Computational Fluid Dynamics Study of an Atmospheric Water Generator

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Introduction

The goal of this project is to use Computational Fluid Dynamics (CFD) to study an Atmospheric Water Generator (AWG). The purpose of this is to aid the development of an optimal AWG configuration. The AWG utilizes a thermoelectric cooler (or Peltier) which is a device that when powered, transfers heat from one surface of the device to the other. This results in a very hot side and a very cold side. Under the right atmospheric conditions (dry bulb temperature and humidity), the cooling of the Peltier device allows humid air to be converted into moisture.

Method

Computational Fluid Dynamics is a branch of fluid mechanics that uses numerical analysis to solve for fluid flows with or without solid interaction. A CFD analysis examines fluid flow in accordance with its physical properties such as velocity, pressure, temperature, density and viscosity. In this project, it is used primarily to study the heat exchange between the solids in contact and between the solids and the ambient air conditions.

A base run of the study is conducted testing the Peltier at 1A, with the aim of studying the simultaneous heating and cooling effect of the Peltier. The images below are a comparison of the initial study with and without fan generated air flow.

Conclusion and Future Works

The initial conjecture was that the heated air flowing out of one heat sink would flow into the other. The CFD analysis has shown that the air in this scenario behaves as an incompressible fluid and would never flow into a heat sink that also has heated air flowing out of it. Future works involves using CFD to find an optimal method of cooling an assembly of multiple AWG units. The study would compare the difference in cooling using small fans for individual AWG units versus using a large fan to cool up to four AWG units. It will also be used to check different orientations that might affect the cooling so as to optimize the efficiency of the Peltier.

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References

“Specification of Thermoelectric Module-TEC1-12706”. Thermonamic Module