COOLING EFFECTS THROUGH THERMOACOUSTICS SYSTEM

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ABSTRACT

The modern approach of cooling system is working on vapour compression cycle that emits harmful gases such as chlorofluorocarbon and hydrocholorofluorocarbon which causes global warming and depletion of ozone layer. Further the vapour compression cycle involve moving parts say compressor that require frequent maintenance which add up the cost. The cause of global warming ,ozone depletion and maintenance free system has led the path to an alternate system of cooling.

This paper describes the alternate system of cooling through thermoacoustics.

Keyword:- *Refrigeration, Thermoacoustic, Coefficient of Performance,*

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1. INTRODUCTION

Thermoacoustics is about the interaction between thermodynamic and acoustic phenomena. Thermoacoustic devices can either use a temperature gradient to produce acoustic waves (thermoacoustic heat engines) or use acoustic waves to produce temperature gradient (thermoacoustic refrigerators). The evaluation between thermoacoustics and modern vapor compression technologies can be compared as: The effect of green house gases and ozone depleting chemicals are higher in later technologies but not in former technology. Also it requires no moving parts with high reliability and durability in refrigeration.

1.2. PROBLEM DESCRIPTION

The modern conventional refrigerators working on vapour compression refrigeration system uses refrigerants such as chloroflurocarbons(CFCs) ,hydro fluorocarbons(HFCS) that are depleting the ozone layer day by day and has become the major concern for global warming also. Further it posses the moving parts that require continuous maintenance and hence it reduces its service life.

So, to overcome from this problem there was an effort to make environment-friendly and less maintenance required refrigeration system called Thermo-Acoustic Refrigeration system.

2. LITERATURE REVIEW

Steven L. et al.[1] provides sufficient evidence that there is an alternate way for production of refrigeration i.e Thermoacoustics refrigeration system.

Arun kumar yadav et al.[2] explain about overall idea about parts of system and actual experimental setup.

Pratik Bhansali et al.[3] shows that temperature difference across the ends of tube depends upon the parameters such as frequency and mean pressure.

M.Naren kumar et al.[4] shows that performance of refrigerator depends upon on the working gas,the pressure inside the resonator tube ,shape of resonator tube,material ,position and length of stack.

Anusha Peyala et al.[5] shows that buffer volume , position of stack from resonator are effecting the temperature difference in the system there by performance of system.

Ashish S. RAUT et al.[6] shows that cop of thermoacoustics refrigeration system depends upon the type of stack dimensions , stack geometry and use of different types of gases such as nitrogen,argon,helium, helium-krypton, and helium-xenon.

3. EXPERIMENTAL SETUP

Thermoacoustic refrigeration system consists of following important apparatus;-

i.)Acoustics Driver ii.)Working fluid iii.).Stack iv.) Resonating tube v.).Amplier vi.)Temperature Sensor

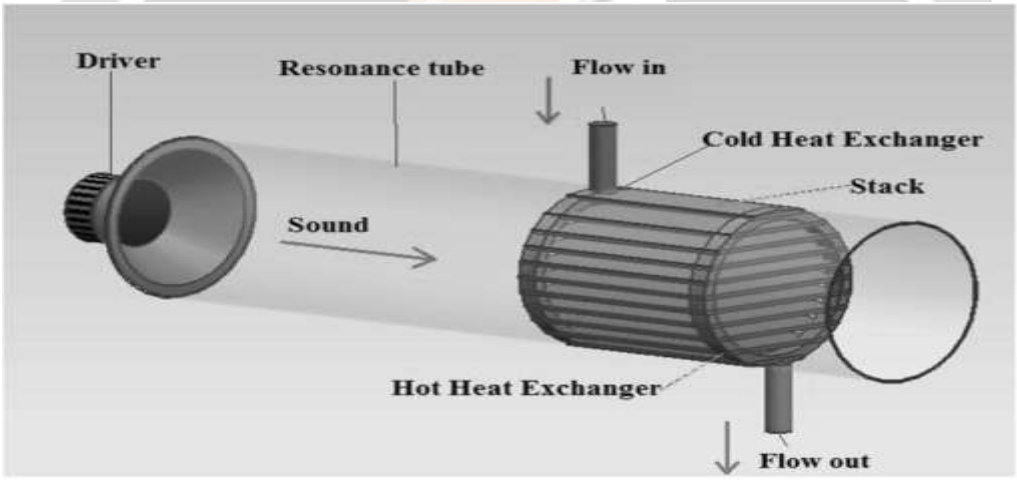

Figure 1 Sound Wave Thermoacoustic Refrigerator

i.) Acoustics Driver:-In a simple term acoustics driver is called a loud-speaker which converts electrical energy into sound waves .Here, acoustic driver is attached to one end of resonator tube to create an acoustic wave in the working fluid at a resonant frequency.

ii.) Working Gas **:-**Basically gas used is inert type say helium ,argon or nitrogen gas as these gas are harmless to the ozone and global warming.

iii.) Stack **:-**It is the primary component responsible for the cooling action. It is made out of a mesh-like structure in which gas expands at the expense of internal energy and produces heat. As it causes a temperature gradient in the system, the material chosen for the stack should have a low thermal conductivity and a large heat capacity. It's made up of spiral and parallel plate structures.

iv.) Resonating tube**:-**A resonating tube is a hollow cylinder of thin glass with one end closed and contains a stack inside and other end is attached to acoustics driver.

v.) Amplifier **:-**An amplifier with maximum power output of 20 watts is used to amplify the power input to the loudspeaker to increase the power output.

vi.) Temperature Sensor**:-**A temperature sensor is a deivce that detects and measures hotness and coldness and converts it into an electrical signal.

3.1 WORKING PRINCIPLE

The working principle of thermoacoustics refrigeration is described in the following manner:-
As the amplified current is supplied to acoustic driver, the high frequency sound waves are generated. The generated sound waves compresses the working gas such as helium or argon resulting in increase in temperature near stack. And as we know that sound waves travels in the form of compression and rarefactions.
According to Joule Thomson effect during a rarefactions when a compressed air is allowed to expand suddenly it produces cooling effects.
This cooling effect is observed on other side of stack inside the resonating tube.

3.2 COEFFICIENT OF PERFORMANCE

Cop is basically is defined as the entity that measures the performance of the system. In general cop of a system is defined as the ratio of cooling output/heating output or refrigeration effect to work input.

$$\textbf{COP} = \frac{\textit{DESIRED EFFECT}}{\textit{WORK INPUT}} = \frac{Q}{W} = \frac{T_{low}}{T_{high} - T_{low}}$$

3.3. CALCULATION OF COP

In this system the area behind the stacks (i.e area closer to free end of tube) is being cooled and considered as low temperature area whose indicated temperature is **12^0C** .(T_{low}=19^0C) as shown in fig 1.

And the area infront of stacks (i.e area closer to loudspeaker end) is hotter and considered as high temperature area whose indicated temperature is **21^0C.**(T_{high}=21^0C)

i.e $\mathbf{T_{low}}$ = 12^0C = 285^0K, $\mathbf{T}_{high}$ = 21^0C = 294^0K

then COP $= \frac{T_{low}}{T_{high} - T_{low}} = \frac{285}{294-285} = 31.66$

4. RESULTS AND CONCLUSION

Thermoacoustics refrigeration system is novel alternative for cooling in a clean and inexpensive manner. Further this experiment give way some discoveries regarding the cop of thermoacoustics refrigeration system.

Based on the investigation following points have been noted down:-

-The cop of thermoacoustics refrigeration system comes to be 31.66

-In the absence of stack the temperature along the resonator tube is almost constant and the variation is of 0.5 degree Celsius.

-But this cop can be increased by adjusting the stack distance along the length of tube ,selecting the proper working gas and materials of resonator tube and power input is important to get the maximum temperature gradient across the stack.

5. APPLICATIONS

Thermoacoustics refrigeration system is used for:-

- In Preservation of medical vaccine,

-In Liquefaction of natural gases,

-In Computer system and electronic industry,

-In cooling radar electronics on board of warship.

5. FUTURE SCOPE

Thermoacoustics refrigeration has got the potential to replace the recent vapour compression refrigeration system in future. Further it also reduces the emission of harmful gases such as chloroflorocarbon(CFCS) and hydro fluorocarbons(HFCS) into the atmosphere that causes global warming and ozone depletion.

Also this refrigeration system is leading a path to a no.of researcher in the field of thermal and acoustic to replace modern refrigeration system.

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