DESIGN, MANUFACTURE & PERFORMANCE TESTING OF A STIRLING ENGINE

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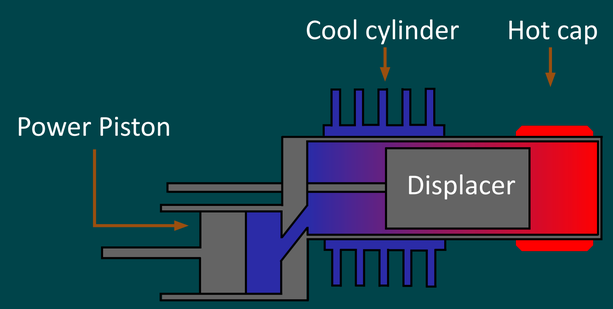
BACKGROUND

Stirling engines are a heat engine first patented by Robert Stirling in 1816. There is currently a growing interest in Stirling engines as they can be powered from nearly any heat source, including renewable sources, and can reach high efficiencies.

HOW STIRLING ENGINES WORK

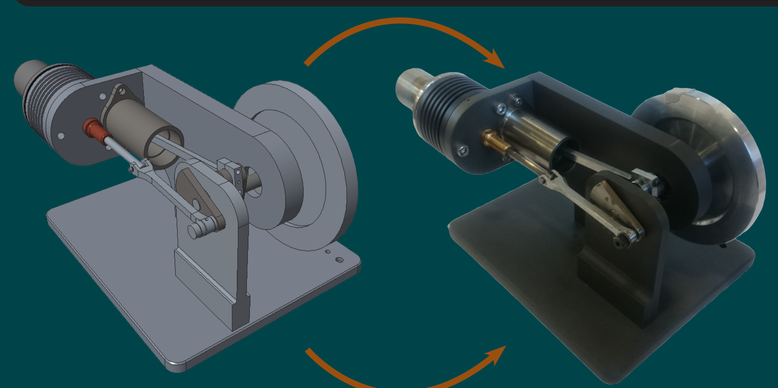
Stirling engines operate on the Stirling cycle and move a working gas between a hot and cool section. The power piston draws mechanical power from the cyclic pressure variation of the gas as it cools and heats.



OUR DESIGN

Horizontally opposed Gamma Stirling engine

Displacer swept volume:	30.8cc
Power piston swept volume:	19.2cc



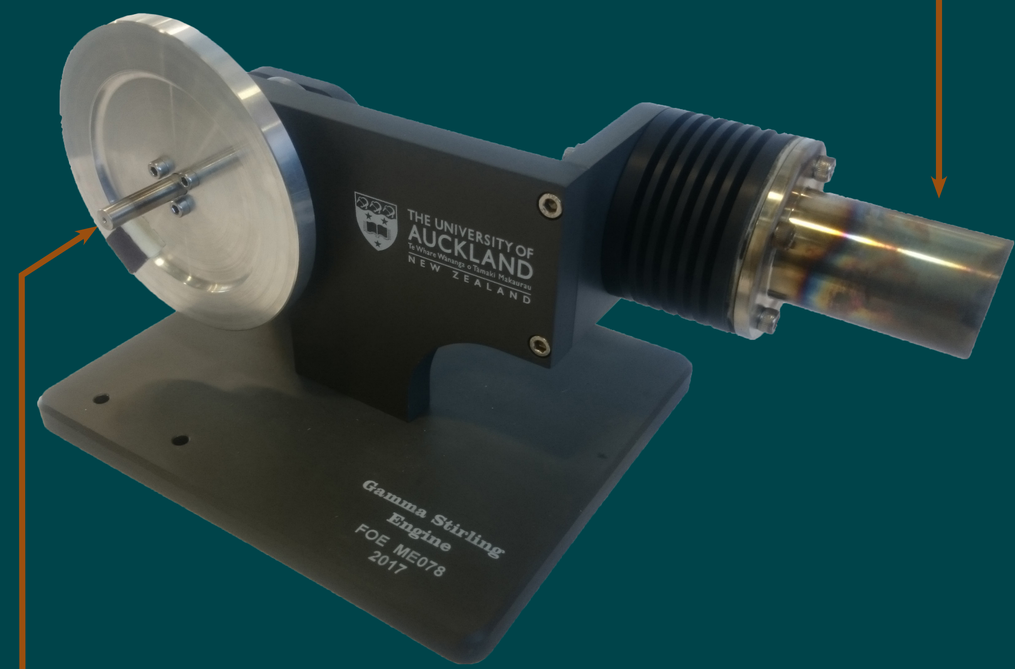
CAD Model

Manufactured Engine

PROJECT OBJECTIVES

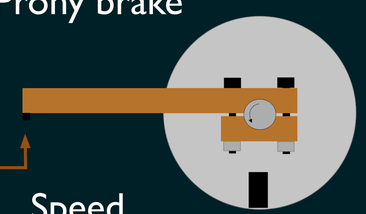
The ultimate motivation behind this project was to assess the potential of using Stirling engines for microgeneration. This first required to develop a working prototype with the following objectives:

- Simple, yet well-performing design
- Allows for attachment of test instrumentation
- Allows for future modifications & adaptions
- Investigate the speed, torque, power output and efficiency



MEASURING PERFORMANCE

Prony brake



Torque
Digital scale

Speed
Optical tachometer

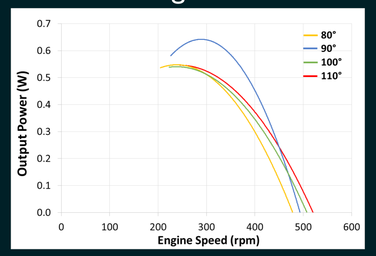
Power = Torque x Speed

HEAT SOURCES

Alcohol Burner	Nichrome Element	Bunsen Burner
Methylated Spirits	5 Coil electrical resistance heater	Butane
≈ 600°C	≈ 700°C	≈ 800°C

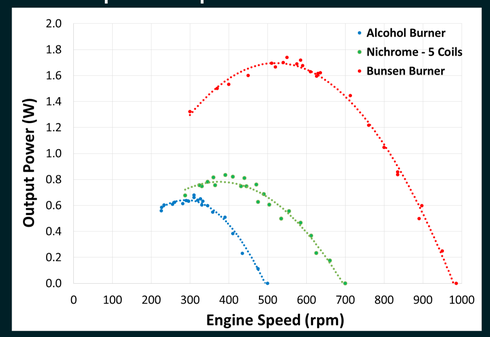
RESULTS

Effect of Phase Angle on Power output



Alcohol Burner

Power Output vs Speed for each Heat Source



CONCLUSIONS

- Maximum power output occurs at a phase angle of 90°.
- Maximum power output of 1.75 W with the Bunsen burner.
- Maximum overall efficiency of 0.4% with the Nichrome element.
  ≈ 1% of its theoretical maximum efficiency.

FUTURE WORK

In order to use the Stirling engine for microgeneration, its performance will need to be improved, particularly its efficiency. The testing instrumentation will also need to be improved to allow for more detailed measurements, such as internal temperatures.