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Working Model of Refrigerator cum Air conditioner

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Abstract

This working model refrigeration cum air conditioner is a device that performs both task at same time of cooling refrigeration cabin and room. By this method the energy and cost can be reduced from actual individually equipment.

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1. INTRODUCTION

Refrigeration is a process in which work is done to move heat from one location to another. The work of heat transport is traditionally driven by mechanical work, but can also be driven by heat, magnetism, electricity, laser, or other means

Air condition is device which produce cooling effect in surrounding atmospheres.

Refrigeration cum Air-condition is device which is perform both function at same time cooling chamber as well as cooling surrounding medium

2. BASIC VAPOR COMPRESSION CYCLE

- The compressor sucks the vapor from evaporator and compress it high temperature. This is work as a pump.
- In this cycle the refrigerant use for the cooling the space. The refrigerant absorbs the heat from surrounding medium in evaporator and release the heat in condenser.
- The expansion valve used for pressure drop of refrigerant.
- The fan is recirculating the air in space.
- The condenser also works as a heat exchanger which transfers the heat from refrigerant to surrounding air.
- The evaporator is work as a heat exchanger which transfers the heat from surrounding (place to be cooled) to refrigerant and converts it into in vapor form.

3. PARTS OF MODEL

1) Compressor.
2) Condenser
3) Expansion
4) Evaporator Valve
5) Blower
6) Pressure gauge
7) Thermo couple
8) voltage controller
9) Relay switch

1. COMPRESSOR

There are two outcomes from compressor one is for suction and other is for discharge.
The compressor sucks the vapor refrigerant from evaporator and discharge to condenser.
The compressor is simple V type reciprocating, single stage, single acting and hermetic sealed type compressor.

Function:

Compresses and circulates refrigerant throughout the cooling system and increase the temperature and pressure at condense level.

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Figure 1 compressor

2. CONDENSNER

- The condenser tubes are made from copper and having 8 mm diameter.
- The condenser cooling is natural convection air cooled condenser.
- The condenser contains the plate type fins which increase the area for heat transfer. These fins are normally made from aluminum because of lower weight.
- These tubes are bended by means of the spring bender.
- The main function of the condenser is to condense the refrigerant.
- **Function:**
  In this process the refrigerant converted into liquid form from vapor form.

Figure 2 Condenser

3. EXPANSION VALVE

In this process due to reduce in pressure the half portion of the liquid is converted into vapor form.
The expansion devices used in model is simple capillary tube.
This device reduces the high pressure liquid refrigerant to low pressure liquid refrigerant.
The expansion devices separate the high pressure and lower pressure side.

Figure 3 Capillary tube

4. EVAPORATOR

These tubes are also bending from the spring bender.
The evaporator tubes are made from the aluminum.
These tubes are also bending from the spring bender.
This latent heat is obtained from the surrounding medium.

The liquid refrigerant from the expansion valve enter into the evaporator and in this evaporator the liquid is converted into vapor.

Figure 4 Evaporator

5. BASE STRUCTURE

- The four angles are joined by arc welding and on which the wooden sheet is fastened by bolts.
- The base structure of model was made from the M.S. steel and wooden sheet.
- This base structure is providing the support to all part of model.

6. CABIN

- The cabin for refrigeration system is made from same wooden sheet as supporting structure.
- This cabin separated inside in two parts one is refrigerator and second is air conditioner.
- This cabin is coated by thermocol sheet inside.

7. REFRIGERANT

- The refrigerant is a heat carrying medium which is absorb heat from low temperature side and release it at high temperature side.
- The refrigerant use in this system is R-134a (Tetrafluoroethane)
- It has boiling temperature -26.15 C. it is not soluble in oil.
- The refrigerant used in system is primary organic refrigerant.
  Properties: Ozone Friendly, Easily Available, Safe refrigerant.

8. BLOWER

- The blower is of Maruti 800 car.
- The blower is used to suck the cooled air from the refrigerant unit and produce the effect of air conditioner.

Figure 5 Blower

9. FAN

- The fan rotated at 3200 rpm.
- The fan running at 230volts.
- The fan use for the circulation of air and increase cooling effect.

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Figure 6 Fan

10. PRESUURE GUAGE

The outlet pressure is a discharge pressure of compressor and for it discharge pressure gauge is used. The inlet pressure is a suction pressure of the compressor so pressure gauge used for it suction pressure gauge.
The pressure gauge is used for measuring the pressure at inlet and outlet of compressor.

FIGURE 7 Discharge pressure gauge

figure 8 suction pressure gauge

12. D.C. BATTERY

- This battery is used for run the blower.
- This battery has 6 volt or 12 volt.
- This battery is used when cutout of electricity.

Figure 9 Battery

11.VOLTEGE CONTROLLER

This voltage controller is used for the controlling speed for blower.

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Figure 10 voltage controller

4.1 HOW TO MAKE?

Base structure:
The four M.S. are assembling in rectangle form which performs as a base of our model.
The wooden sheet and the thermocol sheer perform as a base structure for the compressor and the condensing tube.

Figure 11 Base structure

- Refrigeration cabin: The wooden cabin performs as a refrigeration cabin in which the thermocol sheet is coated inside.
- Air conditioner unit: The blower fitted on the refrigeration cabin performs as the Air conditioner unit.
- The base structure is created by welding joint among the all M.S. angles.
- The supporting structure is created by arranging the wooden sheer on the base structure.
- The refrigeration cabin is fitted on one side of the base structure.
- The general refrigeration circuit is connected as suggested in simple vapour compression cycle.
- The evaporator tubes are fitted inside the refrigeration cabin and the condenser tubes are fitted under the wooden supporting structure because wooden sheet prevent the external damage of the tubes.
- The refrigerant R12 is filled into circuit after condenser.
- The blower is fitted on the refrigeration cabin which performs as an air conditioner.
- The power supply to main refrigeration system is 240 volt A.C.
- The power supply to the blower is same to the main circuit but through the invertors or 12 volt or 6 volt D.C. battery also provide the power supply to the blower.

Figure 12 working model

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4.2 HOW IT WORK?

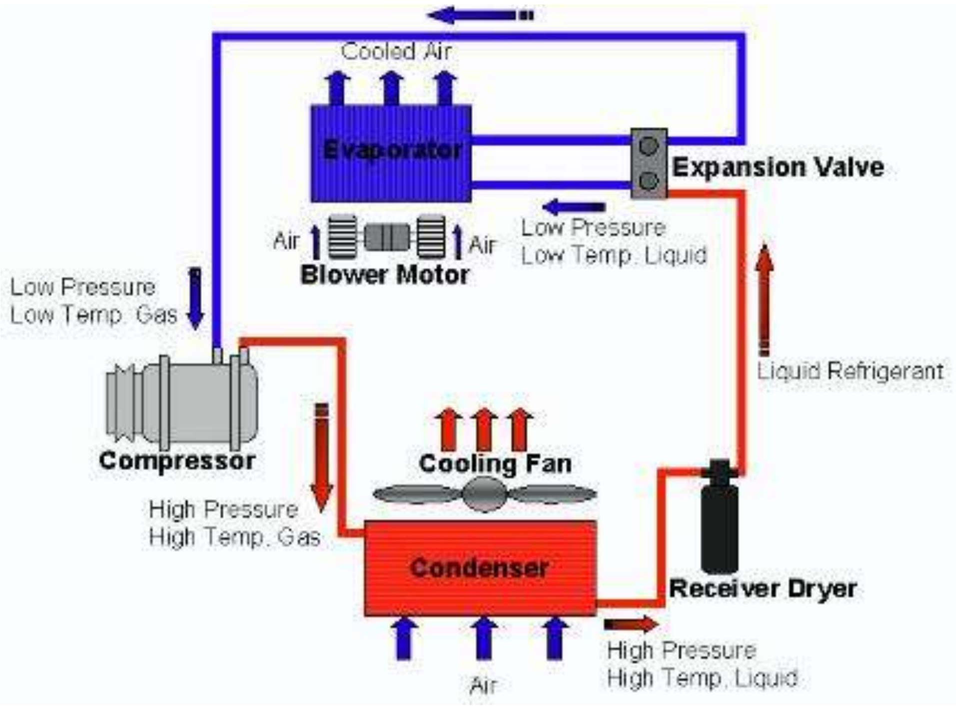

Fig.13 model diagram

- The normal refrigeration system is work on simple vapour compression cycle. This is described below:
- The liquid refrigerant enter into the evaporator absorbs the heat from the surrounding medium and cool the chamber and converted into the vapour form this refrigerant then passes to compressor at low pressure and temperature and compress in the compressor at high pressure and temperature.
- Then it passes to condenser tubes and condenses and converted into the liquid form in this process the vapour converted into the liquid form by naturally air cooling system. Then it passes to calipers tube in which it pressure and temperature decrease. And the liquid passes to evaporator tubes.
- The blower is connected on refrigeration cabin now whenever the requirement of air conditioner system the blower is started by means of direct current battery or by the A.C. through the invertors.

Figure 14 working model

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Calculation

Table 1 Observation table without joining blower

Sr. No.	Description	Reading
1	condenser pressure	0.14 bar
2	evaporator pressure	17.24 bar
3	condenser inlet Temperature	49.8 ℃
4	condenser outlet Temperature	39.2 ℃
5	evaporator inlet Temperature	13 ℃
6	evaporator outlet Temperature	29.7 ℃

Calculations

- $(\text{C.O.P.})_{act} = \frac{\text{Refrigerating effect}}{\text{work done}}$
- Refrigerating effect = $m_r (h_1 - h_4)$
- m_r = mass flow rate of refrigerant = 0.0025 m/s

From P-h diagram

h_4 = Enthalpy at Condenser Outlet =240 kj/kg

h_1 = Enthalpy at Evaporator Outlet =350 kj/kg

- Refrigerating effect = $m_r (h_1 - h_4)$
  =0.275KW
  =0.0025(350-240)

Work done by Compressor

$$\text{Compressor Work} = \frac{N_c \times 3600}{t_c \times EMC} \quad \text{..........................} (4.4)$$

N_c= No. of pulses for energy meter for compressor = 15

t_c = time for 15 pulses for energy meter = 106 sec

EMC = Energy meter Constant = 3200 imp/kWh

Compressor Work = 15*3600/106*3200

=0.1591KW

$(\text{C.O.P.})_{act} = \frac{\text{Refrigerating effect}}{\text{work done}}$

=0.275/0.1591

= 1.7284

Table 2 Observation table with joining blower

Sr. No.	Description	Reading
1	condenser pressure	0.34 bar
2	evaporator pressure	11.72 bar
3	condenser inlet Temperature	51.1 ℃
4	condenser outlet Temperature	40.7 ℃
5	evaporator inlet Temperature	26.1 ℃
6	evaporator outlet Temperature	31.6 ℃

Calculations

$(C.O.P.)_{act} = \frac{\text{Refrigerating effect}}{\text{work done}}$

- Refrigerating effect = $m_r (h_1 - h_4)$
- m_r = mass flow rate of refrigerant = 0.0025 m/s

From P-h diagram

h_4 = Enthalpy at Condenser Outlet = 360 kj/kg
h_1 = Enthalpy at Evaporator Outlet =300 kj/kg

- Refrigerating effect = $m_r (h_1 - h_4)$

=0.0025(360-300)

=0.15KW

Work done by Compressor

Compressor Work = $\frac{N_c \times 3600}{t_c \times EMC}$

N_c= No. of pulses for energy meter for compressor = 15

t_c = time for 15 pulses for energy meter = 97 sec

EMC = Energy meter Constant = 3200 imp/kWh

=0.1739

Compressor Work = 15*3600/97*3200

$(C.O.P.)_{act} = \frac{\text{Refrigerating effect}}{\text{work done}}$

= 0.15/0.1739

=0.8625

CONCLUSION

- After making this model, we conclude that the C.O.P of individual refrigerator is larger than the combine system of refrigeration and air conditioner. This model is more preferable in areas where there is possibility of electricity cutoff during more time of day.

Future scope

- Using stored electricity.
- More cooling effect may be achieved by arrangement of two evaporators.
- It can also be operated using with Solar Energy.
- Can be used in refrigerating trucks for reducing cabin temperature.