International Journal of Engineering Research and Technology.
ISSN 0974-3154 Volume 6, Number 6 (2013), pp. 753-558

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Design and Development of Micro Controller Based Automatic Engine Cooling System

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Abstract

Traditional automotive cooling systems have relied on a mechanical coolant pump and a radiator fan driven off the engine's crankshaft. The dependence of the pump and fan operations on the engine speed often allowed the thermal management system to overcool the fluid, thus, decreasing the overall efficiency. The replacement of traditional automotive mechanical cooling system components with micro controller controlled engine cooling system can improve the efficiency of the internal combustion engine. In this paper the experimental test bench has been designed to investigate the efficiency of the internal combustion engine.

Keywords: Engine cooling system, thermal management system.

1. Introduction

Nowadays internal combustion engine plays an important role in many different industries like transportation, manufacturing etc. Due to the limited availability, environmental pollution and increasing cost of crude, the researchers are giving more attention to reduce the usage of fuel in internal combustion engine. In all the internal combustion engine only 25-30% of fuel energy is converted in to useful work and the remaining 70-75% of fuel energy is wasted due to friction, heat transfer in the cylinder wall, piston, inlet, outlet valves and cooling water. The percentage energy conversion in gasoline engine as shown in Fig. 1. Over the past few decades, many researchers are finding various methods to improve the efficiency of the internal combustion engine.

Among these methods by reducing the heat loss from the engine cylinder is most prominent method to improve the efficiency. In single cylinder engine the extended fins are used to reduce the loss from an engine, but in multicylinder engine the liquid is circulated over the cylinder block to remove the heat from an engine cylinder. The engine coolant is used for not only cooling purpose but also used to prevent corrosion to engine parts and used to maintain the heat in the engine cylinder.

The Fig 2. Shows the conventional engine cooling system. The conventional engine cooling system consists of mechanical pump, radiator, radiator fan, and thermostat. Among these components the efficiency of the conventional cooling system is mainly depends on the mechanical pump and the radiator fan. These components are connected with the engine crank shaft. The performance of the coolant pump and the radiator fan are mainly depends on the engine speed.

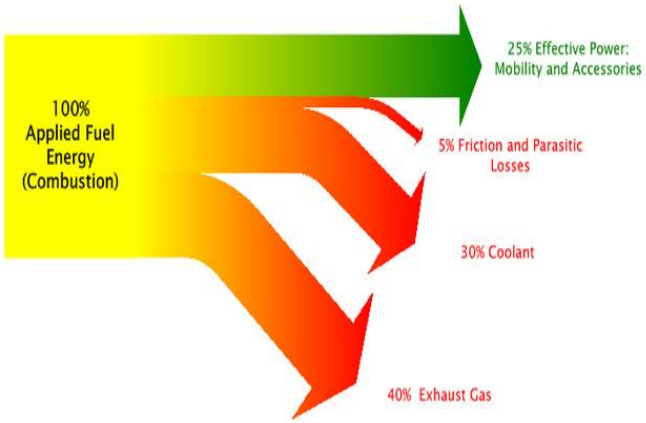

Figure 1: Percentage of energy conversion in internal combustion Engine

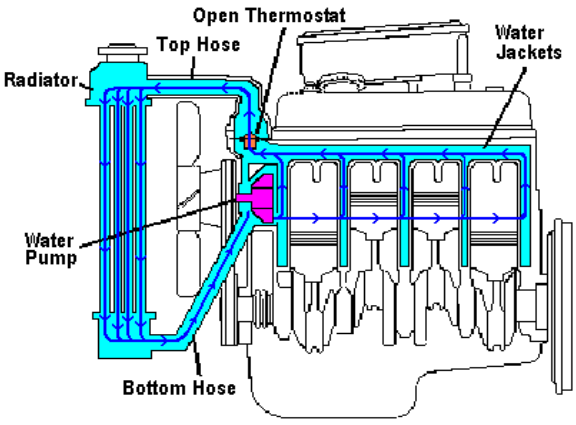

Figure 2: Conventional engine cooling system.

When the engine is running at very high speed the cooling system allow the thermal management system to overcool the fluid, due to this reason the thermal efficiency of the engine will decrease [1]. To overcome this drawback many researchers were modified and developed the advanced cooling systems by replacing the wax-based thermostat valve with a variable position smart valve, and upgrade the mechanical coolant pump and radiator fan with computer controlled servo-motor actuators. The researchers from automotive industries give their attention on electric actuators to drive the cooling system components with possible thermal management opportunities in HCCI applications using a coolant rail.

The different control methods and operating strategies have been proposed by different researchers to control the thermal management system components and to operate hydraulic-driven actuators. [2]-[8]. Hamamoto et al [9] developed an electronically controlled hydraulic cooling fan system which identified the optimum fan speeds per engine operating conditions. Liu and Alleyne [10] created a nonlinear control algorithm which tracked the force and pressure of an electro-hydraulic actuator with a single- stage servo-valve. In this paper the flow control valve is used to control the flow of engine coolant. The quantity of flow is depends on the engine speed and engine coolant temperature.

2. Experimental Test Bench

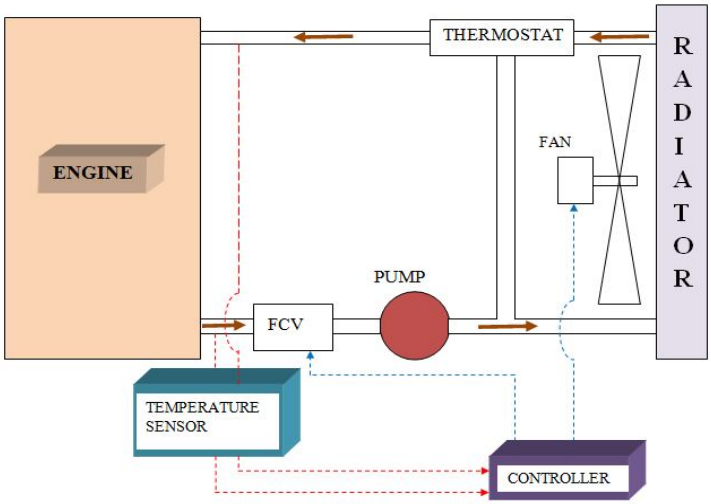

Figure 3: Microcontroller based automatic engine cooling system.

This experimental setup consists of the flow control valve, pump, electric fan, Radiator, thermostat, temperature sensor and DAQ controller. The flow control valve is connected to the outlet side of the engine cylinder block. This flow control valve is used to regulate the coolant flow rate. The pump outlet is connected to the radiator and gets back to the Engine. The PIC 16F87 microcontroller is used to as the controller in

this experiment. The temperature sensors are used to measure the temperature of the engine coolant at inlet and outlet side of the engine cylinder and the temperature sensors are connected to the DAQ controller. When the Engine is turned ON the coolant supply starts from coolant tank and enters pump and goes to radiator and then to the Engine this is the normal method. Once the temperature sensor senses the temperature of the engine it gives output to the controller send's the signal to flow control valve. Based on the controller output the flow control valve regulates the quantity of coolant. From this experimental result the thermal efficiency of the internal combustion engine is increased considerably and also the life of the cooling system components will increase.

3. Conclusion

The new type of engine cooling system was developed to improve the thermal efficiency of the internal combustion engine. This advanced engine cooling system consists of micro controller to control the quantity of coolant into the engine cylinder block. The thermal efficiency of the internal combustion engine is increased remarkably by using this type of engine cooling system.

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