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Numerical Study on Heating Performance Characteristics of a Heat Pump System Recovering Battery Heat for Electric Vehicles

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Extended Abstract

These days, the most important issue for electric vehicles (EVs) is to increase driving performance within a limited battery capacity. One of the main factors affecting driving performance is the heating efficiency of the EVs' heating system. The heating efficiency decreases as the ambient temperature decreases, and more power is needed to improve the heating performance. As a result, the mileage decreases [1]. To overcome this issue, research about a heat pump system in EVs has been actively conducted. The heat pump has the advantage of excellent heating efficiency with less power consumption. In addition, it is possible to adapt a waste heat recovering system to a heat pump cycle. As the amount of energy available for the heat pump cycle increases, a heating efficiency of the cycle can be improved [2]. However, studies on the heat pump system recovering battery heat are hardly conducted [3]. In this study, the objective is to evaluate the heating and driving performance improvement of the heat pump system recovering battery heat under various operating conditions. Python was used for composing the simulation of EVs' heat pump cycle. Python has advantages of high productivity and versatility. The major components are composed of a compressor, a condenser, an expansion valve, and an evaporator. The simulation is validated by comparing the heat pump experimental data. The heating and driving performance of the battery heat recovering system are analyzed according to various cycle operating and battery conditions. For the cycle operating conditions, indoor temperature, external temperature, heat load amount, overheating degree, and supercooling degree are considered. For battery conditions, battery discharge rate, coolant temperature, and flow rate are considered. The heating coefficient of performance (COP) and mileage are investigated according to changes in the battery discharge rate, coolant temperature, and coolant flow rate. The heat recovery efficiency and heating COP increases as the battery discharge rate increases, because the chemical reaction increases the amount of the heat and the coolant temperature. On the other hand, as the discharge rate increases, the efficiency of the battery decreases which resulting in a decrease of the mileage decrease. As the coolant temperature increases, the heating COP increases, and the mileage decreases. This is because the efficiency of battery heat recovery increases as the temperature difference between the coolant and the outside of the vehicle increases. As the coolant flow rate increases, the heating COP and the milage decreases. As the flow rate increases, the coolant temperature decreases owing to the decreased heat recovery efficiency. In addition, the power consumption increases as the pump power increases. The battery heat recovering heat pump system shows better heating efficiency and increases mileage in electric vehicles.

References

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