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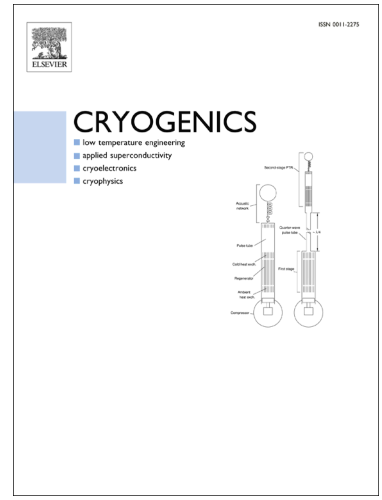

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Experimental study of the influence of cold heat exchanger geometry on the performance of a co-axial pulse tube cooler

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Abstract

Improving the performance of the pulse tube cooler is one of the important objectives of the current studies. Besides the phase shifters and regenerators, heat exchangers also play an important role in determining the system efficiency and cooling capacity. A series of experiments on a 10 W @ 77 K class co-axial type pulse tube cooler with different cold heat exchanger geometries are presented in this paper. The cold heat exchangers are made from a copper block with radial slots, cut through using electrical discharge machining. Different slot widths varying from 0.12 mm to 0.4 mm and different slot numbers varying from around 20 to 60 are investigated, while the length of cold heat exchangers are kept the same. The cold heat exchanger geometry is classified into three groups, namely, constant heat transfer area, constant porosity and constant slot width. The study reveals that a large channel width of 0.4 mm (about ten times the thermal penetration depth of helium gas at 77 K, 100 Hz and 3.5 MPa) shows poor performance, the other results show complicated interaction effects between slot width and slot number. These systematic comparison experiments provide a useful reference for selecting a cold heat exchanger geometry in a practical cooler.

***Keywords**:* cold heat exchanger; co-axial; pulse tube cooler; slot number; slot width

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1 introduction

In comparison with the traditional regenerative coolers such as G-M and Stirling coolers, the pulse tube cooler with no moving parts in low temperature region has the advantages of simple structure, high reliability, low mechanical vibration and low cost [1]. In retrospect, the quick development of Stirling type pulse tube coolers in the past two decades mainly benefited from the improvements of phase shifters[2-4] and regenerators[5-7]. On the other hand, the heat exchangers are also important. Insufficient heat transfer inside both ambient heat exchangers and cold end