# Mechanical Engineering Thesis Defense

## Simulated Thermal Resistance of Thermogalvanic Cells with Triply Periodic Minimal Surface Structures using ANSYS

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## Abstract

Buildings release an abundance of waste heat that is left unused. Thermogalvanic cells (TGCs) can take advantage of waste heat to generate electricity with a low temperature gradient. In this dissertation I simulated the thermal transport of TGCs containing different triply Periodic minimal surface (TPMS) structures and compared to measured values and conducted a mesh convergence study to examine the viability of the CFD solutions. Natural convection effects are one of the driving forces in TGCs. Using the Bousinesq approximation, I was able to capture those effects in the CFD simulations as it accounts for the density variations of the fluid. TPMS structures in TGCs have been shown to increase thermal resistance thereby improving TGC performance. Upon simulating the TGC using the Schwarz P TPMS geometry, the cathode temperature converged as I refined the mesh and approached the measured value. As for the IWP TPMS structure, the solution converged as I refined the mesh, despite having a deviation to the measured values. This was due to the abundance of sharp regions along the walls of the TPMS that ANSYS had difficulty to accurately model.Furthermore, I simulated the TGCs using different boundary condition approximations to observe the cathode and anode temperatures as well as their overall \$\Delta T\$ across the cell. For the TGC containing the Schwarz P geometry, the most accurate approximation to the measured values was \textbf{Case C}. While \textbf{Case D} deviated from the measured values, it had the most accurate \$\Delta T\$ and was well within the uncertainty bounds of the measured values. \textbf{Cases A \$\&\$ B} deviated both from the electrode temperature and the \$\Delta T\$ across the TGC. The deviations are related to the experiments as well as the additional approximations imposed on the simulations. Moreover, the TGC containing the IWP structures presented interesting results. The anode temperatures for \textbf{Cases A-C} were close to the measured values. The main deviation was from the cathode temperatures. Higher temperature readings meant that more cells in the fluid domain were prone to diverging, thereby resulting in a higher calculated cathode temperature.

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Zoom Link: https://asu.zoom.us/j/82264314147