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DESIGN AND FABRICATION OF THREE IN ONE AIR CONDITIONING

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ABSTRACT

The field of mechanical engineering has a theme word called “CHANGE” as its backbone. The new technological advancements and the needs of people have made us think about this project. Our project is maiden venture into the field of air temperature controlling and also deals with human comfort. Human comfort conditions deal with the conditions of environment around you, viz. HOT & COLD. The control of temperature of air around us is done by controlling the output water from the water cooler. Our project is a novel idea to control air temperature around us by the incorporation of cooling system in a single unit. This unit would be an economic utility at all places to provide comfort conditions to the people. “Faster, mightier & smaller” is still the keyword for every invention and development. In day-to-day world we concentrate on the compactness and efficiency of every product. Keeping this in our thought I have designed and fabricate an economical and reliable unit known as “Water Cum Room Cooler”(Three in one air conditioner). “Human comfort is that condition of mind, which expresses itself with the thermal environment”. In our project three rival properties of cool water, hot water & cool air are obtained.

INTRODUCTION

“Faster, mightier & smaller” is still the keyword for every invention and development. In day-to-day world we concentrate on the compactness and efficiency of every product. Keeping this in our thought we have designed and fabricated an economical and reliable unit known as “**THREE IN ONE AIR CONDITIONER**”. “**Human comfort** is that condition of mind, which expresses itself with the thermal environment”. In our project two rival properties of cool water and cool air are obtained. This system can be used continuously. By using our system there is no need of going for a separate air conditioner or air cooler and water cooler. As both purposes are served by a single system, the cost is also lowered to a considerable level. The technology enables the same unit for space conditioning cum domestic hot water heating and water cooling in residences. The earlier air-to-water heat pumps and water-heating heat pumps suffered from drawbacks like high costs, unreliable operation, and inflexible Applications. They were not well positioned in the market to attract peoples. This paper introduces a novel air-conditioning product that can achieve the multi-functions with improved energy performance. The basic design principles and the prototype test results are presented. The results showed that by incorporating water heater and eater cooler in the outdoor unit of a split-type air-conditioner so that space cooling and water heating can take place simultaneously the energy performance can be raised considerably.

WHY R-134a.....

As we know that R-12 is a commonly used refrigerants but nowadays R-134a is the best substitution of that refrigerant. Because it has some good specific properties than R-12.

- (1) Less compressor speed
- (2) Low compression ratio
- (3) High sensitive leak detector
- (4) Less global warming potential
- (5) Zero ozone depletion potential

Less compressor speed:

As we know that density of R-134a is more than that of R-12. Due to this reason for existing R-12 reciprocating compressors, it would require either an average increase in compressor speed of 5 to 8 % or an equivalent increase in cylinder volume for same mass of both refrigerants.

Low compression ratio:

Its density is more than that of R-12, so if we compress with same speed and same mass of refrigerant then result will be that R-12 will be compressed more than that of the R-134a. So R-134a has less compression ratio than R-12.

High sensitive leak detector:

Molecules of R-134a are smaller than R-12. therefore a very sensitive leak detector.

Zero ozone depletion potential: Since R-134a has no chlorine atoms in molecular formula so its depletion potential is zero. All of the refrigerants use R-11 as a datum reference and thus R-11 has an ODP of 1.0. The less the value of the ODP the better the refrigerant is for the ozone layer but ODP of R-12 is 3.4 so it affects the environmental condition .

R-134a PROPERTIES:

Boiling point: -26.15°C at atmospheric temperature

Freezing temperature: -101°C

Evaporator pressure: 1.6397 at -15°C in bar

Condenser pressure: 7.7008 at 30°C in bar

Critical temperature: 101.06°C

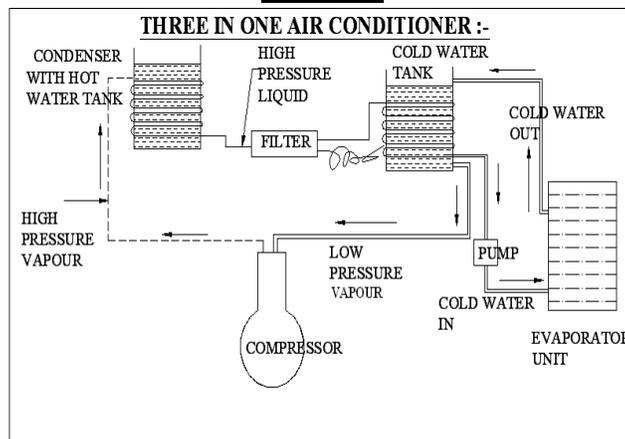
Critical pressure: 40.56 bar

COP: 4.61

KW/TR: 0.762

Specific volume: $0.121 \text{ m}^3/\text{kg}$ at -15°C

DESIGN



TECHNIQUE EMPLOYED.....???

The technique employed here to get the three works from one unit is only the *modification* of simple vapour compression refrigeration cycle.

HOT WATER

Water is used as the condensing or cooling medium & being heated due to the heat exchange from the hot vapour refrigerant.

COLD WATER

Cooling of water is obtained from the evaporator unit due to the heat transfer of water to the refrigerant.

AIR COOLING

Air cooling is obtained due to the fact of heat exchange between hot air & cold refrigerant.

GENERAL PRINCIPLES

As the Three rival properties of

Cool water

Hot water

& cool air....

Are obtained in one unit, it is known as “**Three in one Air conditioner**”. Hence It eliminates the separate use of an air **conditioner**, water heater & water cooler as the three purposes are served in a same unit. The proposed air conditioner is designed for multi-task and for year round service. The device possesses the three functions of space air-conditioning water heating & water cooling. It is designed as a split type unit. A water tank with immersed condensing coils is integrated in the outdoor unit.

The evaporator unit contains **two functional features**:-

1. A water tank with immersed evaporating coils &
2. The air-conditioner.

In the warm seasons, the novel air-conditioner provides space cooling as Its primary task, the same evaporator unit provides the cooled water and also produces domestic hot water through the “water-bath” heat-recovery condenser as its secondary task. In the process, the water temperature will rise. The performance will drop because of the elevated condenser working temperature and pressure. To overcome this limitation, an air-cooled condenser is connected in series with the immersed condenser. This is to overtake the duty of the immersed condenser when the water temperature reaches a high limit & because of the mixed effect of water-heating-cooling and air-cooling, the average performance in the cooling mode will be generally higher than the conventional split-type air-conditioner.

The proposed product is able to work in one of the following “**three**” **operation modes**:

Provision of space cooling and domestic hot water:-

As the rejected heat energy at the condenser is about 15–20% more than the evaporator refrigerating effect, the recovery of all rejected heat for hot water production is not necessary. The hot water consumption depends on the needs of the individuals. As the operation time for space cooling can be lengthy, the water heater is only to recover a part of the condensation heat energy.

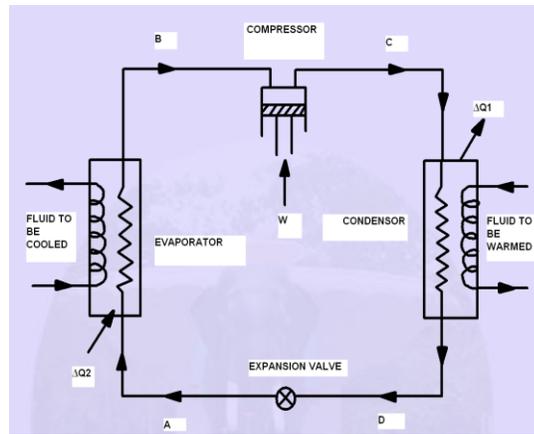
Provision of domestic hot water as a heat pump water heater:-Other than the cooling season, the proposed air-conditioner is primarily used to produce domestic hot water. In this mode, the indoor unit is not in use. The air-cooler at the outdoor unit becomes the evaporator, which works together with the immersed condenser. In order to improve the heat exchange at the water tank, the other side-by-side condenser coil is to be put in service.

Provision of cool water for domestic purposes:-

The secondary side of evaporating unit provides water cooling as the evaporator coils are immersed into the tank of water which has to be cooled.

SIMPLE VAPOR COMPRESSION REFRIGERATION SYSTEM:

A simple vapor compression refrigeration system consists of the following equipments: i) Compressor ii) Condenser iii) Expansion valve iv) Evaporator



The schematic diagram of the arrangement is as shown in Figure the low temperature, low pressure vapour at state B is compressed by a compressor to high temperature and pressure vapour at state C. This vapour is condensed into high pressure vapour at state D in the condenser and then passes through the expansion valve. Here, the vapour is throttled down to a low pressure liquid and passed on to an evaporator, where it absorbs heat from the surroundings from the circulating fluid (being refrigerated) and vaporizes into low pressure vapor at state B. The cycle then repeats. The exchange of energy is as follows:

BASIC WORKING CYCLE PROCEDURES**COMPRESSION:**

The refrigerant being sucked to the compressor through the suction line. Afterward the refrigerant compressed into the compressor and the compressed refrigerant being discharged to the condenser unit through the discharge line.

CONDENSATION:

When the high pressure refrigerant vapour enters the condenser heat flows from condenser to cooling medium thus allowing vaporized refrigerant to return to liquid state.

EXPANSION:

After condenser the liquid refrigerant is stored in the liquid receiver until needed. From the receiver it passes through an expansion valve where the pressure is reduced sufficiently to allow the vaporization of liquid at a low temperature of about – 10 degree centigrade.

VAPORIZATION:

The low pressure refrigerant vapour after expansion in the expansion valve enters the evaporator on refrigerated space where a considerable amount of heat is absorbed by it and refrigeration is furnished.

LITERATURE REVIEW

[1] In 1758, Ben Franklin and a colleague in England, chemist John b Hadley, conducted an experiment on the cooling properties of evaporation. By using a bellows to evaporate highly volatile liquids like alcohol and ether, they were able to drop the temperature to 7°F, building up a thick layer of ice on their mercury thermometer—while the ambient temperature was 64°F (Energy Solution, 2012)

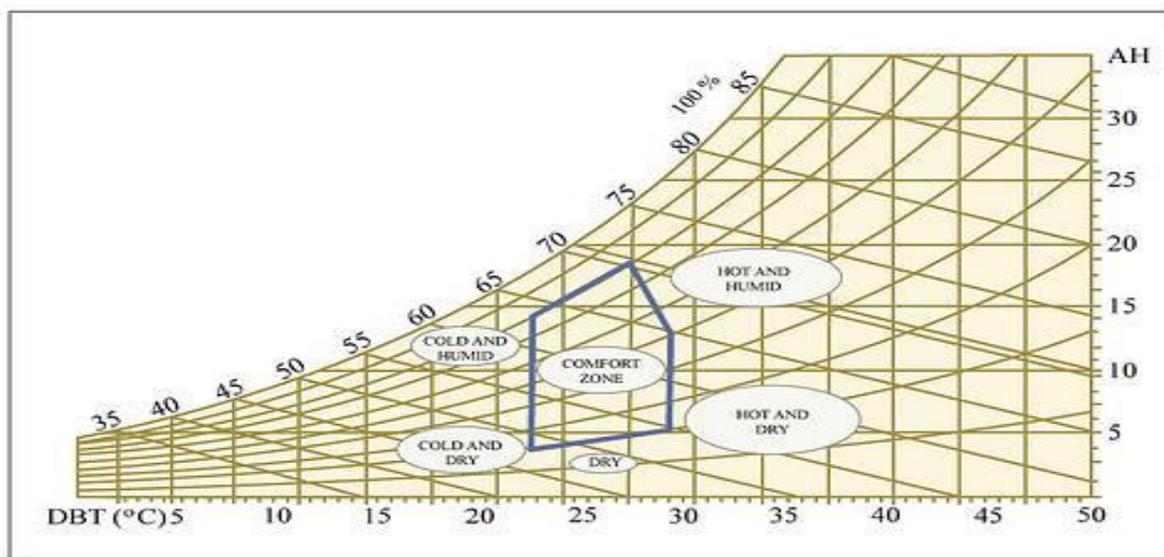
[2] In 1820, another of history's greatest scientists, the British inventor Michael Faraday, showed that by mechanically compressing ammonia to liquefy (condense) it and then allowing the ammonia to expand and evaporate, he could cool air.

[3] In 1842, a Florida physician, John Gorrie, wanted to keep patients cool, was able to use this principle to make ice in an Apalachicola hospital.

[4] In 1851 Gorrie patented his system and hoped to commercialize it to cool buildings, but his financial backer died with it, Gorrie's path to success. Air conditioning would not reappear for 50 years.

[5] In 1902, Willis Carrier of Syracuse, New York perfected a system for dehumidifying a commercial printing plant. The goal was to stabilize the paper, but the invention also kept the plant's temperature more comfortable and the workers more productive. He formed The Carrier Air Conditioning Company of America to produce these systems, eventually extending beyond commercial buildings to homes. With 32,000 employees in 170 countries, Carrier Corporation (now a subsidiary of United Technologies Corporation) is today the world leader in high-technology heating, air conditioning, and refrigeration systems.

HUMAN COMFORT CHART



In comfort chart, the dry bulb temperature is taken as abscissa and wet bulb temperature as ordinate. The relative humidity lines are replotted from the psychrometric chart. The statically prepared graphs corresponding to summer and winter season are also superimposed. These graphs have effective temperature scale as abscissa and percentage of people feeling comfortable as ordinate. A close study of the chart reveals that the several combination of wet and dry temperature with different relative humidities will produce the same effective temperature. However, all points located on a given effective temperature line do not indicate condition of equal comfort or discomfort. The extremely high or low relative humidities may produce condition of discomfort regardless of existing effective temperature. The most desirable humidity range lies between 30 and 70 percentage. When relative humidity just below the 30%, the mucous membranes and the skin surface become too dry for comfort and health. On the other hand if relative humidity above 70%, there is tendency for a clammy or sticky sensation develop. The comfort chart

shows the range for both winter and summer condition within which a condition of comfort exists for most people. For summer conditions, the chart indicates that a maximum of 98 % people felt comfortable for an effective temperature of 21.6 degree Celsius. For winter condition, chart indicates that an effective temperature of 20 degree Celsius was desired by 97.7 percent people.

ADVANTAGES OF THE SYSTEM

- The system saves the energy
- Noiseless in operation
- It contains a compact unit
- Low initial cost
- Low maintenance cost

DISADVANTAGES

- Complicated in construction
- Not portable
- Chance of leakage
- Changing of coils may be required

APPLICATION

- Domestic uses
- Office and Bank
- Industrial purposes
- Anywhere, as per the requirements

CONCLUSION

- An effective integrated air-conditioner, refrigeration and heating system is suggested.
- A simple working model of the system is fabricated and tested.
- The heating unit in the system utilizes heat lost through the condenser and thereby saves energy.

COEFFICIENT OF PERFORMANCE

- The coefficient of performance is the ratio of heat extracted in the refrigerator to the work done on the refrigerant.

Mathematically,

$$C.O.P = Q/W$$

Q = Amount of heat extracted in the refrigerator

W = Amount of work done

CALCULATION

Heat extracted = Mass * Specific heat * Rise in temperature

Density of water = 1000 kg/m³, Volume of water = 1 litre

Mass of water = Volume * Density

$$= 1/1000 \text{ m}^3 * 1000 \text{ kg/m}^3$$

$$= 1 \text{ kg}$$

Specific heat of water = 4.187 kJ/kg-k

Rise in temperature = T₂ - T₁

T₁ = Normal water temperature

$$= 25^\circ\text{C} = 298 \text{ K}$$

T₂ = Hot water temperature = 40°C = 313K

Work done = 1/12 kW

Time taken to raise the temperature from T₁ to T₂ = 10 min

$$\text{Heat extracted (Q)} = 1 \text{ kg} * 4.187 \text{ kJ/kg-k} * (313 - 298) \text{ K} = 62.805 \text{ kJ}$$

$$\text{Work done (W)} = 1/12 \text{ kJ/sec} * 10 * 60 \text{ sec} = 50 \text{ kJ}$$

$$C.O.P = Q/W = 62.805/50 = 1.256$$

(TOP VIEW OF MY PROJECT DESIGN AND FABRICATION OF THREE IN ONE AIR CONDITIONG)



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BIOGRAPHY

RAMAN KUMAR SINGH- basically I belongs to Darbhanga district of Bihar. I did B.Tech in mechanical engineering from C V Raman College of engineering of Bhubaneswar Orissa, and then I did job in Emami Ltd. F.m.c.g Company. Right now I'm final semester M.tech student of thermal science in B.I.T Sindri engineering college Dhanbad, Jharkhand, my final semester M.tech project topic is design and fabrication of three in one air - conditioning.