Stirling Cryocooler

Preliminary Report

Design Team 1

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Project Description

- Main Objective
  - To design and build a bench top apparatus that demonstrates refrigeration processes using the Stirling cycle.
  - Model will be used as a working test apparatus in Experimental Methods Laboratory (ME 495).
  - Sponsor/Client Dr. David Trevas.
  - Project emphasizes learning outcomes as directed by ABET Accreditation for topics in the course.

Background

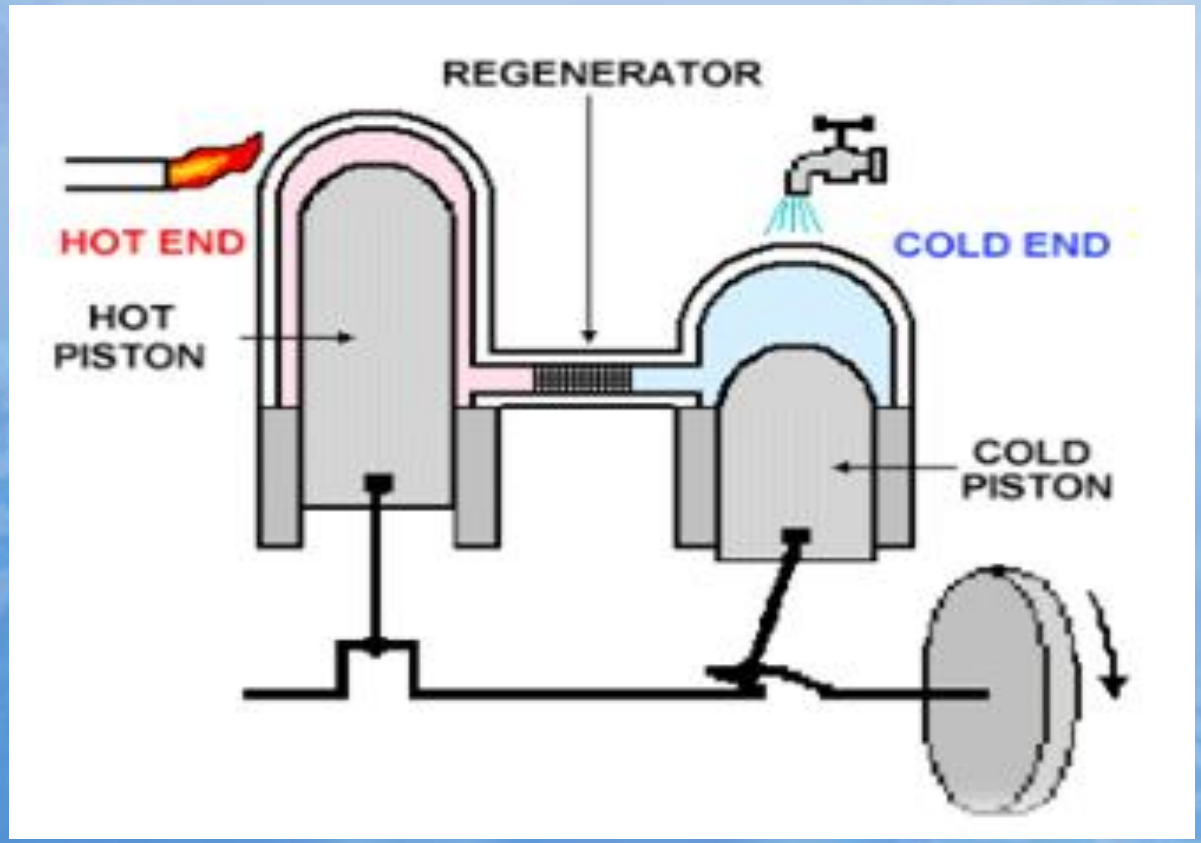
General Stirling Engine/Cooler Principle

- Add heat, make power

- Add power, remove heat

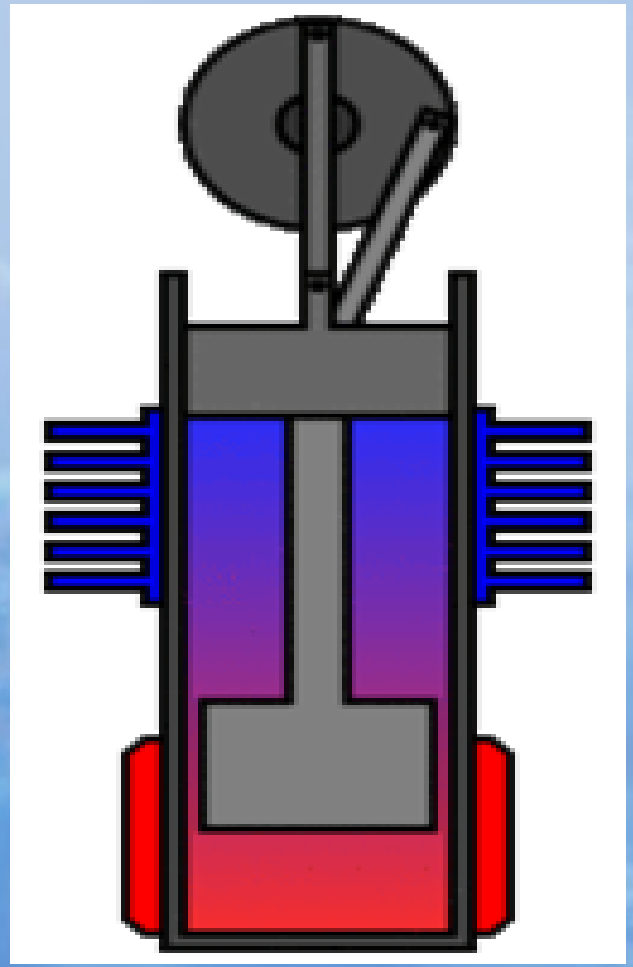
Benchmarking

Alpha Type



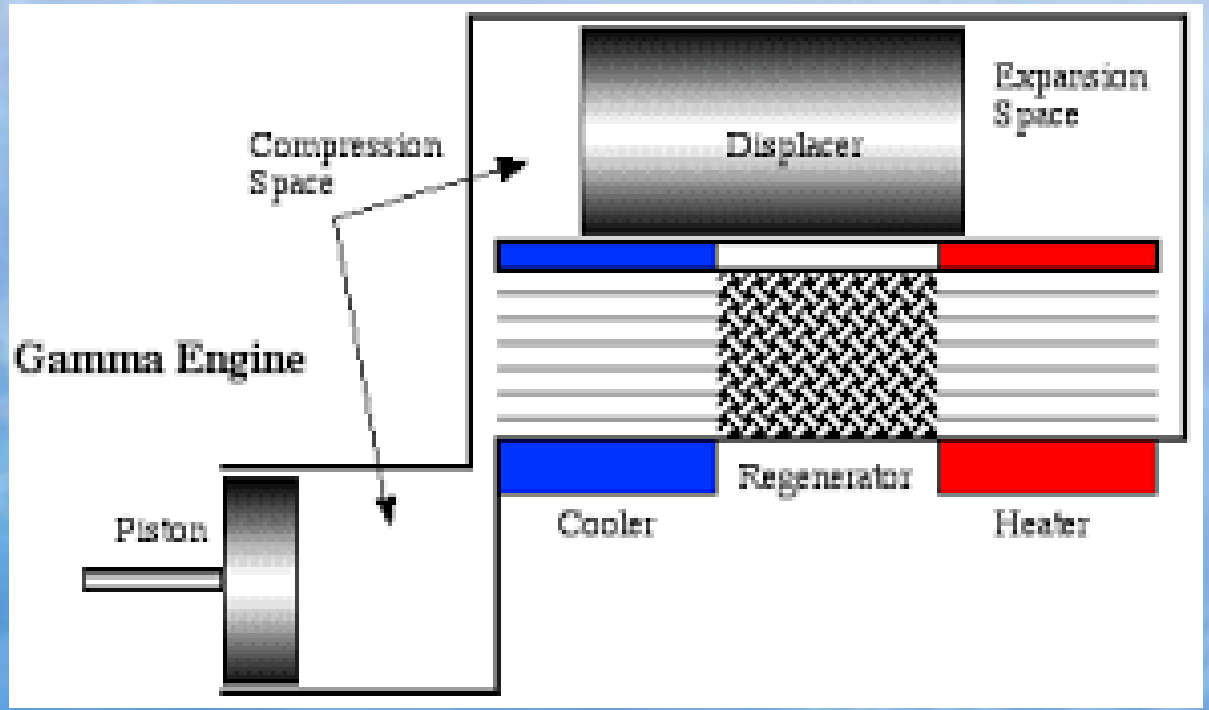
Benchmarking

Beta Type



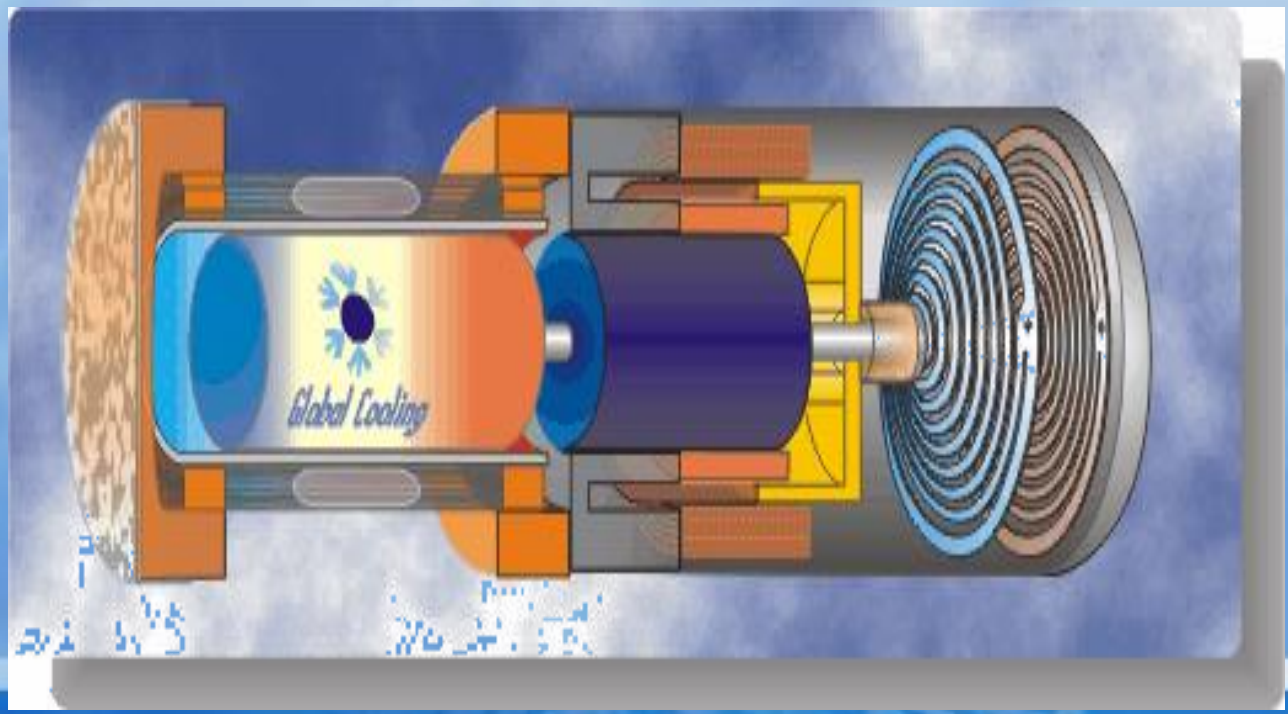
Benchmarking

Gamma Type



Benchmarking

Free Piston Type



Engineering Requirements

Fluid Viscosity
Power Input
Fin Effectiveness
Regenerator Porosity
Regenerator Specific Heat
Regenerator Density
Compression/Expansion Space
Flammability
Condensation Temperature

Insulation effectiveness/Conductivity
Number of Seals
Seal Hardness
Friction from Seal
Compressibility Factor
Frequency
Phase Angle
Dead Volume Fraction
Cooling Space Volume
System Volume

Customer Needs

Transfers Heat from Cooler

Fits in Lab Space

Externally Powered

Educational

Safety

Cost

Durability

Manufacturability

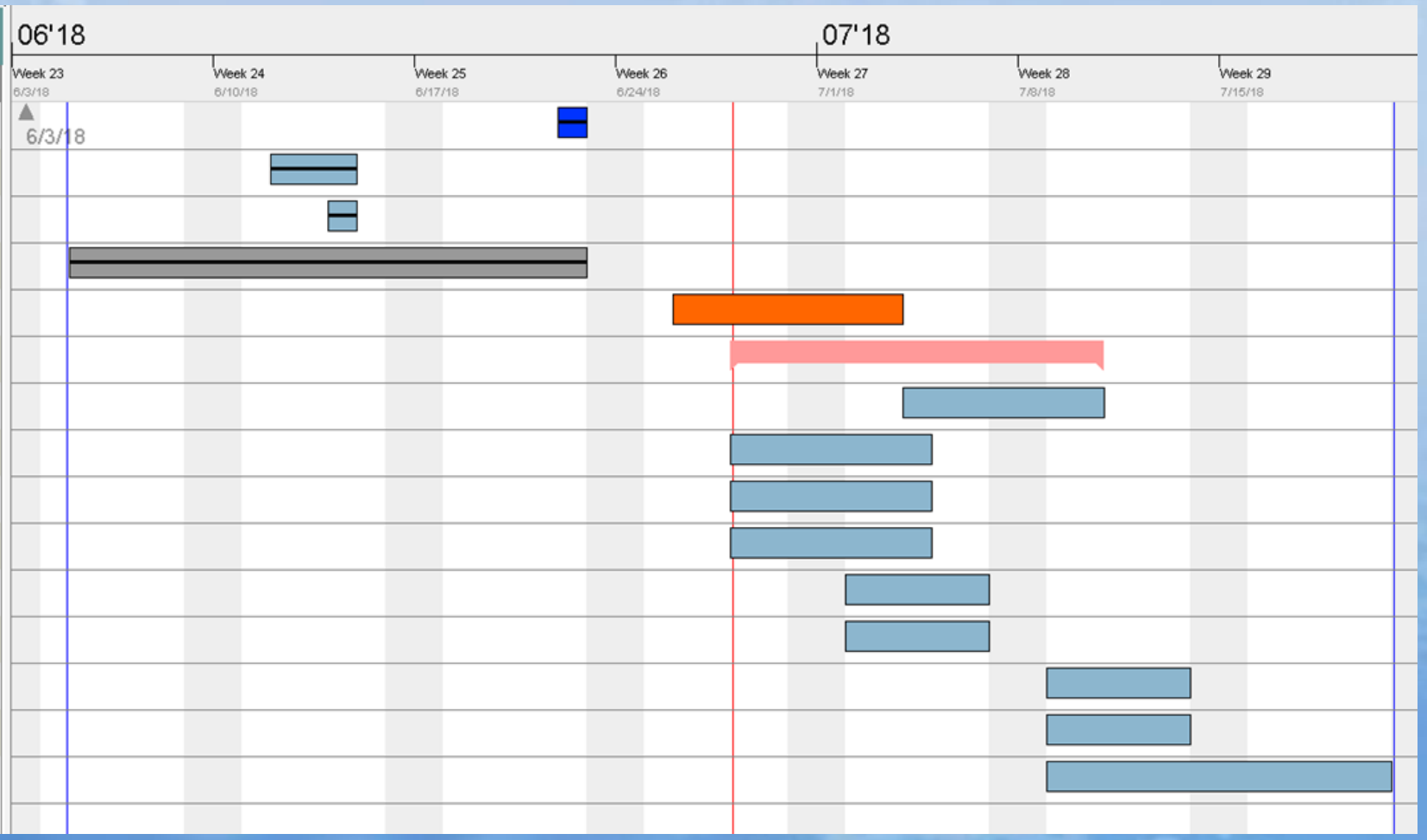
House of Quality

- Based off customer needs and weighted by importance
- Technical Importance (Engineering Requirements)
- Technical Feasibility

Customer Needs	Customer Weights	Decrease Fluid Viscosity	Power Input	Hot Cylinder Fin Effectiveness	Increase Regenerator Material Porosity	Increase Regenerator Material Specific Heat (C_v)	Increase Regenerator Material Density	Increase Compression/Expansion Space	Decrease Working Fluid's Flammability	Decrease Condensation Temperature	Decrease Cooling Space's and Regenerator's Wall Conductivity	Decrease Number of Seals	Increase Piston Seal Materal Hardness	Decrease Piston Seal Coefficient of Friction	Increase Compressibility Factor	Frequency	Phase Ange*	Dead Volume Fraction	Cooling Space Volume	System Volume
Transfer Heat from cooler	5	7	9	9	5	8	8	9		4	7	7	5	8	8	6	8	9	5	9
Fits in Lab space	4			5				9			6	4			5			8	7	9
Externally Powered	3	6	9	3		3	2	7						3	4	3	2	9	7	7
Educational	3	2	4	5	1	1	1	3	1	1					4	1	1	1		
Saftey	5	4	5	5	3	3	4	5	9	3		4	9	7	1			3	2	
Cost	5	4	6	6	4	5	6	7	6	1	7	2	2					3	4	1
Durability	3		4	7	2	5	5	5	9	7	1	5	7	8					1	
Manufacturability	4	5	3	7				6	2	2	3	6	7	7		1	4	2	2	2
Technical Requirement Units		Pa*s	kW	-	-	J/g K	kg/m^3	m^3	Baker	K	kW/m*K	#	BHN	-	-	Hz	°	m^3	m^3	m^3
Technical Requirement Targets		1.9	2	3	50	0.6	8	0.2	1	4	10	2	7	0.05	0.95	70	90	0.25	0.009	0.17
Absolute Technical Importance		119.00	163.00	193.00	69.00	107.00	114.00	210.00	113.00	72.00	109.00	120.00	129.00	136.00	89.00	46.00	65.00	145.00	115.00	115.00
Relative Technical Importance		8	3	2	17	14	11	1	12	16	13	7	6	5	15	19	18	4	9	9

Schedule

Name	Begin date	End date
Find GAMMA Designs	6/22/18	6/22/18
Meet Client	6/12/18	6/14/18
Meet David Willie	6/14/18	6/14/18
Alpha designs	6/5/18	6/22/18
RegenerRegeneration materials ati...	6/26/18	7/3/18
Preliminary design	6/28/18	7/10/18
Select drive motor	7/4/18	7/10/18
Select regen material	6/28/18	7/4/18
Material Selection	6/28/18	7/4/18
Piston Seal Type	6/28/18	7/4/18
Cad Drawings for final design	7/2/18	7/6/18
Bill of materials	7/2/18	7/6/18
Design prototype	7/9/18	7/13/18
Purchacing Materials	7/9/18	7/13/18
Prototype construction	7/9/18	7/20/18



Schedule

- Tasks assigned evenly among team members according to team responsibilities

- Project is ON SCHEDULE!

- Reasonable time frame that coincides with course schedule.

Budget

- In progress.
- Final design specification still needed
- Funding source and spending limit not established