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Parametric Investigation of multi-mesh Regenerator of a Miniature Stirling Cryocooler

Stirling cryocoolers find applications in various military, commercial and scientific projects which require cooling of infrared (IR) sensors, imaging cameras and optical elements. They are used to produce cryogenic cooling in the range of 60-80 K with the cooling power ranging from mW to a few watts. The performance of the cooler largely depends on the effectiveness of the regenerative heat exchanger used in the system. An attempt was made to optimize a 3-mesh regenerator for a Stirling cryocooler operating between a hot end temperature of 300 K and cold end temperature of 80 K using REGEN 3.3. Three mesh regenerators made up of different combinations of #200, #250, #300, #400 and #450 Stainless Steel wire meshes were considered. The study was carried out by varying the average pressure from 10 to 30 bar and the operating frequency from 20 to 80 Hz. The output given by REGEN 3.3 includes the gross and net cooling power, thermal losses, and associated pV work at the cold and warm ends of the regenerator. The optimization of regenerator is defined for a regenerator design that minimizes the required work supplied at the warm end to achieve a desired cooling power at the cold end. Thus the optimization is achieved by maximizing the COP, which is calculated from the net cooling power and pV work at the warm end of the regenerator. The COP is a function of length of each subsection of 3- mesh regenerator, mass flow and the phase between the cold end mass flow and pressure. After the analysis the optimum geometric and operating parameters of the 3-mesh regenerator was obtained. The results obtained from the analysis are helpful for the complete design and development of a miniature Stirling cryocooler.

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