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Design and Fabrication of Human Comfortable Air Conditioner

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ABSTRACT

As the developing world gets more affluent, demand for air conditioning is skyrocketing. The growing demand for cooling is putting a tremendous strain on global energy resources, not to mention the ozone layer. Most people can work comfortably in an office when the temperature is between 20°C and 25°C, but, outside this range, productivity is affected. But the use of air conditioning is increasing pollution in the environment by releasing poisonous gases into the environment. They have a negative impact on the environment as they are part of the greenhouse gases that trap heat and lead to depletion of the ozone layer. The problem is that the hotter our environment gets, the more reliant we become on air conditioning systems. In addition to the negative effects on the environment, air conditioning can also become a health hazard especially to those that are absolutely reliant on the air in a closed region is conditioned according to the temperature outside, without the use of any kind of sensors, refrigerant, etc.

Keywords: skyrocketing , air conditioning , ozone depletion

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1. INTRODUCTION

A refrigerant is a substance or mixture, usually a fluid, used in a heat pump and refrigeration cycle. In most cycles it undergoes phase transitions from a liquid to a gas and back again. Many working fluids have been used for such purposes.

Fluorocarbons, especially chlorofluorocarbons, became commonplace in the 20th century, but they are being appears to have gained widespread market acceptance under several trade names.

Other Types of Refrigerants:

- R-401A
- R-404A
- R-406A
- R-407A
- R-407C
- R-408A

1.1 REFRIGERANT CAPACITY

Measure of the effective cooling power of a refrigerator expressed in British Thermal Units (Btu) per hour, or in tons where one ton refers to 12,000 Btu equivalent to the energy required to melt 2000 pounds of ice in 24 hours.Without the use of these refrigerants if air conditioning is possible, then that is the most efficient cooling system. Avoiding the use of these refrigerants is the need of the hour. So, it’s brilliant to adopt such a system which gives a natural touch to air conditioning.

1.2 NECESSITY OF HCAC

The heat of the summer is simmering and the air conditioners around the country are going full swing. Approximately 20% of the country’s commercial and 30% of the residential buildings use room air conditioners (RACs) as their current cooling method. This does not even include the thousands of packaged terminal air conditioners (PTACs) in use in hospitals, apartments, and hotels around the country. During the hottest part of the summer air conditioners can put a severe strain on the country’s power plants. During peak air conditioning use in the summer, electrical facilities need to produce greater amounts of electricity and therefore emit increased amounts of pollutants.Coal is the most common fossil fuel burned for production of electricity and is known to release dangerous particulate pollutants. The most common pollutants are carbon monoxide, carbon dioxide, nitrogen oxides, hydrocarbons and various heavy metals.

1.3 METHODS USED

The basic premise of the project comes from the first statement of 2nd law of Thermodynamics i.e. heat flows spontaneously from a hot to a cold body - an ice cube must melt on a hot day, rather than becoming colder. The project, later, was built up on heat exchanging theory.

1.4 HEAT EXCHANGER FLOW PATTERNS

A heat exchanger can have several different flow patterns. Counter flow, parallel flow, and crossflow are common heat exchanger types. A counter flow heat exchanger is the most efficient flow pattern of the three. It leads to the lowest required heat exchanger surface area because the log mean temperature drop is the highest for a counter flow heat exchanger.

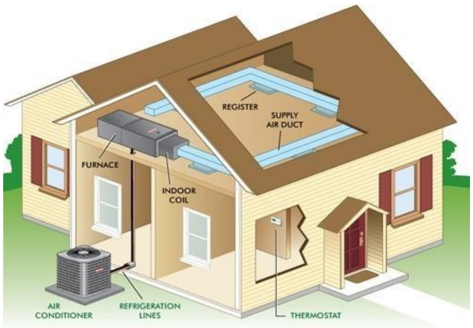
2. LITERATURE SURVEY

2.1 NATURAL VENTILATION

Natural ventilation is the process of supplying air and removing air from an indoor space without using mechanical systems. It refers to the flow of external air to an indoor space as a result of pressure differences arising from natural forces.

2.1.1 Central (ducted) air conditioning

Central (ducted) air conditioning offers whole-house or large-commercial- space cooling, and often offers moderate multi-zone temperature control capability by the addition of air-louver-control boxes.



Refrigerants

Most refrigerants used for air conditioning contribute to global warming, and many also deplete the ozone layer. CFCs, HCFCs, and HFCs are potent greenhouse gases when leaked to the atmosphere.The use of CFC as a refrigerant was once common, being used in the refrigerants R-11 and R-12 (sold under the brand name Freon-12). Freon refrigerants were commonly used during the 20th century in air conditioners due to their superior stability and safety properties.

2.2 Review of Literature

Earth-Tube Heat Exchanger (ETHE) is a device that enables transfer of heat from ambient air to deeper layers of soil and vice versa. Since the early exploration of its use in cooling commercial livestock buildings (Scott et al 1965) there has been considerable increase in its application. ETHE is used to condition the air in livestock buildings (Spengler and Stombaugh 1983). It is used in North America and Europe to cool and heat greenhouses (Santa Mouris et al 1995). There have also been works aiming at gaining better understanding of its working in cooling and heating mode (Baxter 1992, 1994).

Mathematical models of ETHE have also been developed (Puri 1985; Goswami and Dhaliwal 1985). There has also been some work in India. Sawhney et al (1998) installed a ETHE based system to cool part of a guesthouse. Sharan et al (2001) installed a ETHE based cooling system for tiger dwelling at Ahmedabad Zoological Garden. Authors have visited Tata Energy Research Institute, where a system is installed to cool rooms in its training centre near Delhi.

3. DRAWBACKS

3.1 NATURAL VENTILATION

- The impact of wind on a building affects the ventilation and infiltration rates through it and the associated heat losses or heat gains. Wind speed increases with height and is lower towards the ground due to frictional drag.
- The impact of wind on the building form creates areas of positive pressure on the windward side of a building and negative pressure on the leeward and sides of the building. Thus, building shape and local wind patterns are crucial in creating the wind pressures that will drive air flow through its apertures.
- In practical terms wind pressure, will vary considerably creating complex air flows and turbulence by its interaction with elements of the natural environment (trees, hills) and urban context (buildings, structures).
- Vernacular and traditional buildings in different climatic regions rely heavily on natural ventilation for maintaining thermal comfort conditions in the enclosed spaces.

4. AIR CONDITIONER

4.1 *HEALTH EFFECTS*

- Sudden changes in temperature and humidity affect the respiratory system.
- It has a drying effect on skin and mucous membranes.
- It adds to ambient noise, contributing to noise pollution.
- The air circulation can transmit infectious respiratory diseases.

4.2 COMPONENTS USED

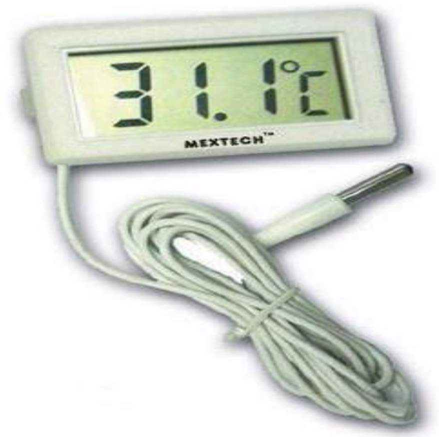
4.2.1 PVC PIPE

PVC is a thermoplastic polymer. Polyvinyl chloride more correctly but unusually Poly (vinyl chloride), commonly abbreviated PVC, is the world's third- most widely produced synthetic plastic polymer, after polyethylene and polypropylene.

4.2.2 WATER TANK

A water tank is a container for storing water. The need for a water tank is as old as civilization, to provide storage of water for use in many applications, drinking water, irrigation agriculture, fire suppression, agricultural farming, both for plants and livestock, chemical manufacturing, food preparation as well as many other uses. Water tank parameters include the general design of the tank, and choice of construction materials, linings.

4.2.3 DIGITAL SENSOR



Digital sensor shows the temperature in digital values (refer the fig 4.5). These sensors are placed in the inlet and outlet of water and air to measure the temperatures.

A house is made (30*30*30 cm) using foam board and thermocol in the shape of a cube. The thermocol is pasted with the foam board of 30*30cm and all the faces are placed in such a way that the thermocol face inside the house. The main purpose of thermocol is to prevent heat transfer, so when the cold air is passed in the house it is preserved and maintained in that temperature. Foam board prevents the heat from the surroundings entering the thermocol house. All the edges/ corners of the house are completely sealed with duct tape to prevent the leakage of air.

5. CALCULATION

Temperature

Air inlet, T_{ai}= 30 ºC Air outlet, T_{ao} = 25 ºC Water inlet, T_{wi} = 23 ºC Water outlet, T_{wo} = ?

Diameter

PVC inner, $D_i = 23 \times 10^{-3}$ m PVC outer, $D_o = 27 \times 10^{-3}$ m

Copper pipe inner, $d_i = 10 \times 10^{-3}$ m Copper pipe outer, $d_o = 13 \times 10^{-3}$ m

Density of air, ρ_a = 1.225 kg/m Density of water, ρ_w = 1000 kg/m

Specific Heat of air, $C_{pa} = 1.005 \times 10^3$ kJ/kgK Specific Heat of water, $C_{pw} = 4.184 \times 10^3$ kJ/kgK Height, H = 0.5 m

1. *Velocity of air and water: Velocity, $v = \sqrt{2gH}$*

(g – acceleration due to gravity = 9.81 m/s)= $\sqrt{2 \times 9.81 \times 0.5}$

1) *v = 3.132 m/s*

2. **Area of air and water pipe:**

Area of air pipe, $A_a = \pi/4 \, (d^2 – d_i^2) = \pi/4 \, (13^2 – 10^2) \times 10^{-6}$

$A_a = 5.4192 \times 10^{-5}$ m^2

Area of water pipe, $A_w = \pi/4 \, (D^2 – D_i^2) = \pi/4 \, (27^2 – 23^2) \times 10^{-6}$

2) *$A_w = 1.57 \times 10^{-4}$ m^2*

3) ***Mass flow rate of air and water:***

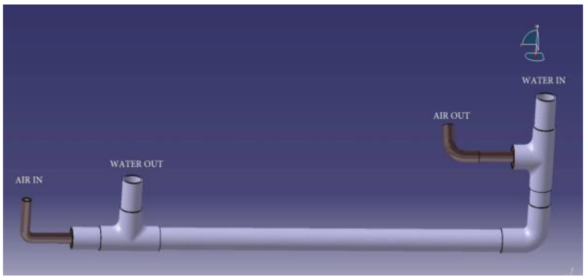
Mass Flow Rate of air, $m_a = \rho_a A_a v = 1.225 \times 5.419 \times 10^{-5} \times 3.132$

4) $m_a = 2.08 \times 10^{-4}$ kg/s

5) *Mass Flow Rate of water,* $m_w = \rho_w A_w v = 1000 \times 1.57 \times 10^{-4} \times 3.132$

6) $m_w = 0.491$ kg/s

6. D ESIGN & ANALYSIS



3D DESIGN

This above design shows the construction of HCAC. The air enters through the inner tube of copper (refer AIR IN in fig. 6.1) which is surrounded by the PVC pipe which carries water in the counter direction The air and water flows at a rate of 3.132 kg/s inside the tubes. The inner and outer tube are concentric to each other, so during the flow heat exchange (counter flow) takes place between the fluids. When the air comes out, there is a decrease in temperature while the outlet water possesses a gentle rise in temperature.

7. CONCLUSION

The HCAC is designed to fulfill the necessity of human comfort zone. Houses, corporate offices, hospitals, etc., making use of air conditioners is 9 out of 10 buildings. In near future, rating it 10 on 10 would not be a wonder. HCAC without polluting the environment gives a comfortable cooling leading ecofriendly environment. The chillness we get from HCAC has a climate of nature as it is made out of nature itself. Since HCAC is fulfilling the principle of air conditioning, with only usage of air and water, eliminating harmful and polluting refrigerants, seems to have a great scope in future.

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