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Energy Conservation by Bed Air Conditioning System

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Abstract: ***Energy conservation has been a major concern in India as well as the whole world. To reduce the power consumption in different fields various types of research and development are going on. One of the major concern is to reduce domestic electric power consumption. In order to reduce power consumption in this field daily household appliances such as AC and Refrigerator which consume more power has to be modified. In this paper we are discussing about the reduction in power consumption of an AC by designing it to cool only the required bed area. This overall reduces the power consumption by more than half of what a normal AC consumes and allows the people for a comfortable sleep. This system is also designed in such a way that it can be easily detachable and transportable including the bed and gets fitted at the minimum time.***
Keywords: Air conditioning, Energy conservation, Power consumption, Confined area, EER, COP, Ton of refrigeration.

I. INTRODUCTION

In normal air conditioning system, more than 70% of cooling capacity is utilized to cool down the walls of the room, wherein this AC same power is utilized to cool down the bad area which reduces the power consumption. The units consume by this AC system per year are very low when compared with the normal AC system Due to its confined bed area space, the time required to cool down the area is very less and the power consumption is very low. Proper insulation is necessary in the case of room air conditioning to avoid loss in cooling capacity of the air conditioning system. The air conditioning system is based on Vapor – Compression Refrigeration System. In this type of system the refrigerant undergoes a change of phase by absorbing and releasing heat from the surrounding environment. The liquid refrigerant absorbs the heat from the cooling space and phase change occurs from liquid refrigerant to gas. The cooled air is recirculated back into the cooling area. The gaseous refrigerant than enters the condenser where it releases the latent heat and gets converted to liquid form. This is occurred outside into the environment. The external air is used in order to achieve the heat transfer between the refrigerant and the surrounding. Then the gas is sent back into the compressor for recirculation and the cycle continues.

The air conditioning system uses R-134a refrigerant. R134-A chemical name is Tertrafluoro Ethane (CF_3CH_2N) which is also a fluorinated refrigerant gass. R-134a do not harm the Ozone layer significantly. Due to the harmful effects of HCFC and CFC on the environment the R-134a refrigerant is a better alternative compared to the previously used refrigerant. Due to its non-toxic, non-corrosive properties the handling of this refrigerant is safe.

A. Different Types Of Air Conditioner Are

1) Central air conditioning: This unit is primarily to cool big buildings, houses, offices, entire hotel, factories, etc. The central air conditioning system comprised of a huge compressor that has the capacity to produce hundreds of tons of air conditioning.

2) Split air conditioner: It consists of outdoor unit, which contains the compressor, condenser and expansion valve; and the indoor, which is comprised of the evaporator coil and cooling fan.

3) Window air conditioner: In this air conditioner compressor, condenser, expansion valve or coil, evaporator and cooling coil are enclosed in a single box. The entire setup is installed on window.

4) Portable air conditioner: This type of air conditioner unit takes in air from the room and cools it, then direct it back into the room. The unit then vents any warm air outside by means of an exhaust installed on window.

5) Packaged air conditioner: This type of unit is perfect for cooling multiple rooms or a large space in home or office. There are two possible arrangement with the package unit. In one unit, the compressor, condenser, expansion valve and evaporator are housed in a single box. The cooled air is thrown by the high capacity blower, and it flows through the ducts laid through various rooms.

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6) Hybrid air conditioner: In the summer this air conditioner works normally like a room air conditioner by removing heat from the room and distributing it outside. In the winter, the hybrid system works in reverse, pulling heat from the outside environment and distributing it inside. When the refrigerant drops below the outside temperature, the heat from outdoor gets transferred to the coils and onto the refrigerant. Then the extracted heat can be turned to warm the room.

II. METHODOLOGY

Air conditioner works on the principle of Vapor Compression Refrigeration System. When you switch on the air conditioner the thermostat turns on the compressor and the blower. The gaseous refrigerant enters the compressor and gets compressed to high temperature and pressure. This refrigerant then enters the condenser coils where desuperheating of the vapor takes place in the discharge line and in the first few coils of the condenser where the sensible heat is rejected to the surroundings. The vapor refrigerant now condenses to liquid state at a constant temperature. The liquid refrigerant enters the expansion valve, where the pressure drops but enthalpy remains constant. Due to drop in pressure, the liquid starts boiling. Consequently the temperature falls below that of the surrounding atmosphere and the refrigerant is partly liquid and partly vapor. This refrigerant then enters the evaporator coils located inside the room. Due to the low temperature of the refrigerant it absorbs the latent heat from the room which is at high temperature and evaporates at constant pressure and the cycle is complete. The vapor refrigerant now enters the compressor and the cycle repeats.

A. Terms Used In Air Conditioning

1) *Ton of Refrigeration:* The amount of heat absorbed in order to produce 1 ton of ice in 24 hours from water whose initial temperature is 0^{o} C.

In SI units, 1 TOR = 210 kj/min, or
= 3.5 kj/sec or 3.5 kW.

2) *Coefficient of Performance (COP):* The ratio of the amount of heat removed from a given space to the work supplied for the heat removal.

$$\text{COP} = \frac{\text{amount of heat removed (or absorbed)}}{\text{work supplied}} = \frac{Q}{W}$$

Where Q and W are expressed in kj/sec or kW.

3) *Refrigerant:* Refrigerant is the substance that by undergoing a change in phase (liquid to gas, gas to liquid) releases or absorb a large amount of latent heat and thus effects a considerable cooling effect. They have very low boiling temperature which allow them to extract heat at a more rapid rate.

4) *Humidity:* It is the amount of water vapor present in the air. Humidity is further divided into 3 types namely

a) *Absolute Humidity:* It is defined as the ratio of mass of water vapor to the mass of dry air in a given volume of the mixture (vapor + air). Denoted by ω and expressed in kg vap. /kg dry air.

$$\omega = \frac{\text{Mass of vapor (kg)}}{\text{Mass of dry air (kg)}}$$

b) *Relative Humidity:* It is defined as the ratio of the mass of water vapor to the mass of saturated water vapor in the same volume and at the same temperature. It is designated by ∅ and expressed in percentage.

$$\emptyset = \frac{\text{Mass of water vapor in a given volume}}{\text{Mass of saturated vapor at same volume \& } temperature}$$
$$= \frac{Pv}{Pvs}$$

c) *Specific Humidity:* It is the ratio of the mass of water vapor to the total mass of the moist air parcel.

5) *Energy efficiency ratio (EER):* Energy efficiency ratio is the ratio of the cooling capacity (BTU/hr) to the power input (W).

B. The Calculation are as Under

$$\text{Ton of refrigeration} = \frac{\sqrt[3]{\text{Volume of room}}}{10}$$

Considering the bed area for double bed to be 6ft×5ft×4ft we get,

$$\text{Ton of refrigeration} = \frac{\sqrt[3]{6\times5\times4}}{10} = 0.49 \text{ ton of refrigeration}$$

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Vapor – Compression Refrigeration System

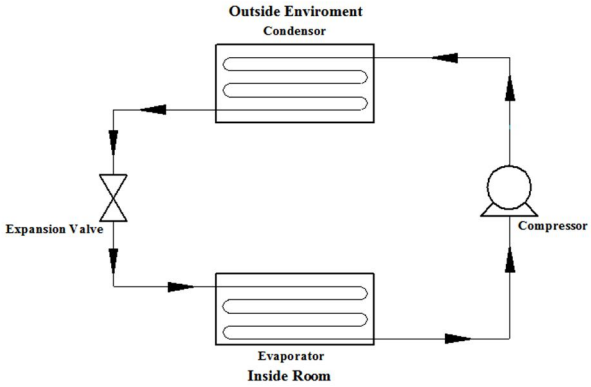


Figure 1: Vapor Compression Refrigeration Cycle

C. Parts of Vapor Compression Refrigeration System

1) *Compressor:* Hermetically sealed 1/6 HP compressor having cooling capacity of 115 Watts with power consumption of 105 Watts is used. Hermetically sealed compressor is preferably used in most of air conditioning system. Reciprocating piston type compressor is used in this system.
2) *Condenser:* This unit is exposed to the environment and heat transfer takes place between the environmental air and the refrigerant.
3) *Expansion Valve:* The expansion valve maintains the pressure difference between the inlet and outlet of the valve and also control the discharge rate of refrigerant into the evaporator.
4) *Evaporator:* Evaporator takes in the hot air from the room to be cooled and recirculates the cold air into the cooling space. The liquid refrigerant changes its phase to gaseous form into the evaporator.



Figure 3: Air Conditioner Unit
Unit dimension: 42×30×23 cm



Figure 4: Sleeping Cot
Unit dimension: 184×82×38 cm

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Figure 5: Cot covered with cloth and ac unit
Confined area: 192×82×151 cm



Figure 6: Enclosed System

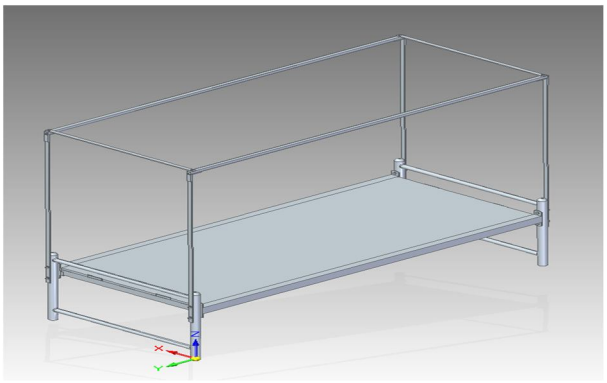


Figure 7: Solid edge model

To find the cooling capacity needed we need to find the volume of area to be cooled and multiply this volume by 6

Volume = Length×Width×Height (Cubic feet)
= 6×5×4
Volume= 120ft^3
Multiplying this volume by 6 we get,

1) C1=Vol×6
=120×6

C1 =720

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Calculate the number of person occupied the room. Normally person produces 147 W of heat for daily basic activities.

2) C2 = N×147W

Assume 2 persons occupy the area

= 2×147W

C2 = 294 W

Add values of C1 and C2 to get the cooling capacity needed.

Estimate Cooling Capacity needed = C1+C2 (W)

= 720 +294

= 1014 W

To find tonnage,

1 Ton of refrigeration = 3517 W

? Ton of refrigeration = 1014 W

We get

Ton of refrigeration = $\frac{1014}{3517}$

= 0.28 tonnage

Cooling Capacity= Ton of refrigeration×Weight of 1 ton of ice

= 0.49 × 2000lb

= 980 BTU/lb

Cooling Capacity = 980 BTU/lb ×144BTU/lb

= 141120 BTU/day

= $\frac{141120}{24}$

= 5880 BTU/hr

= 1723.257 W

Coefficient of PerformanceCOP$_{max}$ = $\frac{Tc}{Tc-Th}$

= $\frac{22}{33-22}$

= 2

Power required to run the compressor = 105 Watts

Assuming running the motor for 8 hrs.a day and considering 365 days operational

We get,

Power Consumed = 105×8×365

= 306600 Wh

= $\frac{306600}{1000}$

=306.6 units/year

= 25.55 units/month

Energy Efficiency Ratio = $\frac{\text{Amount of heat removed in BTU/hr}}{\text{Power consumed}}$

= $\frac{5880}{105}$

= 56

In order to further reduce the power consumption replace the double bed with single bed having confined area of 6×3×4ft and using 0.5 ton air conditioner unit.

III. PRIOR APPROACH

Pereira & Mendes [1] have done the experimental info, where the correlations were developed, had been acquired in calorimeters as stated by ISO standard. The calorimeters and connected dimension question are talked about on the current function. Furthermore, a numerical version to incorporate simulation code is usually also offered and a simulation sample is usually transported out displaying energy usage and space surrounding temperature and family member moisture.

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Moritoa et.al [3] have studied that a greater air flow velocity of disrupted human being rests a lot more then reduce air velocity of airflow. The experimenthad been carried out to determine the impact on sleep of varying airflow velocities from air flow conditioner, using 10 healthful youthful males as subject. The mean air temperature, comparative moisture, and mean glowing heat in the rooms with both atmosphere conditioner were 26.4(0.7) C, 58(7) %, and 26.3(1.3) C, and 26.4(0.7) C, 53(6) %, and 26.1(0.6) C for [A] and [T], respectively. The typical (SD) speed of airflow was in fact 0.14(0.25) m/s and 0.04(0.07) m/s for [A] and [B], correspondingly.The optimum surroundings velocity over the bed inside the areas and the figure of times the airflow produces in the air conditioner [A] had been 1.1 m/s and 28 occasion per evening, respectively, and 0.3m/fine sand 11 instances per night, correspondingly, with the air conditioner [B]. Many of the outcomes did not display a large difference in the total quantity of period during each rest level, or a major difference in the switch of both mean skin and rectal temps between [A] and [C]; these were statistically examined throughout commonly used strategies. The topics considerably experienced even more of the air flow and cooler at [A] than at [B] although comfort feeling does not really vary significantly. When an additional evaluation of the simultaneity of air flow and physiological reaction experienced been performed, the number of moments body motion, the quantity of times heart price improved and the number of situation some sleep phases transformed to the stage of wakefulness due to differing airflow in [A] had been considerably higher than those in [W]. A higher speed of air flow had an unfavorable impact on rest actually although the common air flow speed was much less than 0.2 m/s.

Sogut [4] have studied which utilizes two factors, EEF or energetic COP and MTEWI (modified total comparative heating effect), that was suggested to judge energetic and the environmental functionality of room air conditioner distributed in the Turkish market. In the research, fumes compression chilling routine used entire RAC models is accepted as model for the studies. The outcomes are demonstrated that typical EEF worth of models using R-22 and L-410A gas are 74.53% and 74.64% correspondingly. Rather than, Ur-410A gas, which is utilized in many breaks up devices and promoted while an environmental useful gas, offers an impact that is usually around 23.18% larger than the R-22 gas which is no longer used. The analysis at last focuses on the cause how come EEF and MTEWI elements must be provided concern when it comes to functionality and the environmental impact in the RAC units.

Hoon et.al [5] have suggested a whole new control formula which is applicable the idea of an individual air-conditioner and a community air conditioning method to a floor-standing space air-conditioner (FSAC). The regulation formula could be cut into 3 wind patterns: solid cooling using guide wind flow, regular chilling applying pint breeze, and indirect wind. Solid cooling is usually to create a user who is usually reveled to warm environment thermally neutral quickly, while normal cooling is utilized to keep a thermal-neutral state constantly. An appropriate influence technique for every air conditioning mode was decided through subject matter test. The interior thermal ecosystem was examined by using heat, PMV (forecasted mean vote), and TSV (thermal feeling vote). The residents subjected to the hot ecosystem contacted their thermal-neutral state in the roughly five minutes credited towards the strong cooling (16.4 CMM) by the immediate blowing wind of the FSAC. When the FSAC transformed the control mode to regular cooling (13.9 CMM), it was simpler to preserve the thermal-neutral condition by swinging direct great air flow directionally managed by straight vanes. When roundabout blowing wind was utilized, an up-wards path in a position of 15 was effective in distributing the cooled down air flow and avoiding chilly drafts.

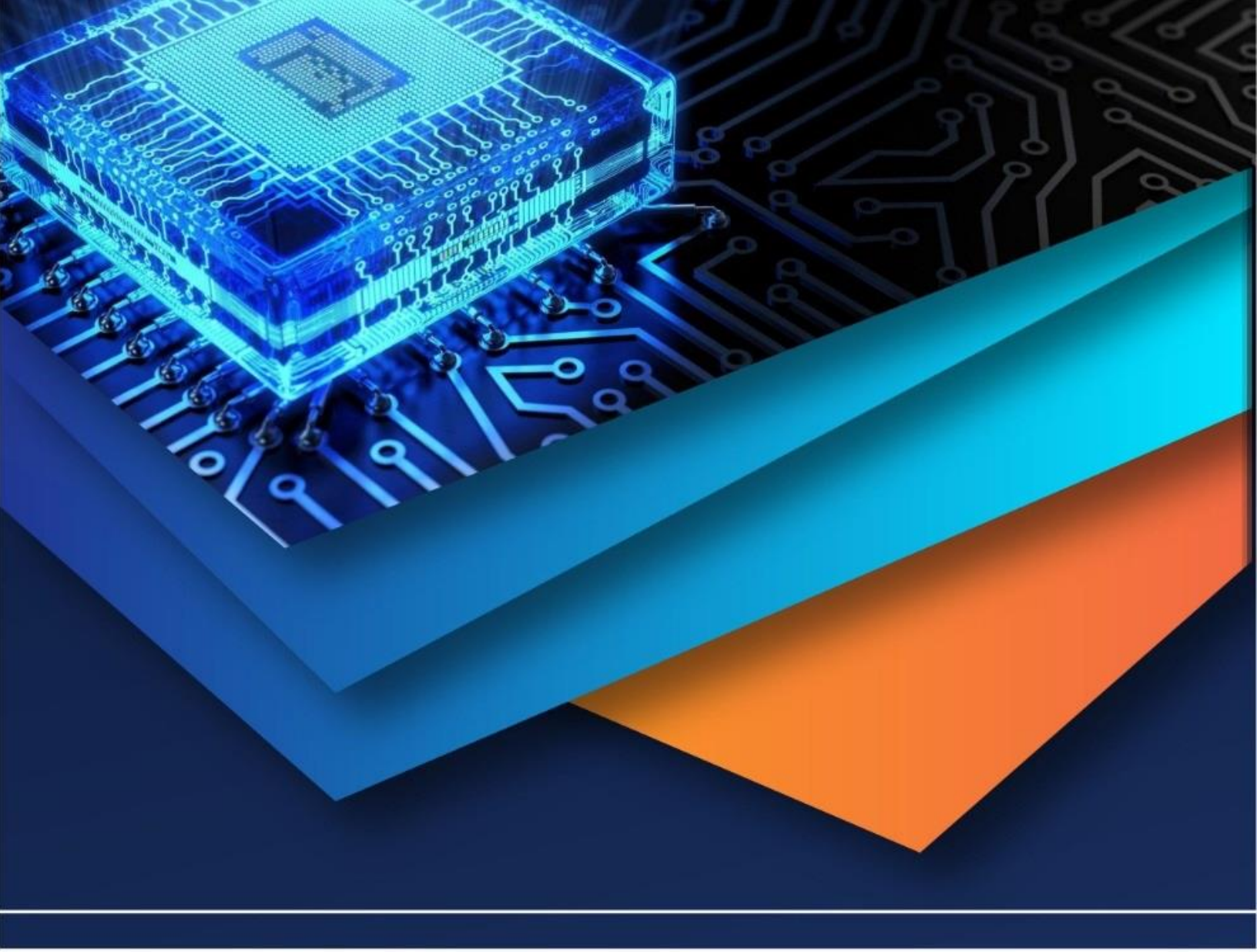
IV. CONCLUSION

Power consumption can be reduced in domestic appliances by modifying them in order to be energy efficient. The normal room air conditioner can be replaced by bed air conditioning if the application is only for sleeping purpose. Otherwise room air conditioner can be used to cool down the entire room rather than just the bed area. The power consumption can be reduced significantly by using bed air conditioning system. Cooling capacity is efficiently used and hence there is no loss to the surrounding. The air conditioning system works on a single phase and it can also run on inverter. The parts of entire setup is detachable and can be transported easily. The tent protects from insects and mosquitoes and hence less chances of getting affected by any airborne diseases.

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