Numerical Study on Immersion Cooling of an Electric Charger for Electric Vehicle Battery with Inlet Flow Rates

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Abstract:

One of the main drawbacks of electric vehicles (EVs) is the long charging time, and active research and development efforts are underway to overcome this issue. The charging time for EVs and efforts to shorten it has led to a significant increase in the required electrical energy due to the growing capacity of EV battery packs. During charging, the main source of heat is Joule heating, which is caused by resistance when current flows through the connector. Without adequate cooling, this can reduce efficiency and compromise safety. While air cooling was commonly used for charger cooling in the past, it is challenging for air's cooling capacity to meet the cooling demands under high-voltage, high-current rapid charging conditions. Therefore, this study conducts a numerical investigation of an immersion cooling method aimed at improving cooling performance by directly cooling the core conductor, which serves as the primary heat source. Numerical analysis was conducted using the thermal-fluid simulation software ANSYS Fluent. As fluid flows between the core conductor and the wire insulation, forming an annular pipe configuration, the Reynolds number of the fluid was calculated accordingly. A nonconductive working fluid was applied to assess the cooling characteristics of the charger connector based on different inlet flow rates and ambient temperatures.

Keywords:

Charger, Electric vehicle, Flow rate, Immersion cooling, Numerical study.