Numerical Modeling on a Two-Stage GM Cryocooler

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Numerical modeling plays an important role in developing new or improving existing cryocoolers. It enhances design optimization and performance evaluation through the study of physical parameters that are usually impractical to measure. In the current cryogenics industry, cryocooler modeling is primarily conducted using 1D tools, such as Regen 3.3 and Sage. However, there are only a few works applying Computational Fluid Dynamics (CFD), despite CFD being one of the most powerful 3D multiphysics modeling tools available in market and capable of providing more comprehensive data than 1D simulations. More importantly, CFD simulations can represent flow patterns visually allowing engineers to understand complex thermal fluid systems like cryocoolers deeply.

In this work, a cycling two-stage GM cryocooler has been conducted using the commercial software, Ansys-CFX. A robust two-stage model was built by considering a quarter of the axisymmetric 3D cryocooler and set up by taking advantages of advanced Ansys-CFX features, such as dynamic meshing, turbulence options, and porous domain settings. Reliable solutions were obtained over entire 3D domains of the model. From the simulation results, regeneration materials and matrix dimensions were evaluated based on the 2nd stage cooling capacities. The temporal and spatial variations of pressure, temperature and Reynolds Number were also studied. Finally, the results were compared against available experimental data to