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Experimental and Analysis of Contemporary Cooling System

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Abstract: ***In our day to day life cooling and ventilation system plays a major role, since they are effective in working but consumes more energy and pollute the environment by releasing ammonia in fridge. In ac cooling gas used to cool the air, the coolant used in the system is a harmful chemical. In order to overcome the above disadvantages in this project natural elements are used for cooling this unconventional cooling system. This system is based on the three practical application in mechanical. This system can be used as both cooling for room as well as for cold storing. The basic principle of the system is pressure is directly propotional to temperature. Since energy consumption is more in ac and fridge, energy needed for the system is equal to energy needed to run a induction motor. The only one electrical material is motor and major part of system is based on the material and design. It is a closed system at the end of cold storage same pressure as given as input can be taken as output, this pressure can be used generate energy for the system.***

Keywords: ***In Ac Cooling Gas Used To Cool The Air, The Coolant Used In The System Is A Harmful Chemical***.

I. INTRODUCTION

More than twenty years ac and fridge act as a cooling system for home, office and cold storage for preservation. They are effective and advancement in technology makes it more efficient. But they are more energy consuming and using chemical for cooling. This leads to release of ammonia affects the environment and health. This system consists of natural cooling elements such as coolant stone and marble and water. The overall process block diagram is shown in fig. 1. This system consist of three stages based on the design and the application,

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- Satge of filteration and pre cooling
- Satge of expansion and cooling
- Stage of final pressure output

A. First stage

This stage consist of water stored in the pot consist of coolant stones and sand at the bottom. The pot is made of sand and coconut hair which act as a membarane for the water flow between pot and sand.
The air from the pump enter the pot through a glass material, which designed in a way to hold the pressure of the first stage since pot can't withstand 2 bar pressure. The first act as filter since water flowed through water, in this water act as both filter as well as natural cooling element. In this stage the pre cooling happens which reduces dust and temperature of inlet air.

B. Second stage

This stage is based on the previously done experiment thomson's model of liquefication of air (or) expansion of gas. This stage consist of chamber made of glass, the pre cooled air from the system enters the second stage where the pressure is suddenly decreased this leads to liquefication of moisture content in air in to water. Since pressure is reduced temperature also reduces. This stage is based on the Thomson joule effect that the expansion of gas reduces the pressure as well as the temperature. This method is used to reduce the water particles in the air, without loss of cooling.

C. Third stage

This stage is used to increase the output pressure of the system. Third stage consists of a glass coil of inlet diameter 8mm and outlet diameter of 5mm. This diameter difference help to increase the pressure of the output air, since this process increases the temperature of the air. Similarly when came out to room at particular temperature increase, since release of air in room leads to the sudden expansion of gas again. This time there is no moisture content in the air removed in second stage dust particles removed in first stage. There will be less liquification because less moisture content in this stage.

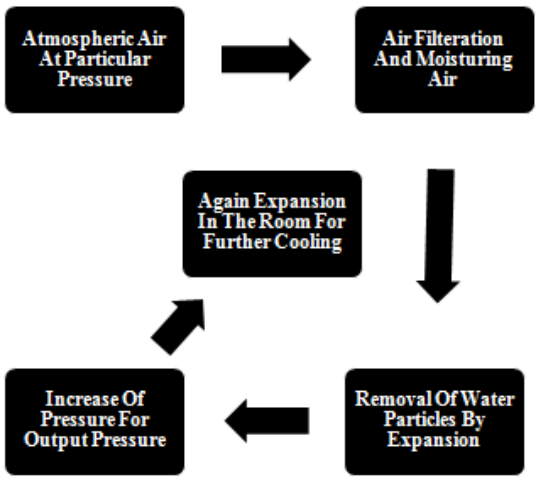

Fig. 1.Overall process block diagram

II. PRINCIPLE OF THE SYSTEM

This system is mainly based on the basic principles such as joule's second law and Thomson joule effect.

A. Joule's second law

This law states that internal energy of an ideal gas is independent of its volume and pressure, depending only on it's temperature.

B. Principle

The basic principle of the system is pressure is directly propotional to the temperature. Thus the system follows the joules thomson effect.

Assumption and consideration

Consider that over all system is a closed loop air enters the system through input one at a particular pressure of 20 bar and 309 k.

Let, p1 = 30 bar and t1 = 309 k

Air entering the system is filtered in water and enters a glass material, in the glass material due to converged opening at the top, at this point Due to water temperature reduced by 5 k and due to expansion pressure reduces by 25 bar thus reduces the temperature is calculated as

% of reduce in pressure = % of drop in temperature

In this stage pressure drop in 16% and temperature drop is also in 16%

At a point in the glass, p2 = 25 bar and t2 = (309-5-6) k = 298 k

Then the pre cooled air enters the stage 2 at a pressure and temperature of

C. First stage

P3 = 27 bar and t2 = 300 k

Since the air travels trough tube of small diameter thus increases slight pressure, the system is the continuos flow system so the pressure increase can be neglected. Since in continuos process air doesn't store anywhere diameter change of tubes slightly changes the pressure and temperature.

D. Second stage

In the chamber air expands suddenly that leads to the liquefication of water particles in the air, thus makes the air lighter and easy to flow.

According to thomson model as discussed earlier, at ordinary temperature and pressure air act as ideal while in the system act as a real gas. Since thomson coefficient for ideal gas is zero. This process changes the real gas in to ideal gas thus removes the water particles the air particles attain an elastic colliding condition.

E. Third stage

At this point p4 = 15 bar and t4 = 290 k

This point where the moisture in the air is removed in the form of water then the cooled air comes out of the chamber. Enter the coil of glass material since the air follows ideal gas laws, there is change in pressure that does not affects the temperature more, if the pressure increases by 20% and the relative temperature change by 8 %.

Thus the pressure and temperature at a point in the coil is,

P5 = 22 bar and t5 = 295 k

The air comes out of the system and again expands suddenly in the room at a rapid cooling rate, since the pressure drops and thus changes the temperature to change slightly thus reduces water particles formation.

There are two reasons why at the end air does not liquefied.

- The moisture particles are removed
- Since the gas is ideal for liquefication process real gas is required

F. Parameters

There are three parameters mainly used

1. Dimension in milimeter
2. Pressure in bar
3. Temperature in Kelvin

G. First stage

For the first stage glass material to be immersed in water as well as need a bulb structure at top for air collection and has an opening at the top. Since the air is collected in the glass because the pot does not withstand that much pressure. This stage is based on the pratical application that in ocean thermal energy conversion under water of sea is used for cooling system.

H. Second stage

This stage is mainly based on the thomson liquefication model that the expansion of reduces the pressure in the air and reduces the temperature of the air. This law is widely used in the liquefication of helium and other gases. The diameter of inlet opening should be greater than the outlet opening or outlet diameter should be less than inlet opening thus increases the pressure at the output.

I. Third stage

This stage increase the pressure for the output, necessary condition for the stage is simple that air enters the coil with large diameter and comes out of coil with smaller opening thus act as a converger and increases pressure. Here the pressure change slightly affects the temperature because air is ideal or air follows elastic collision.

J. Theoretical conclusion

Thus the final output temperature is 285 k because the final pressure in the room is nearly equal to zero due to the size of the room.

Final temperature = 286 k

Thus the required cooling rate can be decreased since the atmospheric temperature be maximum at 315 k.

III. DESIGN AND FABRICATION PUMP DESIGN

The main scope of the project is no chemicals and less energy consumption. The system is free from chemicals it needs a pump to convert ideal gas in to real gas or to increase the pressure of atmospheric air and passed through the water. The materials needed for making pump,

- Induction motor
- Impeller
- Motor housing

At the point near the center dotted circle shown in figure is called the eye of impeller because where the suction of air takes place which pressurize air at the gaps. The pressurized air comes out of the pump as shown in the figure. The pressurized air enters the system and makes the air cooler. The motor used is a simple fan motor of low voltage so energy consumption is reduced. In the overall system pump is the only current based stage all other stages based on the cooling.

A. First stage glass material

Since the pot cannot withstand pressure more than 3 bar and the pot has to be designed to act as membarane which allows the water to flow between sand and the pot.

- The pot normally made of sand and outer coated with plastic in these days since plastic blocks the water flow.
- Sand is mixed with coconut hair and made in to pot. This design has two advantages.
- Since coconut hairs are root when roots are in sand begin to absorb water and porus in between the hair allow the water outside.
- Pot placed in a plastic bucket filled with river sand and water. Inside the water marble stones and coolant stones are placed in order to decrease the water temperature as shown in fig.2.
- A glass material of height 120 mm and has two opening one at the bottom for inserting tube from pump and another opening at the top in given dimensions.
- This material used to hold the air at a particular pressure which makes the pressure to stay inside the glass and make the flow in upwards through the opening.

Fig. 2.Sand pot

B. Second stage chamber

The main aspect of the stage is the removal of water particles in the air, this is achieved by the sudden expansion of air based on the ***Joule Thomson Effect.*** The chamber is designed based on the Thomson liquefication chamber, that causes the sudden expansion of air and removes water at the bottom.The chamber is made of glass material which able to with higher pressure of 4mm thickness.The dimensions of chamber are 170mm long and 80mm broad. It has three opening inlet, outlet and at the bottom as shown in fig. 3.

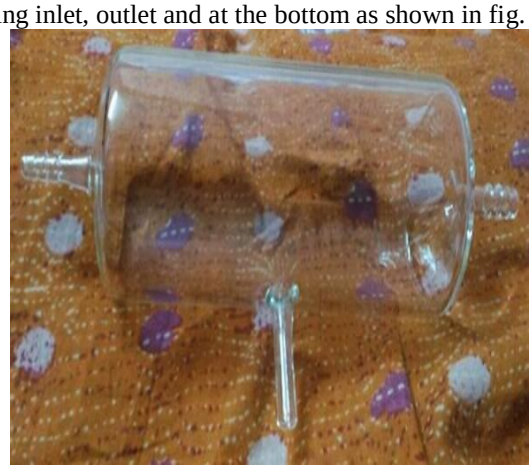

Fig. 3.Chamber

C. Third stage coil

The main objective of this stage is to increase the pressure for the outside expansion which increases the cooling rate at the room.

- It is the simple design of coil made of glass in a number of loops for pressure increasing.
- The opening and outlet diameter is differ thus makes the coil to act as a converger for the system.
- Length of the coil is 120mm and has two opening as shown in fig. 4.

Fig. 4.Glass coil

D. Wood design

Wood materials are used to make the stand and to hold the glass material in the first stage.

- Motor stand is made of wood, in the wood stand motor was fixed and shaft is inserted in the housing.
- Pot closer is made of wood which has two opening on for holding glass and another small hole for tube inserting from pump.
- Chamber need a stand to hold the chamber at a certain height and center bottom should have a gap for water removing process.

The system is a closed path system from pump to end stage room air flows through the system of different stages.

- Pump is placed near the window which sucks the atmospheric air in to the system.
- Tube from pump is inserted in the closer wood and glass material also fixed in the wood hole.
- Tube is inserted in the bottom hole of the glass and the whole setup is kept inside the pot.
- Pot is filled with water and coolant stone, marbles placed in the bucket with sand and water.
- Another tube is inserted at the top of the glass material which is used to connect the first and the second stage.
- The chamber is placed in the stand, in between tube should be down faced in order to take water out.
- Another tube is connected at the other opening from the chamber and the other end of the tube is connected to the glass coil.
- One end of the coil is connected to the tube and other end to the room where the second expansion takes place.

IV. RESULTS AND DISCUSSIONS

Thus the theoretical calculation gives the maximum approximate value for the output air temperature, based on the design of system practical working as follow,

- Air enters the system from the atmosphere through the water stored in the pot with the help of pump and filters the air.
- Where air gets moisturized and cooled flows to the chamber.
- In the chamber air suddenly expands and forms water particles which collected at the bottom.
- In this stage air is fully cooled but with out bigger water molecules or moisture content in the air.
- Then the air leaves the chamber and enters the third stage of glass coil
- Air enters the room with certain pressure and suddenly expands for further cooling.

A. Ventilation and cooling

Since the system sucks the fresh air from the atmosphere and filtered in the water,Cooled air from the third stage comes out to the room.Room consists of exhaust fan setup at the top end which creates vaccum in the room.This stage increases cooling further due to expansion of air.The air flow in to the cold storing room (refrigeration).

B. Cold storing

The outcome air from the room having certain chillness which can be used to preserve materials,Outcome air from home consist of carbon-di-oxide which can be used for refrigeration still does not loss it cooling.Due to the presence of exhaust fan at the starting increases air flow through the system.The air outcome from the system having certain pressure at a flow rate due to pressure in storing.

C. Energy regenration

- Using the outcome air and pressure energy can be generated in two forms
- Thermonic power generation (temperature difference between two electrode causes flow of electron when connected using pn semiconductor or vaccum)
- Output air from previous generation has certain pressure since the system is a loop , this pressure is converted to kinetic energy for energy generation.

D. Advantages

- No chemical is used in the system.
- Eco-friendly non pollutant air cooling system.
- Less energy consumption system.
- Used energy can be regenerated (pressure energy).
- Used as air cooler and refrigerator.
- Act as a ventilation for the room.
- Can be used for thermonic power generation.

E. Application

- Mainly used as a cooling system for home.
- Outcome air can be used as a refrigeration or cold storing.
- It act as a ventilation system for home.
- Outcome air can be used for thermonic power generation.

V. CONCLUSION

First, since μ JT is positive at low temperatures and negative at high temperatures, it must have an inversion temperature. Second, the effect seems to depend (as we expected) on the attractive and repulsive forces acting between molecules. At low temperatures the attractive forces predominate. At high temperatures the repulsive forces predominate. So the joule Thomson effect can be explained this way: At low temperatures the intermolecular attraction is the most important interaction. When the cold gas is expanded, the average distance between molecules is increased.

This means that the molecules are pulled apart. Since they attract each other this takes energy. And since the process is adiabatic, the only source of energy is the internal energy of the gas itself. So, with the internal energy reduced, the gas cools. On the other hand, at high enough temperatures the predominant interaction is repulsion. The gas wants to separate. It wants to expand. When it does expand energy is obtained as the molecules separate. This increases the internal energy of the gas and the gas heats. The output temperature of the system is different from the water temperature air is sucked from the atmosphere and filtered in the water and cooled the moisture is removed and output air is analysed for temperature difference. The experiment is runned under settings thermometer used to measure the amount temperature in the system. The readings are taken on the basis of timing in seconds. Since the measured temperature of the experiment taken and tabulated as given below,

A. Analysis of unconventional cooling system

Table- I: Analysis of unconventional cooling system

S.NO	TIME (sec)	ROOM TEMP (C)	WATER TEMP (C)	OUTLET TEMP (C)
1	60	36	26	29
2	120	35	26	28
3	180	30	27	28
4	240	29	25	28
5	300	29	25	28

As result of the above calculation there is a change in room temperature of upto 6C is tabulated in table-I.

REFERENCES

1. R.G. Ross, "Aerospace Coolers: A 50-Year Quest For Long-Life Cryogenic Cooling In Space," cryogenicEngineering, springer, new york, (2007), pp. 225–284.
2. T.W. Bradshaw, A.H. Orlowska, "Technology Developments On The 4k Cooling System For Planck And First," sixth european symposium on space environmental control systems, (2011), pp. 465–470.
3. Planck collaboration, "planck 2013 results. I. Overview of products and scientific results," astronomy & astrophysics 571, (2014), a1.
4. Planck collaboration, "planck early results. Ii. The thermal performance of planck," astronomy & Astrophysics 536, (2011), a2.
5. Barret, d., nandra, k., barcons, x. Et al, "athena+ : the first deep universe x-ray observatory,"Société française d'astronomie et d'astrophysique, (2013).
6. M.B.C. Branco, charles, i., butterworth, j., "Athena X-Ifu **Detector Cooling Chain" proc. Spie** 9144, space telescopes and instrumentation 2014: ultraviolet to gamma ray, (2014), 91445v.
7. I. Ravera, Et al, "The X-Ray Integral Field Unit (X-Ifu) For Athena," proc. Spie 9144, space telescopes and instrumentation 2014: ultraviolet to gamma ray, (2014), 91442l.
8. T. W. Bradshaw, A. H. Orlowska, and C. jewell, "Life test and performance testing of a 4k cooler for Space applications," cryocoolers 10, springer, 2012, pp 521-528.

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