90%. Maximum operating temperature specified by the manufacturer is 55 °C. The both engines emit a large amount of heat which has to be discharged from the system in order to allow work with the parameters recommended by the manufacturer.

Experimental studies

The study was conducted in the OBRUM Research Department in Gliwice. The study aimed to verify that the selected components of the cooling system will allow to provide optimum working condition for the engines. The test bench consisted of the following elements:

- UQM 125 motor,
- UQM 125 motor inverter,
- alternating current dynamometer,
- radiator of the electric motor,
- measurement systems developed for testing of the cooling system.

The complete test stand and measuring equipment is shown in Fig. 1.

Fig. 1: Test stand

The test stand was subjected to a series of tests to verify proper operation of the cooling system. During each test, the temperature in the system was measured with six sensors, whose arrangement is shown in Table1, and using an infrared camera measuring temperature at three spots.

Table1: Measured parameters in the system

No.	Sensor No.	measurement
1.	2	Coolant temperature behind the radiator [° C]
2.	3	Ambient temperature [° C]
3.	4	Coolant temperature before the radiator [° C]
4.	5	The air temperature behind the radiator [° C]
5.	6	The air temperature before the radiator [° C]
6.	7	Coolant temperature before engine UQM125 [° C]
7	HYDAC flowmeter	Coolant temperature behind the radiator [° C] Coolant temperature before the radiator [° C] Cooling fluid pressure [bar] Coolant flow [l / min]

Results

The measurement confirmed that the selected components of the cooling system ensure the uninterrupted operation of the engine. The maximal temperatures obtained in our case were 37°C where the maximum temperature at which motor can work (given by the manufacturer) is 55°C. Examples of results of the measurements using IR camera are shown in Fig. 2. Fig. 3 presents the temperature value obtained during the entire test in spots described in Table 1.

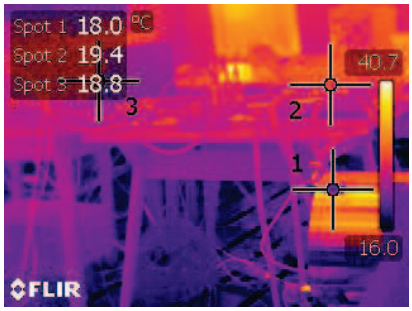

Fig. 2: Images taken by FLIR infrared camera

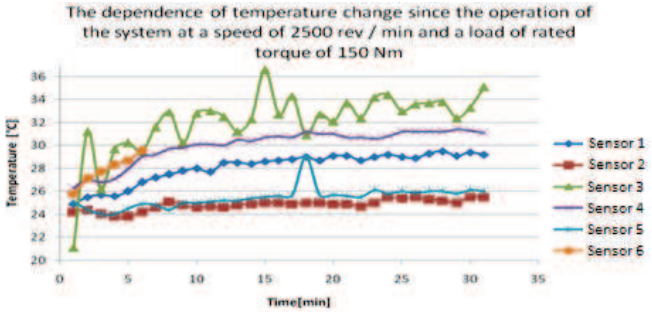

Fig. 3:Results from measurement system

Summary

On the basis of experimental studies of the cooling system of the engine UQM125 it was stated that the components of the cooling system(ie. the radiator and axial fans) were selected correctly. The selected components ensure operation of the engine with the greatest efficiency and protect UQM125 system from overheating.

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