

Accepted Manuscript

Analysis and Comparison of Different Phase Shifters for Stirling Pulse Tube Cryocooler

Tian Lei, John M. Pfotenhauer, Wenjie Zhou

PII: S0011-2275(16)30042-X

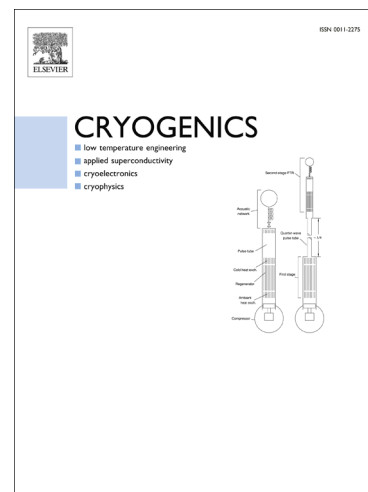
DOI: <http://dx.doi.org/10.1016/j.cryogenics.2016.09.007>

Reference: JCRY 2626

To appear in: *Cryogenics*

Received Date: 17 February 2016

Accepted Date: 15 September 2016



Please cite this article as: Lei, T., Pfotenhauer, J.M., Zhou, W., Analysis and Comparison of Different Phase Shifters for Stirling Pulse Tube Cryocooler, *Cryogenics* (2016), doi: <http://dx.doi.org/10.1016/j.cryogenics.2016.09.007>

This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

Analysis and Comparison of Different Phase Shifters for Stirling Pulse Tube Cryocooler

Tian Lei^{a,*}, John M. Pfothhauer^b, Wenjie Zhou^b

^aDepartment of Energy Conversion and Storage, Technical University of Denmark, Denmark

^bSolar Energy Lab., College of Engineering, University of Wisconsin-Madison, USA

Abstract

Investigations of phase shifters and power recovery mechanisms are of sustainable interest for developing Stirling pulse tube cryocoolers (SPTC) with higher power density, more compact design and higher efficiency. This paper investigates the phase shifting capacity and the applications of four different phase shifters, including conventional inertance tube, gas-liquid and spring-oscillator phase shifters, as well as a power recovery displacer. Distributed models based on the electro-acoustic analogy are developed to estimate the phase shifting capacity and the acoustic power dissipation of the three phase shifters without power recovery. The results show that both gas-liquid and spring-oscillator phase shifters have the distinctive capacity of phase shifting with a significant reduction in the inertial component length. Furthermore, full distributed models of SPTCs connected with different phase shifters are developed. The cooling performance of SPTCs using all four phase shifters are presented and typical phase relations are analyzed. The comparison reveals that the power recovery displacer with a more complicated configuration provides the highest efficiency. The gas-liquid and spring-oscillator phase shifters show equivalent efficiency compared with the inertance tube phase shifter. Approximately 10-20% of the acoustic power is dissipated by the phase shifters without power recovery, while 15-20% of the acoustic power can be recovered by the power recovery displacer, leading to a maximum coefficient of performance (COP) above 0.14 at 80 K. A merit analysis is also done by presenting the pros and cons of different phase shifters.

Keywords: Stirling pulse tube cryocooler, phase shifter, gas-liquid phase shifter, spring-oscillator phase shifter, power recovery

1. Introduction

In recent decades, the SPTC has attracted substantial attention due to the advantages of avoiding moving parts at cryogenic temperature, low vibration and reliable operation.

*Corresponding author, E-mail: tile@dtu.dk

Download English Version:

<https://daneshyari.com/en/article/5444223>

Download Persian Version:

<https://daneshyari.com/article/5444223>

[Daneshyari.com](https://daneshyari.com)