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C3Or3C-07: Research on the Influence of Average Pressure on the Thermodynamic Cycle and Performance of Pulse Tube Cryocoolers

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With the increasing demand for miniaturized and high-performance pulse tube cryocoolers in space exploration, infrared remote sensing and other fields, how to improve the refrigeration quantity of pulse tube cryocoolers per unit volume has become the key to meet this demand. To improve the refrigeration quantity of a pulse tube cryocooler per unit volume, it is necessary to increase the energy transfer density of the working fluid per unit volume. The average pressure, as a key parameter affecting the energy transfer density of the working fluid, not only affects the thermodynamic cycle inside the pulse tube cryocooler, but also has a significant impact on the refrigeration performance of the cryocooler. In this study, a one-dimensional model of linear type pulse tube cryocooler based on Lagrange method is developed, and the mechanism of the influence of average pressure on the energy transfer density of working fluids is researched by this model. This study also validated the accuracy of numerical calculations and the rationality of theoretical analysis based on experimental research. The experimental results are consistent with the theoretical analysis, and the deviation between the numerical calculations and experimental results is between 10% and 20%. Based on the above mechanism, the selection methods of average pressure in different situations are summarized, and it provides theoretical support for high energy density pulse tube cryocoolers.

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