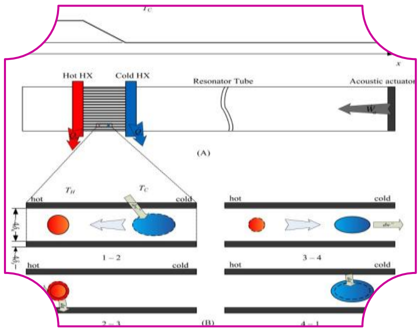
REVIEW OF RESEARCH
IMPACT FACTOR : 5.7631(UIF) UGC APPROVED JOURNAL NO. 48514 ISSN: 2249-894X
VOLUME - 8 | ISSUE - 3 | DECEMBER - 2018

A STUDY ONDESIGN AND FABRICATION OF THERMO ACOUSTIC REFRIGERATOR



Gagan Kumar Jha
Research Scholar , L.N.M. U Darbhanga .

ABSTRACT

One of the harmless types of cooling systems that provide a wide variety of scopes for further study is a thermo-acoustic cooling system. Any key benefits are the absence and existence of moving sections of any toxic gases that deplete ozone like cfcs and Freon. The air is the job fluid. This study investigated thermal acoustic refrigeration performances, which are the idea that sound waves are used to cool the air. The main purpose of these works is to design and develop a lightweight, cheap and readily available thermoacoustic refrigerator and to evaluate the effects. The specification includes stack measurements, acoustic driver selection and acoustic resonator selection.This experiment demonstrates that thermal acoustics can be cooled, but due to material limitations high performance is beyond control. This simple system generates the temperature gradient of 50C. The experiment shows that a higher performing material that has a high heat carrying capacity and fluids like inert gases will boost the performance.

KEYWORDS: *Thermo Acoustics, Acoustic Resonator, Stack, Working Fluid Thermo Acoustic Refrigeration; Acoustic Driver/Loudspeaker, Heat Exchangers, Resonator, Stack.*

INTRODUCTION

Heat conduction and entropy changes of a medium are the main factors for the thermoacoustic. It includes the study of interactions in strong frontiers between temperature oscillation and pressure oscillation due to sound waves. In a practical cooling problem, acoustic thermal refrigeration uses thermal acoustic principles. Thermo acoustic cooling is a revolutionary clean and cheap alternative to cooling. By developing a practical model, the efficiency of thermo acoustics for modern cooling has been demonstrated. Thermoacoustic cooling is an evolving cooling technology that needs no moving parts or noxious coolants in its operation.The illustrated work is also an alternative to traditional structures that are marred by high energy prices and adverse environmental effects. Coolers are used to store food and several reasons and maintain items that should be cold. In nearly every area, refrigerator has numerous applications. Ozone-depleting substances (ODS) such as chlorofluorocal carbon dioxide (CFCs) and hydro-carbon dioxide (HFCs) are used to deplete the ozone layer as traditional refrigerators. An alternative for cooling is required to overcome this issue. One choice is the Thermoacoustic cooler, with no uncomfortable, environmentally friendly cooling items such as CFC and HFCs. Instead it uses the sound power theory to produce oscillations sufficient to compress working gas. Thermo acoustics incorporates acoustics and thermodynamics in both divisions to transport heat by means of the sound.The thermal acoustic consists mainly of the acoustic driver (loudspeaker), that is connected to a resonator tube and in this case carries the working medium as air. In the Resonator tube the stack are mounted. At the fundamental frequency of the resonators, the loudspeaker induces acoustic standing waves in the resonant tube. This standing wave pushes and extends the operating media of the resonator pipe through the stack. This cyclic compression and expansion of the working medium creates an acoustic heat pumping interaction between the oscillating gas and the surface of the stack. In contrast to a compression cooling, the key drawback of this Thermo acoustic cooler is its low performance.[6-11]

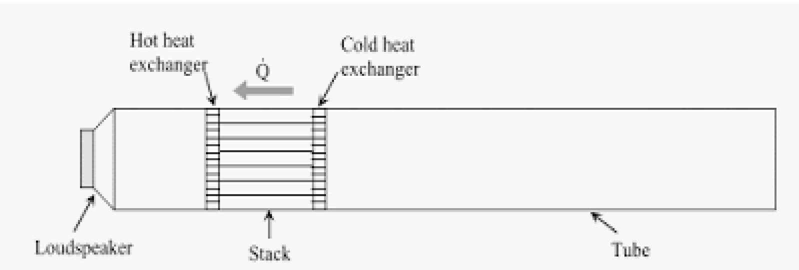
LITERATURE REVIEW

In the 1960s it became more necessary to use the sound wave for cooling. While the physical explanation of this cooling technique is simple, it is not simple to analyze the phénomene and the equations which explain it. However, important work on this field began at Los Alamos National Laboratory about two decades ago. The finding is based on the thermoacoustic phenomenon of more than 100 years ago. Different types of thermoacoustic and heat-engines have been produced. In this sector there are also several other study groups. However such devices continue to be built in preliminary stages. In the field of inert heat gases, Garret et al. has created a new space craftscryocooler utilizing high-amplitude sound waves in the discovery of the space shuttle.The thermoacoustic instruments of Tijani et al. reached temperatures as low as -65 degrees Celsius. You used it to analyze the effects by the binary gas mixture of several significant thermoacustomic parameters, including the prandtl number. By Laser Doppler Anemometry (L.D.A) along with microphone acoustic pressure monitoring, Bailliet et al. measured the acoustic flow in the resonator of a thermoacoustic refrigerator. The experimental and theoretical findings were well coordinated. In a pulse tube refrigerator Jin et al. studied thermoacoustic phenomena. They explored the characteristics and the effects of the thermoacoustic primary mover. In their experiments they reached a cryogenic temperature of 120 K. In order to extracted heat from an electronic circuit, Symko et al. used a refrigerator and a prime mover.They have powered the thermoacoustic devices between 4-24 kHz frequencies and have examined the device output. Jebali etc. have analyzed and compared experimental data with the calculations of the efficiency of a thermoacoustic cooler subject to variable loading. The heat exchanger was held in their experiments at ambient temperature, and the cold heat exchanger's temperature was varying to 0.5 and 10 K of the stack. The cooling load for these temperature fluctuations has been measured and estimated while the driving frequency varies between 30 and 65 Hz. Sakamoto et al. performed thermoacoustic cooler experiments with two pads inside of acoustic loop tube.As a prime mover, Stack 1 was used and Stack 2 as a heat pump. They used air and helium gas as the working fluid at atmospheric pressure. They saw a decrease of about 289K in temperature.

Design and Fabrication Of Thermo Acoustic Refrigeration System

Design considerations

This work includes the design and creation of the thermo-acoustic cooler. For the design study the thermo-acoustic principle is used. Some parameters are used along with a group of independent dimensional variables.



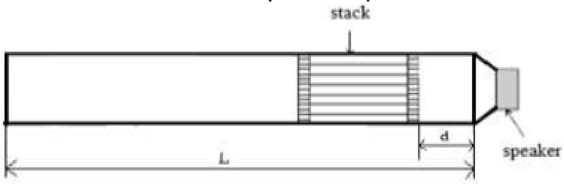
Thermo acoustic refrigeration system

Resonator

A resonator is a system that has a resonant behaviour, which at some frequencies naturally oscillates, and which is regarded as resonant frequencies (which are greater than others). Electromagnetic and/or mechanical (including acoustic) oscillations in a resonator. Either resonating frequency waves are produced or particular frequencies from a signal are selected. An device used to produce sounds of particular tones uses acoustic resonators. For electromagnetic resonators a cavity resonator is preferred; waves occur inside the system in a hollow position. In a cavity with one side (hollow), a sound-by-air resonator, known as Helmholtz resonators, produces sound.[1-5]

Stake

The "stake" is a piece of wood or other material that has been pointed at one end in order to be easily moved as a support in the field. Where temperature gradient is obtained, stakes should be chosen for the highest heat capacity and the low thermal conductivity in comparison with the working medium.



Stack position

Speaker

Speakers are electromagnetic transducer waves that translate into sound wave. The speaker takes audio from an analogue or digital system that can be used to produce sound waves in the desired frequency. The main object of the speakers is to build the resonators. Frequency and amplitude determines the sound produced by speakers. It is defined by the changes to air pressure produced by the speaker's sound waves. The frequency defines how the sound is i.e. high or low pitch. Active speakers are also called speakers and can intensify the input sound.

Amplifier

An electronic enhancer is an electronic system (informally) enhancing the signal's strength. The amplifier uses an energy source and controls the output in order to adapt the input signals with greater amplitude.

Temperature Sensor

For showing the experiment's temperature readings, temperature sensors are used. It can produce an analogue or digital output depending on the temperature sensor. For the measurement of the temperature in this experiment, thus a boarded IC sensor is used. Working Fluid Air is selected for the present design as a working fluid. The higher the sound velocity of light gases such as H2, He, Ne. For cooling, lighter gases are required as heavier gases condense, freeze or show an unsuitable behavior.

List of Parts

S1.No.	PARTS	Qty.	MATERLAL
1	The Resonator	1	
2	The Stake	1	
3	Speaker	1	
4	Amplifier	1	
5	Plexi Glass Tube	1	Glass
6	Aluminum Stopper Film	1	Aluminum
7	Temperature Sensor	1	
8	Control unit		

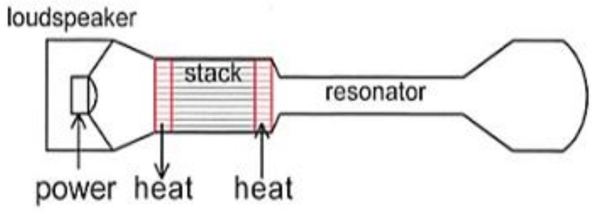
Fabrication of Thermo acoustic refrigeration system

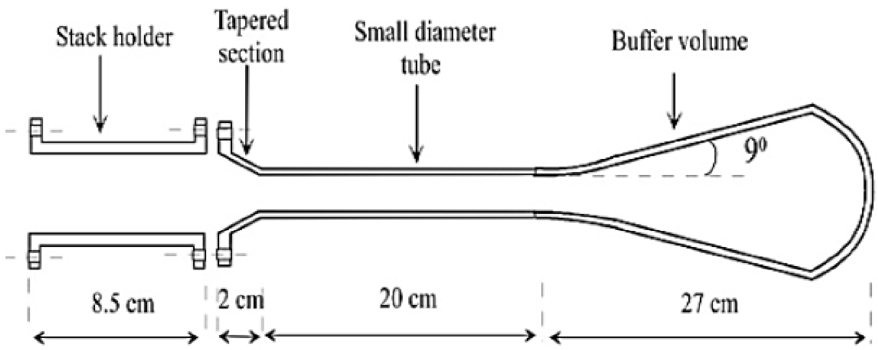
Selection and discussion of the components of the thermal acoustic refrigerators and the design parameters. The manufactured model is focused on the selection of components

Figure 3.1: Fabricated model

METHODOLOGY:

After a comprehensive analysis of existing literature and a detailed review of the tijani model, which is the basis of this work, this design process is carried out. The thermoacoustic cooler system consists of several components among which the acoustic driver, lamp, heat exchanger and resonator are among the most important. Due to the inclusion of the resonator, the Tijanimodels vary from other models. Below are the fundamental configurations of the modules and the optimized resonator used throughout the project.





Tijani model

A regularly accessible acoustical driver/loudspeaker was selected and installed in a PVC housing (3.5-inch, 120-watt, 2-way coaxial speaker). The stack was manually assembled using the Mylar and nylon cords. Copper meshes were chosen for the heat exchangers. The resonator was constructed with copper tubing and the buffer volume was built from the necessary copper sheet. Below you will find the final assembly.


Acoustic Driver/Loudspeaker

EXPERIMENTATION

The experimental procedure is described below:

- The sound waves are created by a loudspeaker, passed through a 300Hz resonator tube.
- The setup has been going on for a while.
- Digital temperature and stopwatch was used to measure temperature and time.

RESULT AND DISCUSSION

We evaluate thermoacoustic chilling system efficiency and achieve a 50 c degree Celsius temperature difference between the two stack ends.

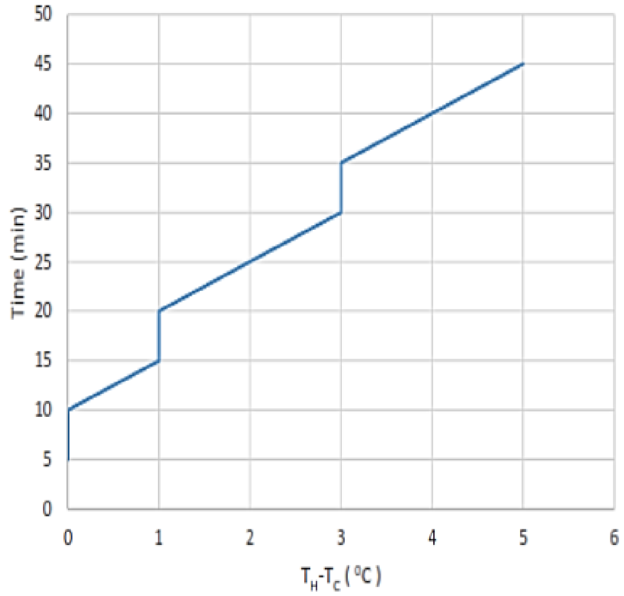
Ambient Temperature (hot end) T_h=28^{0}c (degreeCelsius)

On the cooler end of the stack, a thermocouple was positioned to demonstrate the temperature and time difference in the atmosphere. The following is a special case.

Ambient Temperature (Hot end) T_H=37 degree Celsius	
Time(min)	**T_C(Cold end) Degree Celsius**
5	37
10	37
15	36
20	36
25	35
30	34
35	34
40	33
45	32

Table: Cold end temperature at one end of the stack

At the cold end and at time, the graph displays temperature. The chart shows that at cold end the temperature decreases with time to 220° Celsius in 65 minutes, with a temperature drop of 5° Celsius. The thermoacoustic system is an experiment with a temperature gradient of 220C and this system can be developed for cool industry. The sound created by working machines in industry can be used for cooling the rooms by using thermal acoustic cooling.



Graph: temp Vs time

In this experiment, in the presence of the acoustic wave the temperature field in the resonator tube is measured. Thermocouples are used to calculate the temperature of 3 points inside the resonator.

CONCLUSION:

The promising field of thermoacoustics can be a successful refrigeration device if properly explored. In comparison with the cooling system, the performance of this device is currently very poor. The primary motivation for this work is the creation of a simple, fully functional thermal acoustic refrigerator. This article addresses the design and manufacture of a simple, affordable and readily available thermo-acoustic refrigeration device. Experimental research and results were performed on the characteristic nature of the fabricated cooler and its efficiency. A stack-wide temperature gradient is defined for the given operating condition of 50 degrees Celsius.This working instrument demonstrates that a thermal acoustic system can and can cool air for just a limited time. If we have been able to make the system with better materials, this would have a more insulating tube.

REFERENCES:

1. T.KIRANMAYEE and M.L.S.DEV KUMAR; DESIGN & FABRICATION OF THERMOACOUSTIC REFRIGERATION; JETIR (ISSN-2349-5162); October2017, Volume 4, Issue 10
2. Tijani, M.E.H., J.C.H. Zeegers, and A.T.A.M. De Waele."Construction and performance of a thermoacousticrefrigerator." Cryogenics 42 (2001): 59-66.
3. Bailliet H., LottonP., Bruneau M., Gausev V., Valiere J.C., and Gazengel B. "Acoustic power flow measurement in a thermoacoustic resonator by means of laser Droppler anemometry and microphonicmeaseurement."Applied acoustics. 60(1): 1-11, 2000.
4. Symko O.G., Abdel Rahman E., Kwon Y.S., Emmi M., and Behunin R., "Desin and development of high frequency thermoacoustic engines for thermal management in microelectronics." Microelectronics Journal, 35(2): 185-191, 2004.
5. G. W. Swift, "Thermoacoustic engines and refrigerators," Phys. Today 48, 22-28 (1995)
6. "Thermal Management of Computer Systems Using Active Cooling of Pulse Tube Refrigerators." H.H. Jung and S.W.K Yuan. Available:http://www.yutopian.net/Yuan/papers/Intel.PDF. 17 July 2006.
7. "Thermoacoustic Refrigeration for Electronic Devices: Project Outline." Stephen Tse, 2006 Governor's School of Engineering and Technology.

8. "Frequently AskedQuestions about Thermoacoustics." Penn StateGraduateProgram in Acoustics. Available: http://www.acs.psu.edu/users/sinclair/thermal/tafaq.html. 17 July 2006.
9. "Chilling at Ben & Jerry's: Cleaner, Greener." Ken Brown. Available: http://www.thermoacousticscorp.com/news/index.cfm/ID/4.htm. 17 July 2006.
10. Huelsz G., and Ramos E. "On the phase difference of the temperature and pressure waves in the thermoacoustic effect." International communications in Heat and Mass transfer, 22(1): 71-80, 1995
11. MEH Tijani, S Spoelstra, P W Bach "Thermal relaxation &Dissipiation in Thermoacoustic Systems",Journal of Applied Physics, Aug2003 ECN-RX-03-054Daniel A. Russell and Pontus Weibull, "Tabletop thermoacoustic refrigerator for demonstrations," Am. J. Phys. 70 (12), December 2002.