The Thermo-Acoustic Effect

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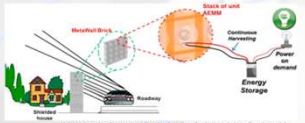
The thermo-acoustic effect is a phenomenon in which a temperature gradient is produced across a porous structure, known as a stack, when an acoustic wave is introduced to the system. The inverse of this process can also be achieved through the "Engine Configuration." The objective of this research project is to evaluate this phenomenon and explore potential applications for this unique and unusual process. This includes evaluating how porosity, length, and position of the stack affects the temperature gradient.

Motivation

Advantages:
- Simple design (few parts)
- No moving parts (reliable)
- Robust and durable
- No emissions of greenhouse gases

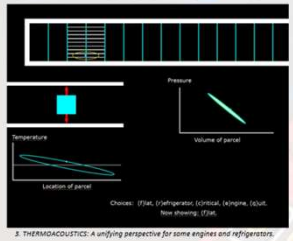
Applications:
- Energy Harvesting from processes with waste heat or excess sound
- Powering low power electronic devices for monitoring

1. World's cheapest solar power to be generated in Mexico. (n.d.).



2. Acoustoelastic MetaWall noise barriers for industrial application with simultaneous energy harvesting capability.

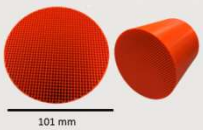
How Does It Work?



3. THERMOACOUSTICS: A unifying perspective for some engines and refrigerators.

- When an acoustic wave is introduced, the particles of the air in the stack expand and contract and exchange heat with the walls of the stack
- This results in the temperature gradient that is produced across the stack

Stacks



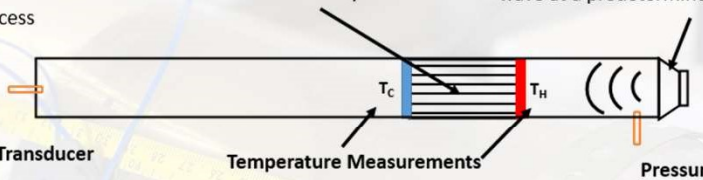
Property	C170	C178	P100
Diameter, mm	97	76.2	101
Length, mm	170	178	100
Porosity	0.8	0.85	0.64
Material	Ceramic	Ceramic	PLA

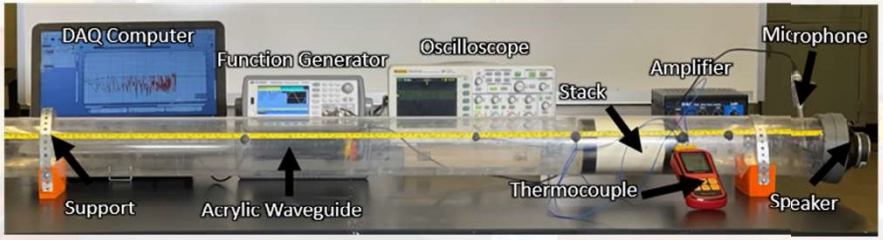
The Experimental Setup

Refrigeration Configuration

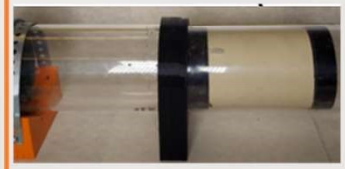
Stack- a porous length of material. The interactions of the acoustic wave and the walls of the stack are the key to the whole process

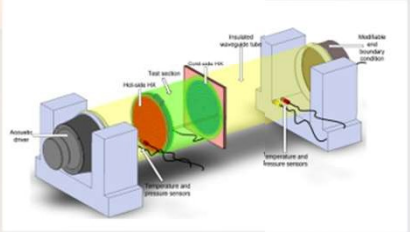
Acoustic Driver- creates the static pressure wave at a predetermined frequency





Engine Configuration

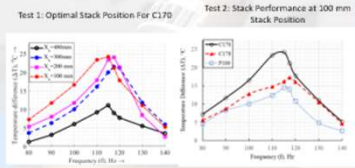




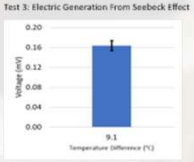
Heat Exchanger- adds heat to the air in order to promote the motion of the air parcel through the stack

Results

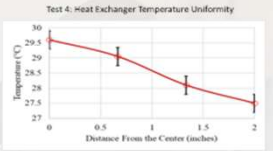
Refrigeration Stack Performance



Practical Application of Refrigeration Configuration



Preliminary Engine Configuration Tests



Take-Aways

- **Test 1**: The temperature difference **increased** as the stack was moved **closer** to the speaker. This is likely due to the increase in SPL on the hot side of the stack which is more optimal
- **Test 2**: The **porosity** seems to drive the performance as **opposed** to the **length** and **material**. This will be verified as more stack testing is conducted with more samples
- **Test 3**: Proof of concept that this phenomena can be useful. Further optimization is required to amplify the output
- **Test 4: Temperature** is mostly **uniform** in various positions of the heat exchanger. Further testing and optimization of design underway
- The **scalability** of these devices must be evaluated, as making the configuration smaller would be invaluable
- Engine configuration still a work in progress. Results have yet to be verified

Acknowledgements

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1. World's cheapest solar power to be generated in Mexico. (n.d.). Retrieved April, from https://inhabitat.com/worlds-cheapest-solar-power-is-generated-in-mexico/
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