Performance Evaluation of a 3D Printed Low Temperature Difference and Source Gamma Type Stirling Engine

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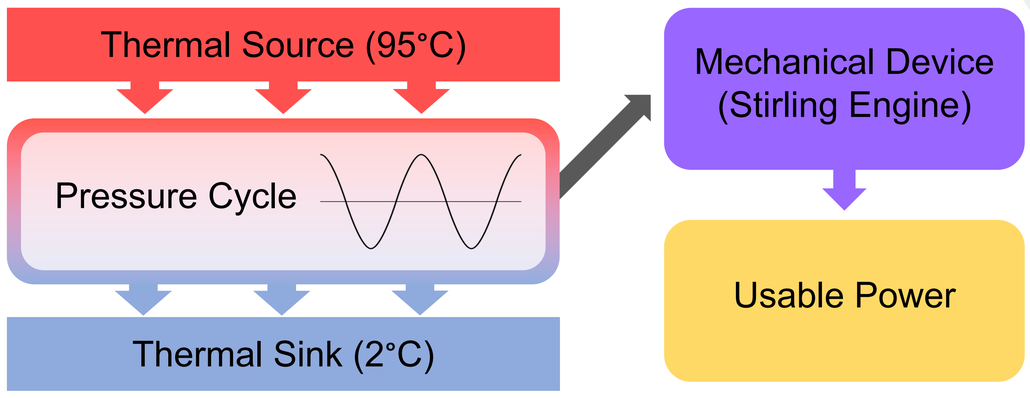
BACKGROUND

Stirling engines are a type of closed cycle heat engine that are able to extract power from a cyclic pressure change that is produced from the heating and cooling of a working fluid caused by a temperature difference between a thermal source and sink. Stirling engines also make use of a regenerator that work as both an internal thermal storage device and an internal heat exchanger, that can increase performance.

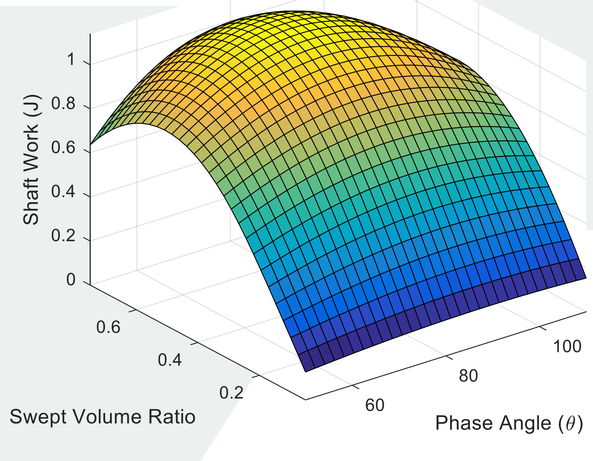


AIMS AND OBJECTIVES

Develop a gamma Stirling engine with a modular design that included:

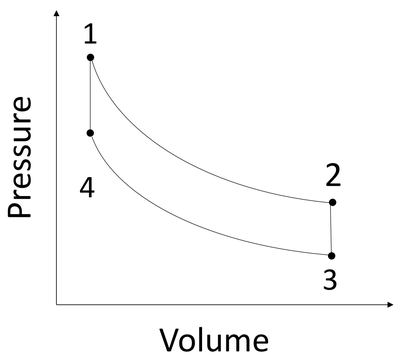
- Modular Heat exchangers
- Modular Regenerator
- Power Piston with:
  - Adjustable stroke
  - Adjustable phase angle

Performance test developed engine



DESIGN AND RESULTS

Ideal Stirling Engine Cycle

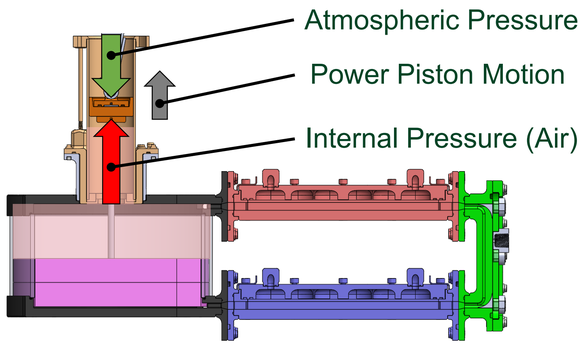


1 → 2 Expansion

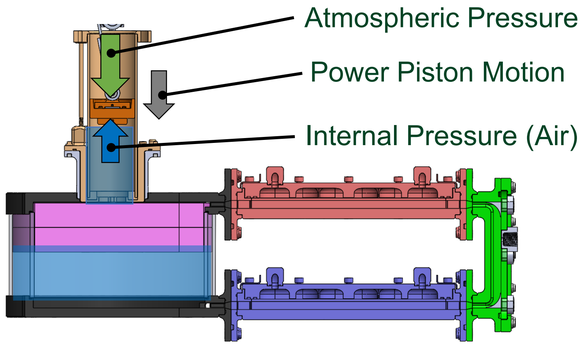
2 → 3 Heat Rejection

3 → 4 Compression

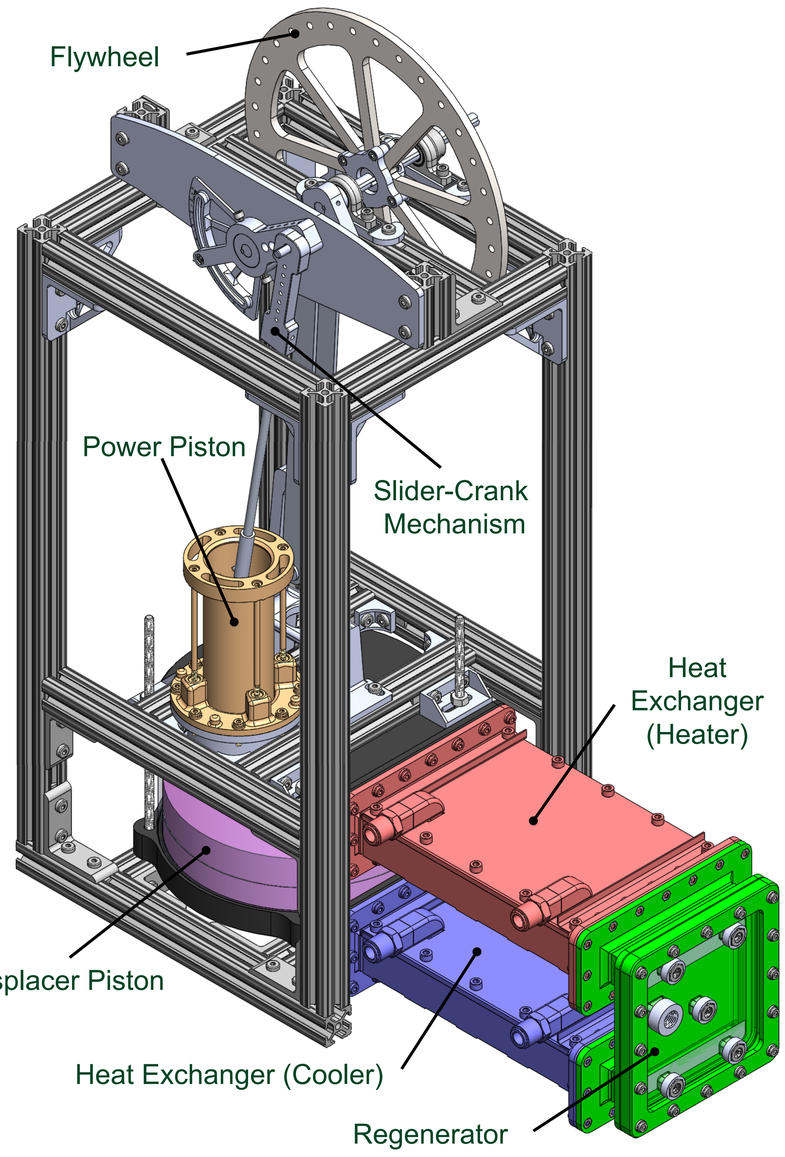
4 → 1 Heat Addition



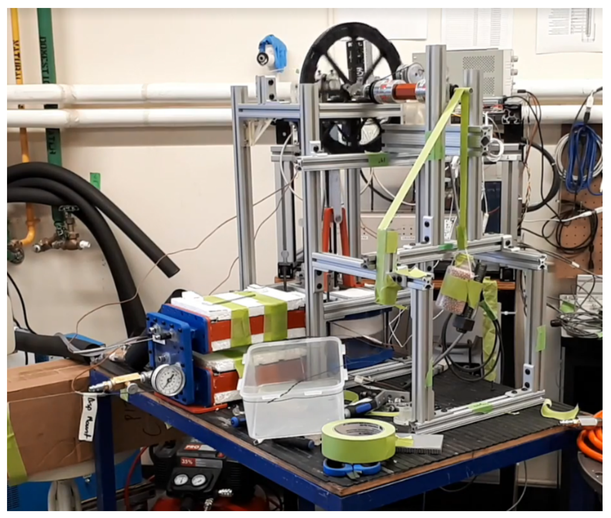
Expansion Stroke Schematic



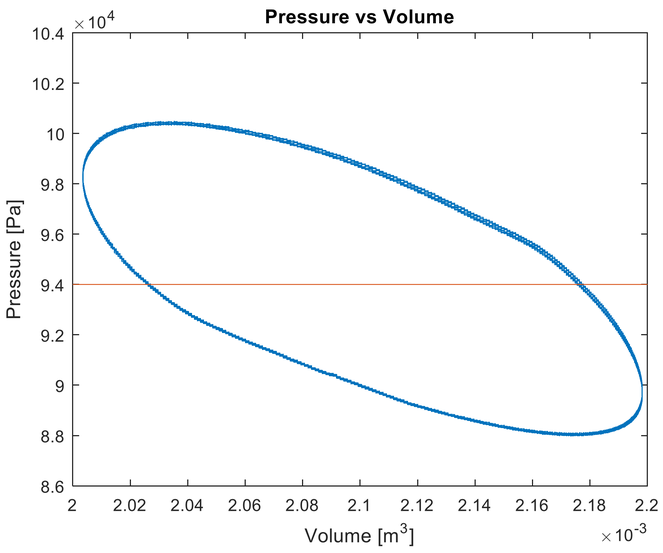
Compression Stroke Schematic



Gamma Stirling Engine



Experimental Setup



Experimental Pressure Volume Diagram

FUTURE DIRECTIONS

- Determine maximum engine performance by finding optimal: swept volume ratio, phase angle
- Compare steady state heat transfer correlation to a transient cycle
- Predict engine performance for larger scales

PARTNERS

- Alberta Innovates
- Terrapin Geothermics Inc.

FES PROJECT OVERVIEW

This Future Energy Systems (FES) project is part of the Geothermal Theme, entitled **Optimizing Geothermal Energy Production and Utilization Technology** (FES T05_P03) With the vast amount of energy available in geothermal reservoirs identified throughout Alberta, a new technology is need to access and convert this low grade heat into a useful form. This means converting available fluid temperatures, typically <100 ℃ into electricity or space heating. This project focuses primarily on the development of proof-of-concept and viability studies of ultra-low maximum temperature (ULT_{max}) Stirling engines, their design and the development of predictive models for system scale up and development.

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