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Experimental analysis of a dehumidifier with modifications in domestic refrigeration system

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Abstract
This research paper focuses on the affordable solution of discomfort in high humidity conditions. As we know that human comfort depends on temperature as well as humidity combination. If the level of humidity is very high (usually in rainy season), the level of human discomfort rise steeply. In developing countries like India most of the population is not able to bear the operating cost of devices like air conditioner to counter such severe atmospheric condition of high humidity. This work proposes a solution in such condition where normal desert cooler, based on evaporative cooling, is not able to provide a suitable human comfort since it cannot control humidity. A low capacity domestic refrigeration system is modified to control the humidity level in high humid environment. This solution suggests a device to act between a desert cooler & high power consuming air-conditioner.

Keywords: dehumidifier, domestic refrigeration system, high humidity conditions

Introduction

Human comfort is mainly related to condition of temperature, humidity & air velocity in a confined space of human occupancy. Various comfort charts based on extensive recorded data for different age groups & physical condition of humans are available for use. American Society of Heating, Refrigerating and Air-Conditioning Engineers (*ASHRAE)* is the apex professional body that published lot of information related to human comfort internationally.

A domestic vapour compression refrigeration system mainly consists of components such as compressor, condenser, evaporator & capillary tube (expansion device) to produce required cooling. General working medium is a CFC chemical known as refrigerant. Due to its ability to deliver high COP in low space requirement, it is most preferred refrigeration & air conditioning system for domestic use. Fig.1 shows the major components as well as condition of refrigerant used during its flow.

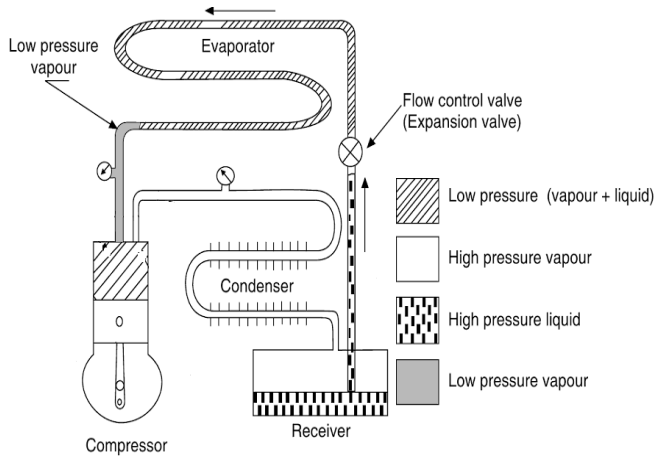

Fig 1: Basic components of refrigerator

Types of dehumidifier

Refrigerant dehumidifier: In this type of dehumidifier we use a refrigerant compressor for the flow of the refrigerant throughout the cycle. The humid air is sucked through grille and then it passes over cooling coils where the humidity in the air converts into water droplets that can be drained. After that the air is passed over heating coils where its temperature come to its original temperature and the air is circulated in the room.

Desiccant dehumidifier: In this method the desiccant material is used for the dehumidification process. Desiccants in either solid or liquid forms have a natural affinity for removing moisture. As the desiccant removes the moisture from the air desiccant releases and warms the air that is latent heat become sensible heat. The dried warm air can then be cooled to desired comfort condition by sensible coolers. To reuse the desiccant it must be regenerated or reactivated through a process in which moisture is driven off by heat from an energy source such as electricity, waste heat, natural gas or solar energy.

Description of Setup

In this type of refrigerant dehumidifier, we have used a simple refrigerant cycle. Two fans are used which are used for sucking and throwing out the air. The first fan takes the atmospheric humid air and the second fan throw out the conditioned air into the room according to the desired conditions. The compressor is used for the processing of the refrigerant and then it is circulated throughout the cycle. The copper coils are used for the circulation of the refrigerant. Two types of coils are used one is heating coils and other is cooling coil. In the heating coil the refrigerant at high pressure and temperature from the compressor flows. A capillary tube is also used for the expansion of the high pressure temperature refrigerant. After that it goes to freezing coils where it comes

into contact with the humid air. The humidity in the air converts itself into water droplets. These water droplets are collected in the bucket or a container from where it can be drained time to time. An automatic drainage system can also be used but we have used a simple manual drainage system. The spacing between the coils can be changed. These changes can be tested for different spacing between the coils and the speed of the fans. The outer body of the dehumidifier is made of the fibre. The light weight of the fibre makes it light in weight. For the support of the fan the ply board is used. The vibrations of the fan can be easily controlled by the ply board. For changing the spacing between the cooling and heating coils a simple sliding mechanism is used.

Table 1: List of parts used for setup

2 Fan	RPM-2200 Volt - 2300 Ac 50 hz Current -0.65A(Max.) Efficiency - 25%
Sweep	300 mm
Copper coils	Diameter ¼ inch Length – 40 feet Thickness – 25 swg
Cappilary tube	Diameter - 0.5 mm Length –90 cm
Compressor	
Output Pressure	600 psi
Power	400 watt
1 Switch	
1 Bucket Or Tub	
Refigerant	Type – CFC And HC Amount - 1 Point
Hygrometer	Digital
Fibre Sheet	Thickness 5 mm
Ply Board	Thickness1 – 20 mm Thickness2 –7mm

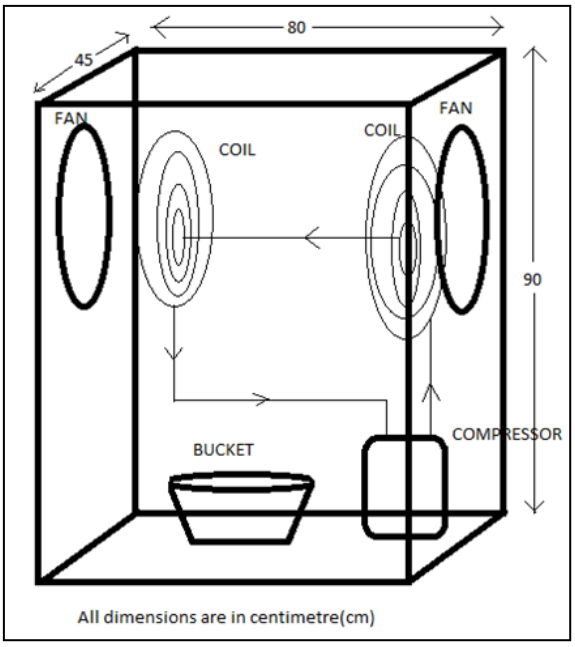

Fig 2: Schematic diagram of setup

Working of setup

The atmospheric humid air from outside comes into contact with the cooling coils. In the cooling coils the freezing refrigerant flows. This refrigerant makes the water vapour in the air convert into the water droplets. These water droplets are collected in a bucket or a tub. The air when comes into the contact with cooling coil its temperature is reduced. To regain the original temperature the air is passed over the heating coils. These heating coils contain the high temperature and pressure refrigerant and hence the temperature of the air is increased while the temperature of the refrigerant is reduced. This refrigerant then passes through the capillary tube where it expands and then the cooling in the cooling coils is obtained. The collected water in the tub or bucket can be drained afterwards. The draining of Water can be done automatically where a switch analyzes the filling of the bucket or the tub and in manual type the bucket can be emptied time to time. The most common type of dehumidifiers are the refrigerant dehumidifiers.

Fig 3: Photograph of under-constructed setup

This type of dehumidifier differs from a standard air conditioner in that both the evaporator and the condenser are placed in the same air path. A standard air conditioner transfers heat energy out of the room because its condenser coil releases heat outside. However, since all components of the dehumidifier are in the same room, no heat energy is removed. Instead, the electric power consumed by the dehumidifier remains in the room as heat, so the room is actually heated, just as by an electric heater that draws the same amount of power.

In addition, if water is condensed in the room, the amount of heat previously needed to evaporate that water also is re-released in the room (the latent heat of vaporization). The dehumidification process is the inverse of adding water to the room with an evaporative cooler, and instead releases heat. Therefore, an in-room dehumidifier always will warm the room and reduce the relative humidity indirectly, as well as reducing the humidity more directly, by condensing and removing water.

Conclusion

A device is fabricated to fill the gap between a desert cooler & commercial air conditioner. The performance of device is

based on several factors like ambient temperature, air velocity, moisture content etc. The main feature of this device is control humidity with consumption of low electricity.

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