Journal of Energy Research and Environmental Technology (JERET)
p-ISSN: 2394-1561; e-ISSN: 2394-157X; Volume 3, Issue 4; October-December, 2016; pp. 248-252

http://www.krishisanskriti.org/Publication.html

Homemade Portable Room Air Conditioner

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Abstract—*High temperatures have always been a challenging condition in every tropical country such as India. Doing regular work in hot summer days can be tiring and people are more prone to making mistakes. Appropriate air conditioning is required for general comfort of everyone. However, it has been observed that the air conditioners located at work places are mostly at fixed locations and also may not be sufficient to reduce the discomfort due to high temperatures during summer.*

Multiple air conditioning units are rare as the usage of electricity is high leading to additional financial constraint. These lead to work places becoming stuffy and uncomfortable. Additionally, air conditioning contributes indirectly to the release of greenhouse gases and other pollutants in the atmosphere. Also, it has been noted that spending increased amount of time in an air-conditioned environment can significantly contribute to health problems such as asthma, tightness in the chest and other respiratory ailments.

One of the methods to address the above financial, health and environmental issues related to air conditioners is to use a homemade portable air conditioners. Portable air conditioners are light weight and less expensive than the regular air conditioners. Homemade air conditioners work on the simple concept of cooling the hot air by bringing it in contact with a cold fluid.

In the present project, a portable air conditioner was constructed that was affordable and reliable. A table top fan, copper tubes, a small pump and ice was used to assemble an effective and simple to use room air conditioner.

1. INTRODUCTION

Portable air conditioner is an innovative product meant to reduce the discomfort due to the high temperatures. It is designed to make it easier to move from one place to another. The portable homemade air conditioner can be used in absence of a regular air conditioner to substantially improve the environment of the room on a hot day. The conventional fan producing warm air can be modified and will give cold air similar to a normal air conditioner in a closed room but without the associated expenses involved.

The main aim of the present project was to increase the effectiveness of an ordinary table top fan for thermal comfort with the minimum investment of energy. For this purpose various resources from home and surrounding was to be effectively used.

2. GENERAL AIR CONDITIONING SYSTEM

Air conditioning in the past has been used where the climate is too hot for comfort. The cooling fluid used was chlorofluorocarbon compounds that have quite a low boiling point at atmospheric pressure. This is essential for the fluid to stay in the pipe for a long time without decomposing either themselves or the pipe. The liquid is let into the cooling unit through a valve. It evaporates while it passes through the pipe taking heat from the air. The temperature in the cooling coil depends partly on the amount of fluid let in by the valve, which is controlled by thermostat. The minimum temperature at the cold surface can be fixed by controlling the pressure in the cooling coil, with the valve. The boiling point of any liquid depends on the pressure.

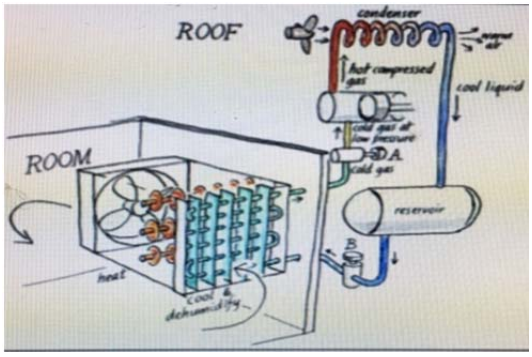

Fig. 1: Minimal Air Conditioning

The pressure controller is therefore set to make a cooling fluid boil at the lowest temperature that is likely to be needed to control the humidity but always over 0^{o}C. The temperature needed for cooling is nearly always higher than that needed for dehumidification. The vapor that emerges through the pressure controller is gathered up by a compressor. The compression also heats the gas, which is led away from the room, to be cooled down. Cooling will increase the relative humidity of the air. Therefore, humidification is not usually built into the system. The cooled liquid is piped back to the reservoir, for the next cycle through the room air conditioner.

The entire process described above is inefficient and uses electricity, which is itself produced by inefficient conversion of heat energy. Such systems are therefore confined to small places where the inefficiency is compensated by the generally high reliability and freedom from maintenance.

3. TYPES OF AIR CONDITIONING SYSTEMS

Where precision control of the environment is required, several types of air conditioning systems are commonly used. Cooling coils using chilled water, evaporative condensers, cooling towers, and ground loop systems based on lifecycle economics are used. Operating efficiencies and maintenance costs associated with outdoor design conditions and environment could adversely impact the operation of air cooled condensers.

3.1 Unitary Air Conditioning Systems

Unitary Air Conditioning Systems are generally limited to loads less than 100 tons. Unitary systems are packaged in self-contained or split configurations. Self-contained units incorporate components for cooling and heating in one apparatus. Thermostatic expansion valves are preferred over capillary tubes and orifices for refrigerant control when available as a manufacturer's option. This is due to the fact that expansion valves provide better superheat control over a wide range of operating conditions. Split systems may include the following configurations:

a) Direct expansion coil and supply fan combined with a remote compressor and condensing coil.
b) Direct expansion coil, supply fan, and compressor combined with a remote condenser, cooling tower, or ground – loop system.

These systems generally are economically cheaper than the central systems but may have higher life cycle costs. If part load operation is anticipated for a majority of equipment operating life, multiple unitary equipment for superior operating efficiencies and added reliability should be considered.

3.2 Room Air Conditioning Units

Room Air Conditioner Units are self-contained units serving only one confined space. These units are typically mounted on window or through-the-wall type air conditioners. Rooms served by these units should have a separate HVAC unit to provide ventilation air for a group of rooms. These units are mostly used when they are life cycle cost effective.

3.3 Built up Systems

Built up Systems consist of individual components assembled at a building site. Generally, when a large volume of air is to be handled that's when these systems are used. These systems may be used as remote air handling systems with a central cooling plant. The number of unitary air handling units is determined by an economic division of the loads, considering:

(a) The value of space occupied by equipment;
(b) The extent of ductwork and piping;
(c) The multiplicity of control, maintenance, and operating units; and
(d) Energy conservation factors .

3.4 Split System Air Conditioners

The more common of the two types of central air conditioners, split system air conditioners have the compressor / condenser housed in a unit outdoors and the evaporator indoors. The primary benefit of split system air conditioners is that they keep the noisy part outside. Split system air conditioners can be designed to connect into the existing ductwork, cooling the home evenly and quietly.

4. ASSEMBLING OF PORTABLE AIR CONDITIONER

Based on the details of air conditioners given in Section 3above, it was decided that for effective cooling for a small room, a homemade portable air conditioner will be suitable and can be constructed at a very nominal cost as compared to the other air conditioning units. Also, the electricity costs required for the same is expected to be lower than the regular air conditioning units. For testing the above facts, a portable air conditioner was assembled using the material as detailed below.

(a) Table Fan – voltage (220volt), motor speed (1200rpm), power (100w), current (0.45amps)
(b) Copper Coil - length (31.5 feet), diameter (1/2") and number of turns are 10
(c) Vinyl Tube – length (1.5 m), diameter (1/2")
(d) Water Pump – voltage (220volt/50hz), power (18w), current (0.08amps)
(e) Ice - salt added (30gm per lit)
(f) Bucket - 8 or 9 Lt

Fig. 2: Table Fan

Fig. 3: Copper Coil and Vinyl tube

Fig. 4: Ssubmersible Water Pump and Salty Ice

The final design of the Portable AC that was tested had the copper tube wounded on the front surface of the fan (Fig. 5).

Fig. 5: Copper Coiled Fan

The copper coil was connected to the vinyl tube which was then dipped in the ice water in a bucket. A submersible water pump was used to circulate the chilled water through the copper tube. It should be noted that there is no suction applied at the outlet end of vinyl tube.

The number of turns of the coil was decided after a few trial runs. Initially fewer turns was used which prevented regular flow of water. Therefore, the final design has ten turns this time as compared to earlier construction. It was also observed that the time consumed was less and regular flow rate of water, helped it to operate satisfactorily.

5. OPERATION OF THE PORTABLE AC

The components of the air conditioning unit were used to assemble the unit according to the schematic diagram shown in Fig. 6.

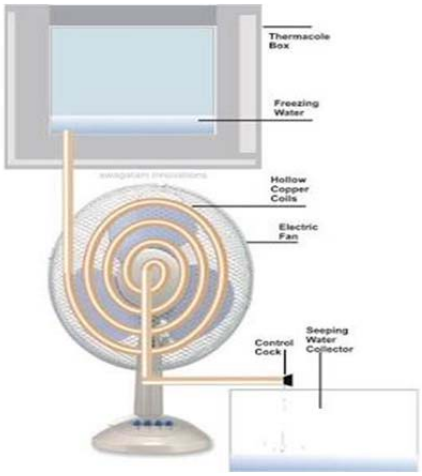

Fig. 6: Schematic Diagram

The cooling system contain refrigerant (in this case icecold water). The refrigerant passes through the copper coil, which is wound on the front panel of the fan, with the help of aquarium pump. As soon as the icecold water fills up the complete “copper spiral”, instantly the air surrounding the coils starts getting cooler. This is due to copper being an extremely good conductor of heat and it starts radiating coolness through its outer wall into the atmosphere around it. However, cooling the air in the vicinity of the coils will not achieve the purpose of lowering the overall temperature in the room. The low temperature created around the coils requires to be spread over the entire enclosed area of the room where the copper coils has been installed. This is simply done using a table fan and ensuring that the diameter of the fan exactly matches that of the cooper spiral or vice versa for maximum efficiency.

It has been observed that by keeping the fan very close to the spiral and switching the fan on amazingly initiates the generation of fresh cold breeze throughout the room. The heat transfer takes place from low to high temperature i.e. the copper coil absorbs the heat from air and given to the refrigerant which is flowing in the coil after that the heated refrigerant collected in the chamber and recalculated in the coil. However, it should be noted that the size of room is a big factor in deciding the effectiveness of the portable AC. If the portable AC so assembled is insufficient to reduce the temperatures in the room, get increase the large volume of air have to be cooled hence it takes large time.

There are few assumptions made to calculate the duration of time required to fill a 1L bottle and the power being consumed.

- Specific heat capacity of water 4.19J/g^{o}C
- Density of water is 1000g/l.
- Flow rate is constant throughout the process.

- Room (in consideration) have homogeneous temp throughout the room.
- For one hour of operation of pump and fan, power required is 0.018 and 0.1kwh.

The above assumptions give the flow rate as 0.77lit/min and the power consumed by fan and pump together for one hour is 0.118kwh.

The homemade AC was tested in a small room to measure its actual effectiveness to reduce the room temperature. Temperature was measured using a thermometer at specific distance and regular intervals of time. The results are shown in Table 1below.

Table 1: Time Required for Cooling

Temperature(^{0}C)	Time(min)
27	0
26	15
24	30
22	45
20	60

6. PARAMETERS OF HOMEMADE AC

A number of parameters are to be considered while designing a homemade AC. These parameters are listed below.

a) Set-up Cost

Overall set up cost of the convectional air conditioning is very high as compared to the homemade one to install. So the better alternative option is to go for a portable air conditioner which is very low in cost in comparison to convectional air conditioning.

b) Energy Consumption

One of the major concerns is high electricity consumption leading to high electricity bills which is not affordable by every second person. Therefore, with respect with energy consumption, portable homemade ACs is better than the regular AC units.

Another advantage is that the present design of the portable air conditioner can work with invertors as it does not require huge voltage while conventional air conditioner cannot work on invertors.

c) Cooling agent

The cooling agents used in the conventional air conditioner are of very high cost which is chlorofluorocarbon and liquefied ammonia gas. Another important factor to be considered is ecofriendly nature of the unit. Conventional air conditioners are not at all ecofriendly in nature as they release greenhouse gases and other pollutants. In the present portable air conditioner, cooling agent used is water in form of ice which is easily available and quite cheap in comparison to the ones being used in conventional air conditioner. Additionally, it is more environment friendly as it does not release any greenhouse gases.

d) Movable

Conventional air conditioners are mostly installed in one location. On the other hand, portable air conditioners are very light in weight in comparison to conventional air conditioner and hence it is movable to any place as per needs.

e) East of Maintenance

Potable air conditioner can be self repaired as it does not consist of high technicality and is very simple in design. In case of any problem, e.g. copper tube getting corroded it can be easily changed. Conventional air conditioners can only be repaired by skilled workers.

g) Space requirement

Portable air conditioner is smaller in size than the conventional AC. Therefore it can be easily used in a small room without too much space requirement.

7. EFFECTIVENESS OF THE PORTABLE AC

To increase the effectiveness of the Portable AC, numerous trials were conducted and the following conclusions were drawn.

(a) **Cover the fan front and back with copper coils -** By covering the fan from both sides will give more surface area for all three modes of heat transfer and this will result in faster cooling of the small confined room.

(b) **Increased flow rate of cold water** – Increasing the flowrate of the cold water through the copper coil significantly will lead to less time being consumed for cooling the room.

(c) **Increased fan surface area** – By using a larger sized fan, will lead to increased surface area. This leads to the coolant being exposed to a larger volume of air surrounding the fan and eventually faster cooling of the room is achieved.

(d) **Use salty ice –** Ice made from salty water will take longer for dissolving as compared to ice made from fresh water. Therefore, frequency of changing the water in the reservoir will be less compared to the case where fresh ice is used.

(e) **Usage of insulated reservoir –** Using thermacol fitted or clay or sand container to store the chilled water being circulated will reduce the heat loss of ice into the atmosphere. This will lead to reduced frequency required to change the chilled water.

8. CONCLUSIONS AND RECOMMENDATIONS

Results obtained from the present project work suggests that the final design of the homemade portable AC can be used as an viable option for cooling a small room without too much financial and space investment. It is economically very attractive choice and satisfies the basic air conditioner function for cooling purpose. The air conditioner has been rigorously tested and reliability of its design has been noted. The present design offers numerous advantages as listed below:

- Maintenance cost normally less than for water cooled systems.
- In event of power failure, it can still work on invertors.
- Simple mechanical design
- Minimal concerns due to thermal and chemical pollution of cooling fluids.

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