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C1Or1C-01: CFD study of the 2D gas piston in pulse tube cryocoolers

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There are three parts of the gas moving through the pulse tube of the pulse tube cryocooler, part I is the gas moving between the cold heat exchanger and the pulse tube, part II is the gas oscillating in the pulse tube all the time, part III is the gas moving between the pulse tube and the warm heat exchanger. The part of the gas that always moves in the pulse tube acts the same function of a solid piston, this part of the gas is called the gas piston. The shape and the position of the gas piston change with time and the operating conditions rather than remaining fixed. And the 1D model cannot reflect the change of the gas piston near the wall, but the 2D model can be realized. Also, the uniformity of the fluid flow field in the pulse tube can be demonstrated by the shape of the gas piston which can be simply envisioned as a 2D gas piston in the pulse tube. In this study a CFD method is used to obtain the details of the 2D gas piston. The velocity field in the pulse tube is obtained by the commercial code ANSYS Fluent, and a LaGrange particle tracing method is introduced to process the velocity data in order to obtain the boundary of the 2D gas piston. Additionally, this work investigates the influence of various parameters including pressure ratio, pulse tube aspect ratio and frequency on the shape of the gas piston. It reveals that larger pressure ratio, larger aspect ratio and lower frequency cause a larger deformation of the gas piston in one cycle. These effects are especially noticeable at the warm end of pulse tube, which displays a larger deformation than other positions in the pulse tube under the influence of changes in those parameters.
Keywords: Pulse tube cryocooler, CFD, 2D Gas piston

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