Thermodynamic Analysis and Design of Miniature BLDCM Driven Crank Driven Cooler

K. Santhosh, B.T. Kuzhiveli, Centre for Adv. Studies in Cryogenics (CASC), Nat'l Inst. of Tech., Calicut, India

Stirling cryocoolers are widely used in the cooling purpose of military, satellite imaging cameras and other applications. Stirling cryocooler working is based on Stirling cycle. The cryocooler consists mainly compression piston, regenerator and expansion piston. Generally crank driven compressors driven by BLDC motor. These are smooth, silent and at the same time system runs with low vibration and acoustic noise. Helium gas used as refrigerant. Crank used in the design to maintain a ninety-degree phase difference between compression piston and expansion piston to achieve realistic process. There are many losses in the cryocooler such as conduction loss through solid bodies, temperature swing loss, regenerator ineffectiveness loss, pressure drop loss, shuttle conduction loss etc.sage 6.0 and regen3.3 are Graphical interface that support simulation and optimization. Sage software is used to model and optimize Stirling cycle engines and coolers, pulse-tube cryocoolers, and other types of cryocoolers. Mass, momentum, energy equations are solved by numerical analysis for 1-D fluid flow with charge pressure of 30 bar. In order to reduce losses in regenerator a clear study helps us to find optimum parameters which are suitable to give better coefficient of performance. In this step the length of regenerator bed, diameter are fixed, and the two ends of regenerator such as, warm end and cold end are maintained at a temperature of 300 K and 80 K respectively. The use of multi mesh in the regenerator helps in enhancing the performance of the cooler. In the later stage complete cryocooler is studied by a software tool sage6.0. A systematic Sage software model is made with each and every component and analysis done for cryocooler to get 1.5 W cooling capacity with less than 20 W compressor input power. The variation of COP, refrigeration effect, Work input and other with the operating parameters are studied.