A Novel Active Cooling System with Shape Memory Alloy Based Thermostat for Internal Combustion Engine

Pacifique Turabimana[1], **Jung Woo Sohn**[2,#]

1 Department of Aeronautics, Mechanical and Electronic Convergence Engineering, Kumoh National Institute of Technology, Republic of Korea
2 Department of Mechanical Design Engineering, Kumoh National Institute of Technology, Republic of Korea
Corresponding Author / E-mail: jwsohn@kumoh.ac.kr

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The harmful emissions and high fuel consumption after a period of operation for internal combustion engines have been always major problems in the automotive industry. One of the causes of those problems is the engine overheating, and malfunctioning of the thermostat. However, some thermostats are open and close mechanically based on the coolant temperature. For a period, they fail to operate properly and open or close without concern for the normal maximum coolant temperature. The modern ones on the market are electrically operated by using a heating element around the charge cylinder to melt the wax for quick contraction. After some working period, they also fail to achieve their normal working conditions that end with engine overheating problem. Thus, the objective of this research is to propose a new thermostat with a similar size and shape to the existing one. However, it operates without wax and has different components and configurations. It contains a shape memory alloy (SMA) spring that rounds a linking tube of the main valve on the radiator hose and the bypass valve to return water into the cylinder block. SMA spring works inside a bias spring that is made in stainless steel and both springs operate contrary to each other. Bias spring extends the SMA spring at its martensite phase to close the main valve and open the bypass. While at maximum coolant temperature, the SMA spring compresses the bias spring at its austenite phase after being supplied by an electrical current to close the bypass and open the main valve to let water flow from an engine block radiator. Hence, the supply of electrical current to the SMA spring depends on information from the coolant temperature sensor. Therefore, based on the shape memory effect and engine cooling system's equations, we develop a new active cooling system with an SMA-based thermostat. The simulation of the cooling system with a new configuration and existing ones have been done to analyze their effects on engine operation.

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