Research Paper Engineering

Effect of Stack Positioning on a Temperature Difference of Thermo Acoustic Refrigerator

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ABSTRACT

This paper is focuses on stack position and its effect on thermo acoustic refrigerator. By fixing other parameters of thermo acoustic refrigerator we will vary stack position inside the resonator to see its effect on temperature difference. Thermo acoustic refrigeration is an environmental friendly technology as it uses gases like air, helium as a refrigerant. Its biggest advantage is that they do not use harmful gas as a refrigerant. It is pollutant free method of providing refrigeration. It uses helium and other noble gases which are non Combustible, non-poisonous inert gas having zero global warming effect. The only disadvantage of this thermo acoustic refrigeration is it has low C.O.P. compare to other conventional cooler. But most efficient system are tried to be made. Lot of researches are going on in this area.

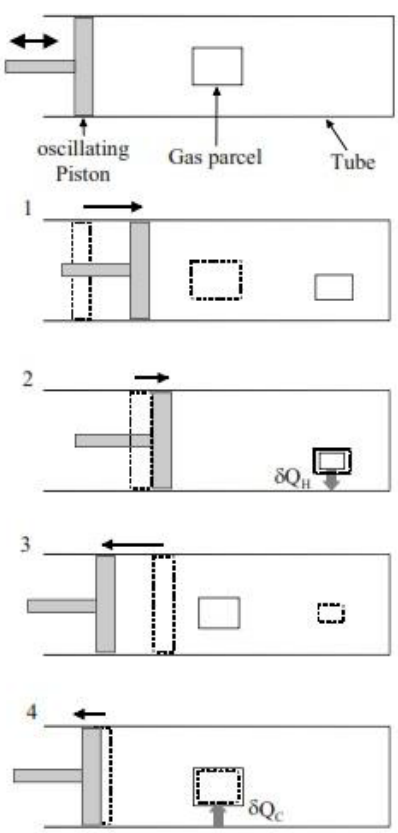
KEYWORDS Thermo Acoustic Refrigerator, Stack, C.O.P, Noble Gases, Temperature Difference.

Introduction:

PHYSICAL PRINCIPLE OF THERMO ACOUSTIC REFRIGERATOR

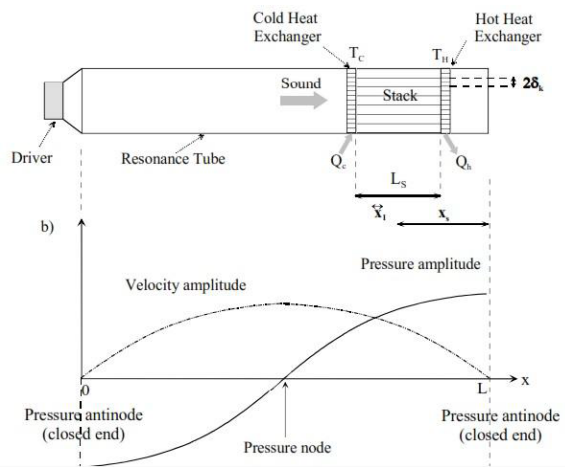
Physical principal of thermo acoustic refrigerator consist of four processes.

1. The first step in thermo acoustic refrigeration is translation movement and compression of a packet of gas in one direction away from the pressure antinodes.
2. The compression of gas heats it up, so that local surface will be absorbing some of thermal energy.



3. The gas then moves back and expand toward the pressure anti node in the third step.
4. In the last step it absorb the heat from surface area.

COMPONENT OF THERMOACOUSTIC REFRIGERATOR



ACOUSTIC DRIVER

Acoustic driver is a used for generating the acoustic wave in a thermo acoustic refrigerator.

Acoustic driver is speaker which is generating the sound wave in thermo acoustic refrigerator.

Acoustic driver is connected to function generator via audio amplifier.

Function generator is use for setting up the constant frequency wave. It generates those signals and audio amplifier is amplifying those signals and then it comes as an input to acoustic speaker.

So that how acoustic driver is generating the constant frequency acoustic wave.

RESONATOR

Resonator is a device used for containing the working fluid.

It is of two types

1. Half wave length type

2. Quarter wave length type.

In a half wave length resonator length of resonator is half wavelength while in a quarter wave length resonator length of resonator is quarter wavelength.

Its one end is fixed by acoustic driver while other end is sealed.

This type of situation makes pressure node and pressure anti node at respective end of resonator.

STACK

Stack is one of the most important parts of thermo acoustic refrigerator.

Stack is made of large number of closely spaced surfaces which are parallel to the resonator tube

Thermo acoustic effect take place in a stack and performance of thermo acoustic refrigerator depends on the stack.

Stack spacing, stack position, stack thickness and stack length are one of the most important criteria while designing the stack and performance of thermo acoustic refrigerator largely depends on this criteria.

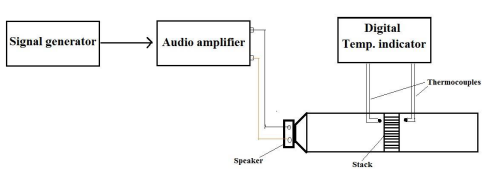
Material requirement of stack is such that low thermal conductivity and higher heat capacity than the working gas required.

Low thermal conductivity required because of heat conducting across the stack make the poor performance of thermo acoustic refrigerator.

Higher heat capacity is to maintain the temperature gradient across the stack.

WORKING MEDIUM

Air, helium and other noble gases are used as a working medium in a thermo acoustic refrigerator.



Block diagram of experimental set up of thermo acoustic refrigerator.

Block diagram shows the experimental set up of thermo acoustic refrigerator.

As shown in fig. signal generator is connected to speaker via audio amplifier.

Either side of stack is connected to thermocouple to measure temperature on either side of stack.

Thermocouple wire connected to digital temperature indicator.

Digital temperature indicator shows the temperature on either side of stack in its display.

Signal generator is used for sending the constant frequency wave. On the other hand audio amplifier amplifying the signal sends by signal generator and gives it to the speaker which is connected to thermo acoustic refrigerator.

Due to thermo acoustic process temperature difference is created on either side of stack which is measured by thermocouple and temperature of either side of stack is shown in the display of digital temperature indicator.

So these are the detail of our experimental set up of thermo acoustic refrigerator.

Reading procedure of experiment of thermo acoustic refrigerator

First we have fixed all the parameter. Operating frequency is set to 500 Hz. Working air at 1 atmospheric pressure. Only varying part is stack position inside the resonator of 37cm.

We have taken reading of stack position at 1cm,2.5cm,4cm,6.5cm,8cm,12cm,16cm,20cm,24cm,28cm,30cm,32cm and 33cm.

So these all are the 13 stack position inside the resonator. All reading is taken at the frequency of 500Hz.

Time period for every reading is 10 minute which is divided in interval of two means reading is taken at every two minute.

So reading is taken at 0 min, 2min, 4min, 6min, 8min and 10min of either side of stack in which one side is hot side and another side is cold side

Reading and conclusion

❖ **Stack position VS Maximum temperature difference.**

Stack position(cm)	Maximum Temperature difference(Th-Tc)°c
1	4.4
2.5	4.6
4	6.0
6.5	5.3
8	5.4
12	3.5
16	2.0
20	0
24	1.5
28	-4.1
30	-3.7
32	-4.6
33	-2.8

❖ **Stack position VS Maximum temperature decrease.**

Stack position(cm)	Room Temperature Tr °c	Tc °c minimum	Maximum Temperature decrease(Tr-Tc minimum)°c
1	36.8	35.8	1
2.5	37.8	36.9	0.9
4	37.1	35.2	1.9
6.5	38.4	36.8	1.6
8	36.8	35.4	1.4
12	37.3	36.8	0.5
16	37.7	37.6	0.1
20	38.1	38.1	0.0
24	38.2	38.2	0.0
28	39.0	37.9	1.1
30	39.6	38.9	0.7
32	34.9	33.6	0.3
33	35.8	34.9	0.9

❖ **Maximum temperature difference VS Maximum temperature decrease.**

Maximum Temperature difference(Th-Tc)°c	Maximum Temperature decrease(Tr-Tc minimum)°c
4.4	1
4.6	0.9
6.0	1.9
5.3	1.6
5.4	1.4
3.5	0.5
2.0	0.1
0	0.0
1.5	0.0
-4.1	1.1
-3.7	0.7
-4.6	0.3
-2.8	0.9

Conclusion

From our experiment we have found that performance of thermo acoustic refrigerator depends on stack position.for stack position of 4cm we have found maximum temperature difference of 6°c and maximum temperature decrease of 1.9°c.so from the reading table we can say that higher your temperature difference,better temperature decrease you will get and that will depend on stack position.

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