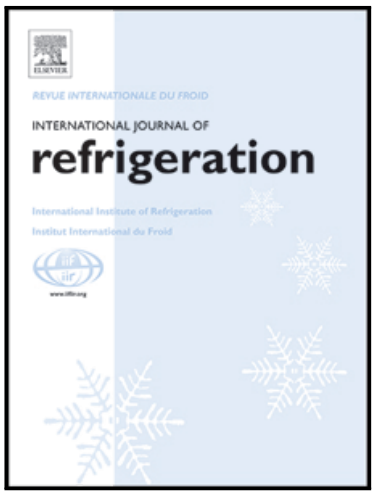

Experimental Investigation of Pulse Tube Refrigerator with Rod Type Displacer as Phase Shifter

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Highlights

A pulse tube refrigerator with rod type displacer as phase shifter is successfully built.

Input voltage, charge pressure and frequency were studied.

The relative Carnot efficiency of 15.3% was obtained.

Cooling power increases with voltage increasing without decreasing efficiency largely.

Experimental Investigation of Pulse Tube Refrigerator with Rod Type Displacer as Phase Shifter

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Abstract: Pulse tube refrigerator with rod type displacer as phase shifter has higher theoretical efficiency. A preliminary experiment just got efficiency less than 10%. The refrigerator is improved by changing the linear compressor with a new one for studying its basic character in this paper. A Relative Carnot efficiency of 15.3% is obtained at 99.8K with 30.0W cooling power. There is an optimum voltage for efficiency. Cooling power can be adjusted in a wide range with voltage change without big loss of efficiency, which is a very unique character of displacer type pulse tube refrigerator.

Key words: Pulse tube refrigerator, Displacer, Linear compressor

1. Introduction

With the appearance of various types of the pulse tube refrigerators, such as orifice type(Mikulin et al., 1984), double inlet type(Zhu et al., 1990) and inertance tube type(Kanao et al., 1994; Tominaga, 1992), pulse tube refrigerators are widely used in many fields, such as aerospace, superconductivity, and liquefied natural gas (LNG) etc.. The pulse tube refrigerators have many advantages, such as small vibration, compact structure, efficient performance and long lifetime. However, the efficiency of the pulse tube refrigerator is still lower than that of the Stirling refrigerator. The efficiency of the space using pulse tube refrigerator is less than 20% (Durand et al., 2014; Liu et al., 2017), 22% is the high performance one till now (Hu et al., 2010). The efficiency of Stirling refrigerator can be over 30% (Penswick et al., 2014). One of the reasons is that the expansion work cannot be recovered from the hot end of pulse tube in the traditional refrigerator. The efficiency of the pulse tube refrigerator will be improved if the expansion work can be recovered by a

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