



Contribution ID: 722

Type: **Contributed Oral Presentation**

C2Or1C-01: Numerical investigation of the efficiency potential of a cryogen-free VM type pulse tube cooler

Tuesday, July 23, 2019 11:00 AM (15 minutes)

Vuilleumier (VM) type pulse tube cooler is a novel kind of cryocooler to obtain liquid helium temperature which had been experimentally verified. However, the efficiency is not satisfying. Based on previous work on a low pressure ratio system, a numerical investigation that explore the effect of high pressure ratios on refrigeration performance is presented in this paper. The research system is a cryogen-free in which a Stirling type pulse tube cooler is used to provide the cooling power required for the thermal compressor and offers adjustable pre-cooling temperature for optimum efficiency. Firstly, by increasing the displacer swept volume to increase the pressure ratio, the dimensions of main components were optimized with the lowest no-load temperature as the optimization target. Then the dependence of system performance on average pressure, frequency and pre-cooling temperature were studied. Finally, the effect of pre-cooling temperature on overall cooling efficiency at 5 K was studied. Compared with the previous low efficiency under low pressure ratio, a higher relative Carrot efficiency of 1.05% was predicted with an average pressure of 2.5 MPa, a frequency of 3 Hz and pressure ratio of 1.89. Further optimization is underway.

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Session Classification: C2Or1C - Non-Aerospace VM and Thermoacoustic Cryocoolers