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C3Po1D-04: Numerical study on two-stage Stirling cryocooler with a long second expansion space

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Design of two-stage Stirling cryocooler with a unique long second expansion space volume is proposed to effectively reduce the displacer length and mass. The thermodynamic performance of this cooler which is similar to a pulse tube cryocooler with the warm-end expander is investigated by the numerical analysis. The long expansion space at the second stage behaves as a pulse tube with a temperature gradient along the longitudinal direction. Similar to the conventional two-stage Stirling cooler, the displacer simultaneously recovers the expansion work at the first stage expansion space and the warm end of the second stage expansion space. Although the long expansion space is an additional compliance volume to the second stage, the stepped displacer can still produce sufficient phase shift for both regenerators at the first and the second stages. This configuration brings the advantage of recovering the expansion work and eliminating the moving part at the coldest region of the cooler. The designed two-stage Stirling cryocooler has a cooling power of 10 W at 50 K and 30 W at 100 K with the input PV power of 404 W. The detailed thermal analysis presents its characteristic with the comparison to a conventional two-stage Stirling cryocooler which has the same displacer diameters.

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