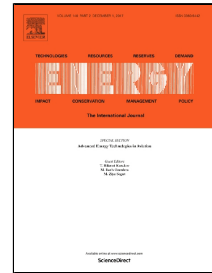


Accepted Manuscript

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PII: S0360-5442(17)32122-9
DOI: 10.1016/j.energy.2017.12.079
Reference: EGY 12028
To appear in: *Energy*
Received Date: 03 May 2017
Revised Date: 13 December 2017
Accepted Date: 16 December 2017

Please cite this article as: Shaowei Zhu, A new concept of cold resonator pulse tube refrigerator, *Energy* (2017), doi: 10.1016/j.energy.2017.12.079

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A new concept of cold resonator pulse tube refrigerator

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Abstract

Since the invention of the pulse tube refrigerator, improvements have mainly focused on developing new phase shifters, while the basic structure of the cold head is not changed much. With the combining of step piston pulse tube refrigerator with thermoacoustic refrigerator, a new concept called resonator pulse tube machine is proposed. It is investigated by a numerical simulation, which shows that it can work as a refrigerator or a cold engine depending on the swept volume ratio of the step piston compressor.

Keywords:

Pulse tube refrigerator

Thermoacoustic refrigerator

Resonator

Cryocooler

Regenerator

Cold engine

Introduction

The development of a pulse tube refrigerator depends on inventions, discoveries and understanding of the basic working mechanism of the pulse tube refrigerator. From the basic pulse tube refrigerator¹, orifice pulse tube refrigerator²⁻³, double inlet pulse tube refrigerator⁴, inertance tube pulse tube refrigerator⁵⁻⁸ to piston or displacer type pulse tube refrigerator⁹⁻¹³, the efficiency of the pulse tube refrigerator is improved step by step. The piston or displacer type pulse tube refrigerator have two moving parts though their theoretical efficiency is high. To get high efficiency with one moving part, step piston pulse tube refrigerator¹⁴⁻¹⁵ is introduced.

In a thermoacoustic refrigerator¹⁶, a no-load temperature of -65°C was reached. It is rather higher than that in the pulse tube refrigerator. This refrigerator is a standing wave type, we may call it as standing wave thermoacoustic refrigerator. There is no much progress of achieving lower no-load temperature¹⁷.

If combine the standing wave thermoacoustic refrigerator with step piston pulse tube refrigerator, a new type pulse tube refrigerator called resonator pulse tube refrigerator is generated. Its cold head consists of an after cooler, a regenerator, a cold heat exchanger, a resonator, and a pulse tube. The after cooler and pulse tube are connected to the compression space and expansion space of the step piston compressor

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