DESIGN OF HYBRID AIR COOLER USING VAPOUR COMPRESSION REFRIGERATION SYSTEM

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Abstract: *Now a days, global warming is one of the serious concern for environment to get protected from it every one is taking help of technology by the means of different types of refrigeration system for comfort food process, medicines, blood storage, humidity control, etc. use of refrigeration system is not only ineffective environment but also give total comfort. In India middle class and poor families cannot afford all types of Refrigeration system like an AC, Refrigerator, etc. Generally they purchase only Air cooler. To solve this we can integrate Refrigeration system of AC, refrigerator and Air cooler in one product. In this type of system consist of various components such as compressor, condenser, capillary tube, evaporator, motor, fan, etc. Our project is to use technology of vapour compression refrigeration system.*

Key words: *compressor, condenser, evaporator, expansion valve, electric fan.*

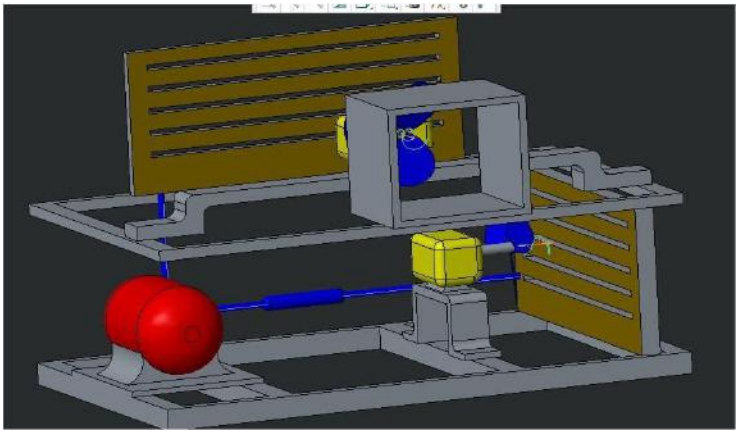
1. INTRODUCTION:

Refrigeration is the process of maintaining low temperature in comparison to surrounding temperature. Refrigeration is the process of removing heat from an enclosed space or from a substance and rejecting it elsewhere for the primary purpose of lowering the temperature of the enclose space or substance and then maintaining that lower temperature .Basic concept of the project is to design an appliance that can work like AC as well as fan but will not consume that much amount of electricity, cost, size and water. In this method of cooling system we are going to use copper pipes, fan, compressor, cooling gas, compact body, condenser, Evaporator, etc.Cooling systems or air conditioning systems are going to be in detail description in the following report; these systems also have huge impacts on the surrounding environment. New method of cooling with concept of AC could solve the problems generated by the existing air-conditioning installations. It not only reduces the power consumption but also increases cooling effects and having less cost than air-conditioning system. It works in the absence of water and having less maintenance as compare to domestic cooler. And its cost is cheaper than the AC, so it will beneficial for middle class people.

2. WORKING CONCEPT:

- The vapor-compression uses a circulating liquid refrigerant (R134a is also known as Tetrafluoroethane) as the medium which absorbs and removes heat from the space to be cooled and subsequently rejects that heat elsewhere. All such systems have four components: a compressor, a condenser, a thermal expansion valve (also called a throttle valve or metering device) and an Evaporator.
- That hot vapor is routed through a condenser where it is cooled and condensed into a liquid by flowing through a coil or tubes with cool water or cool air flowing across the coil or tubes.
- This is where the circulating refrigerant rejects heat from the system and the rejected heat is carried away.

3. DESIGN OF HYBRID COOLER:



4. COMPONENTS:

- **COMPRESSOR:-** The primary advantage of a hermetic and semi-hermetic is that there is no route for the gas to leak out of the system and less maintenance and it is widely used in household refrigerator. Compressor compresses the refrigerant. We are use hermetically sealed compressor. In hermetically sealed compressor, the compressor and motor are welded in steel casing and the two are connected by a common shaft. This makes whole compressor and the motor a single compact and portable unit that can be handled easily. The hermetically sealed compressor is very different from the traditional open type of compressor.

- **Compressor selection:-** Compressor = 96 watt, btu-365, 92Kcal/hr
  Capacity 1 TR, 50 Hz, 1PH
  Condenser temp. range =-23.3°c to 54.4°c
  Temp. Range = -5°c to 15°c

  Specification**:-** Inlet pipe 6 mm, 220/50Hz, 1 PH, thermally protected, capacity 1 TR.

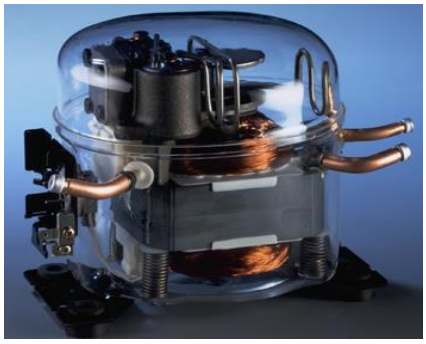


Fig1:-Compressor

- **CONDENSER: -** The initial part of the cooling process de-superheats the gas before it is then turned back into liquid. The condenser is a heat exchanger that rejects all the heat from the refrigeration system. This includes not only the heat absorbed by the evaporator but also the heat energy to the compressor. The condenser accept hot, high pressure refrigerant, usually superheated gas from the compressor and reject heat from the gas to some cooler substance, usually air and water.

  Specification**: -** Height 240 mm, Length 255 mm, No coil present in condenser with IP/OP is 8, condenser pipe 10 mm, width 40 mm

Fig 2:- Condenser

- **EXPANSION VALVE:** The capillary tube substituted for the convectional liquid line from the condenser and soldered to the suction line to form a single heat exchanger. The function of expansion valve to allow the low temperature and high pressure liquid enters with the restricted area, and they can be leave from the expansion valve with low pressure and temperature in form of mixture of vapour and liquid, and then keep the evaporator active. Expansion process one of the main factors responsible for energy loss in VCR cycle.

  Specification: - Length of capillary tube 1300 mm. No of turns 11, Diameter is 2mm.

Fig3:- Expansion Valve

- **EVAPORATOR: -** During this process it changes its state from a liquid to a gas. For the purpose of compression, evaporator part also suggested. The evaporator has number of circular tube inside it as shown in figure bellow, and is manufactured to yield same pressure drop as the original one. The number and diameter of the tubes are selected iteratively to obtain the same design requirements, such as, heat load, pressure drop, at the inlet and exit condition.

Fig4:- Evaporator

- **FAN:-**An apparatus rotating blades that create a current of air for cooling or ventilation.
  Specification**:-** Blade diameter is 234 mm , Angle is 23^0 .

Fig 5:- Fan

- **MOTOR:**
  1. Electric motor is used to convert electrical energy into mechanical energy.
  2. In particular, the squirrel-cage design is the most widely used electric motor in industrial Applications.
  3. Electric motors are used to produce linear and rotary forces (torque).
  4. This motor runs at 1500 rpm & 1.5 HP.
  5. We used copper winding motor.

Fig6:- Motor

- **REFRIGERANT:-**
  1. In this project we are use a refrigerant is R-134a. It is also known as tetrafluroethane (CH3CH2F) from the family of HFC refrigerant.
  2. Currently it is also being widely used in the air conditioning system in newer automotive vehicles. It exists in gas form when
  3. Expose to the environment as the boiling temperature is -14.9°F or -26.1°C.
  4. The CFCs and HCFCs refrigerants produce more defects to ozone layer.
  5. Hence we are used to R134a and concluded that energetic defect occurred in compressor was highest as compare to the other refrigerant through their analysis it has been found that instead of 145g of R134a if 60g of R600a is use in consider system gave same performance which ultimately result in economical advantages.

V. Analysis of standard vapour compression refrigeration system:-

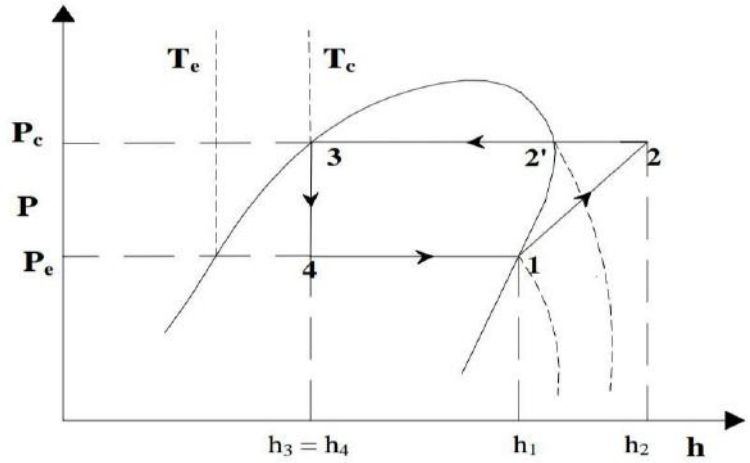


Fig 7:- Standard vapour compression refrigeration cycle on p-h chart

- **Evaporator:**
  Heat transfer rate at evaporator or refrigeration capacity $Q_e=m(h_1-h_4)$
  The evaporator pressure $P=P_{sat}(T_e)$
  Where,
  m-mass flow rate in kg/s
  h_1, h_4 – are specific enthalpies kj/kg
  P_{sat}- saturation temperature
  Te-evaporator temperature
- **Compressor :**
  Power input to the compressor $W_c=m(h_2-h_1)$
  h_1, h_2-specific enthalpies
- **Condenser :**
  Heat transfer rate of condenser $Q_c=m(h_2-h_3)$
  h_1, h_2-specific enthalpies
- **Expansion device:** $h_3=h4$

The COP of the system is given by

$$COP= (Q_e/W_e) = (m (h_1-h_4)/m (h_2-h_1)) = (h1-h4)/ (h_2-h_1)$$

At any point in the cycle , the mass floe rate of refrigerant m can be written in terms of volumetric flow rate and specific volume at that point i.e.,

$$M=V/v$$

Applying this equation to the inlet condition of the compressor

$$M=V_1/v$$

Where, V_1-volumetric flow rate at compressor inlet, v_1-indication of the size if the compressor.
The refrigeration capacity in terms of volumetric flow rate

$$Q_e=m (h_1-h4) =V_1 ((h_1-h_4)/v_1)$$

$(h_1-h_4)/v_1$-volumetric effect (kj/m^3)

5. CONCLUSION:

R134a refrigerant is non-toxic and does not flare up within the whole range of operational temperatures. This project is very cheap and effective as compared with the conventional cooler and air conditioner system as it based on VCRs system. It has very low power consumption which ultimately increases the COP of the system which increases the cooling effect (refrigeration effect) of the system. It has very low effect on environment as it saves electricity and water. The concept is very cost effective as compared to AC and Very Energy Effective system.

6. LITERATURE REVIEW:

- Taliv Hussain , Arjun Sharma, "Effect Of Sub-cooling in VCRS Cycle and Compared to simple VCRS System" , ELK Asia Pacific Journal ,Punjab 978-81-930411-4-7.
- According to this paper, Decreasing the consumption of power in a vapors compression air conditioning system with increase in refrigeration effect and reduction of compressor work is a major concern and challenging problem especially in the area where extreme weather conditions of about 50°C exists.Experimental results show that the use of sub-cooling by heat exchanger will improve the COP.
- G Venkatarathnam , S Srinivasa Murthy," Refrigerants for Vapour Compression Refrigeration Systems", General Article on Feb 2012.
- In this article, various issues related to this changeover of refrigerants being used in vapor compression refrigeration systems are discussed. This paper Discuss the mandate of Montreal Protocol banning ozone depleting substances, and Kyoto Protocol later on curtailing the use of substances which contribute to global warming, conventional refrigerants are to be replaced by environment friendly working fluids.
- R. T. Saudagar, U. S. Wankhede, "Experimental Analysis of Vapor Compression Refrigeration System with Diffuser at Condenser Inlet", International Journal of Engineering and Advanced Technology (IJEAT) on April 2013.
- This concept reduces size of condenser to achieve the same system efficiency. This paper discusses design and testing of diffuser at condenser inlet in vapors compression refrigeration system.
- K. Nagalakshmi , G. Marurhiprasad Yadav, "The Design and Performance Analysis of Refrigeration System Using R12 & R134a Refrigerants", Int. Journal of Engineering Research and Applications Feb on 2014.
- In this report, the design and performance analysis of refrigeration system using R12 & R134a refrigerants are presented. The design calculations of the suitable and necessary refrigerator equipment and their results are also reported here.

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