**VDR3: Prototype**

Team 507

Department of Mechanical Engineering, Florida State University

EML4551: Senior Design 1

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**Design Description:** The goal of our project is to increase the heat transfer within a hybrid vehicle battery by 5% over an industry standard. Our design should focus on innovation to battery cooling within the battery modules of a pouch cell battery. Some important aspects of our project that are critical to success are minimizing weight added to the module, minimizing volume added to the module, the ability to remove heat from the modules effectively, and minimizing pressure loss due to pumping coolant through the module. The design that we chose to move forward with consists of 3, 1 cm inner diameter aluminum pipes wrapped around the inner perimeter of the module with aluminum sheets spanning the area in between. The aluminum sheets will separate the 4 cells and transfer heat to the coolant filled pipes. Glycol based green coolant will be pumped into the pipes in order to maintain cooling effectiveness throughout usage. The pipes as well as the sheets will be Al 6061 T6 aluminum, as this material balances good thermal properties, weight, and cost in a manner that best satisfies our project requirements. The aluminum sheets will be wrapped around the pipes and welded to increase the surface area contact between the aluminum sheets and the pipes. The lower and middle pipes will be connected via tee joints to the inlet and outlet pipes, and the top pipe will be connected to the inlet and outlet by a 90 degree elbow. The pipes and connectors will be threaded to minimize leakage.

**Current and Future Work:** We are currently discussing methods we could use to test our design. We have proposed using temperature sensors at the pipe inlets and outlets as well as the volumetric flow rate of the coolant in order to calculate how much heat is removed from the system. We are also sourcing heating pads that can be used as the “cells” in our prototype testing. We have sourced all the supplies we need for our future prototype and will begin ordering as soon as a budget is discussed. In the future we will also be simulating our concept in Simulink and COMSOL in order to get a better understanding of our concept's behavior and effectiveness over time. Other areas of future work include determining the optimal mass flow rate of coolant throughout the module to find a balance between amount of heat transfer and pressure drop across the module.

**Problem Areas and Potential Solutions:** Since weight is an important factor to consider, the initial design of four cabinets was reduced to three to balance weight with the amount of heat removed. The total weight of the cooling concept (excluding the pouch cell weight) is 1.381 kg, which is 24% of the total weight of a 2018 Nissan Leaf module. This is slightly over the 20% target, so a conversation with our sponsor regarding tolerance will be had to see if this is acceptable or if further reductions in weight need to be made. Initially, the design was to weld a thin aluminum sheet to the edge of aluminum pipes so that heat may travel from the center of aluminum plates outwards toward the cooling pipes via temperature gradient. The difficulty of manufacturing this method was mentioned, and an alternative method of wrapping the edges of aluminum sheets around the cooling pipe and welding the sheet on itself was adopted. The dimensions of 2018 Nissan leaf battery modules that the pouch cell sizes are benchmarked off is 300 mm x 222 mm x 34 mm. The introduction of this new method would bring the outer module height to roughly 38 mm. We were told modifications could be made to dimensions, and an increase of 4 mm will be discussed with our sponsor to see if it is acceptable.