COMBINED AIR REFRIGERATION, AIR CONDITIONING AND WATER DISPENSER SYSTEMS

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Abstract – *This project "Combined Air Refrigeration, Air Conditioner and Water Dispenser systems" deals with the study of air conditioner, air refrigeration and water dispenser system in a single unit. The main object behind this project is to develop the multifunctional system which can provide cold water, refrigeration effect and air conditioning effect with regular air/space conditioning system. The design mainly consists of compressor, condenser, expansion valve and other accessories (back pressure valve and diffuser). The refrigerant is used as a medium which absorbs the heat from the low temperature system and discards the heat so absorbed to a higher temperature system. This transfer of heat is used in a sensible manner to bring out the various heating and cooling effect. Common condenser and common compressor feds the system having separate evaporators. Systematic analysis of the project was carried after its completion. The various performance characteristics were checked in' cool pack software 'for various inputs. Various design and operations were modified with a view to save space, initial and maintenance costs.*

Key Words: **Compressor; Condenser; Expansion valve (capillary tube); evaporator; Back pressure valve; diffuser; cool pack software**

1. INTRODUCTION

Due to increase in the temperature of the earth because of the global warming, the use of the air conditioning has become an essential part for all human beings. Refrigeration is basically the changing of phase refrigerant to get heating and cooling effect from it. Earlier air was used as a refrigerant .Since air does not change its phase, i.e, and remains gaseous state throughout the cycle, therefore heat carrying capacity per kg of air is very small as compared to vapour absorbing systems. The air cycle refrigeration system, as originally designed and installed, are now practically obsolete because of their low co efficient of performance and high power requirement.

The advent of high speed passenger aircraft, jet aircraft and missiles has introduced the need of the compact and simple refrigeration systems, with minimum reduction of the payload.

At present in the market we have the separate form of the water cooler, air conditioner and air refrigeration system. All three of them work on the same principle. Moreover, the standard of the people have improved. They all have installed these three equipment's in their homes, offices, and living room and many more. But the most disadvantages are that they have high electrical consumption which makes people worry about it.

So the attractive point of our project is that it can provide all these facilities in compact way with lesser electrical consumption in a single unit.

2. LITERATURE REVIEW

[1] Prof. S.M. Sheikh, et al. Published journal (IOSR_JMCE) "Performance Investigation of Window Air Conditioner" in this journal he is studied the proper definition of air conditioning system and the advantages and application of air conditioning system. Also by the calculation he determines the all parameters related to the air conditioning system and based on that he consider the specification for this unit.

[2] P. Dasthagiri, et al. Published paper (2015) "Fabrication and Analysis of Refrigerator Cum Chilled Water Dispenser" in this paper he is studied that why the combine system is required, we can cooled or freeze water with help of refrigerator.

[3] Himanshu, et al. Published paper (2014), "Feasibility Study and Development of Refrigerator Cum Air Conditioner" in this paper he is studied that combine system of refrigerator with air-conditioner.

[4] B. Naveen, et al. Published paper (2013), "Waste Heat Recovery in R & Ac Systems" This report deals with design and fabrications of a three in one air conditioner.

[5] Dr. U. V.Kongre, A. R. Chiddarwar, et al. Published paper (2013) "Testing and Performance Analysis on Air Conditioner cum Water Dispenser" The paper introduced basic design principles and the test analysis performed in the laboratory. The paper also introduced comfort conditions and suitable coefficient of performance with respect to atmospheric condition, without sacrificing the air conditioning output.

3. Working Principles

Before the basic component of the " combined air refrigeration , air conditioner and water dispenser system" are compressor , condenser, expansion valve and evaporator, back pressure valve and diffuser.

3.1 Compressor

It is the machine which is used to compress the vapours refrigerant from the evaporator and to raise its pressure so that the corresponding saturation temperature is higher than that of the cooling medium. It also continually circulates the refrigerant through the refrigeration system. Since the refrigeration of the system requires some work to be done on it, therefore must be driven by some prime mover.

Fig: Compressor

3.2Condenser

It removes the heat of the hot vapors refrigerant discharged from the compressor. The heat from the hot vapor refrigerant in a condenser is removed first by transferring it to the walls of the condenser tubes and then from the tubes to the condensing and cooling medium. The cooling medium may be air or water or a combination of these two.

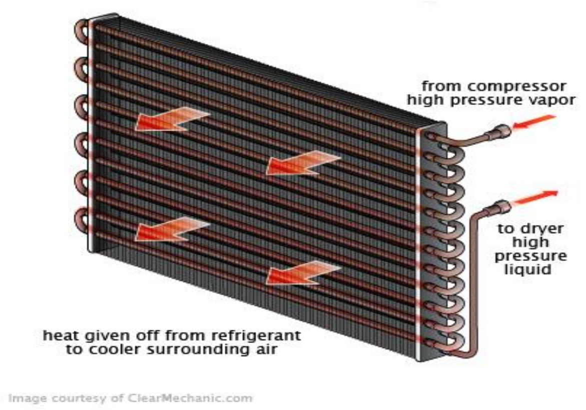


Fig: Condenser

3.3 Expansion device

It is also called metering device or throttling device. It divides the high pressure side and the low pressure side of the system and maintains the desired pressure between them. It controls the flow of the refrigerant according to the land on the evaporator.

It reduces the high pressure liquid refrigerant to low pressure liquid before being fed to evaporator.

Fig: Expansion device

3.4 Evaporator

Evaporator absorbs heat from the surrounding location or medium which is to be cooled by means of the refrigerant. The refrigerant enters the evaporator where it boils and changes into vapor. The temperature in the evaporator must always be less than that of the surrounding medium so that heat flows to the refrigerant.

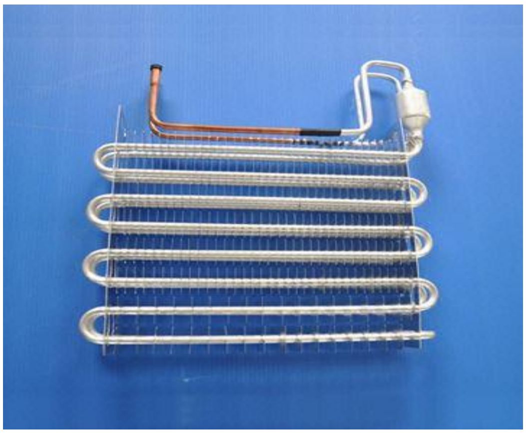


Fig: Evaporator

3.5 Back Pressure Valve

When the refrigerant is passed through the evaporating coil the mass flow of the refrigerant is different for the combine system. After evaporation the refrigerant is passed to the compressor, at that time, refrigerant from three evaporating coil is collected in capillary tube and pass to the compressor. To maintain the mass flow rate back pressure valve is used.

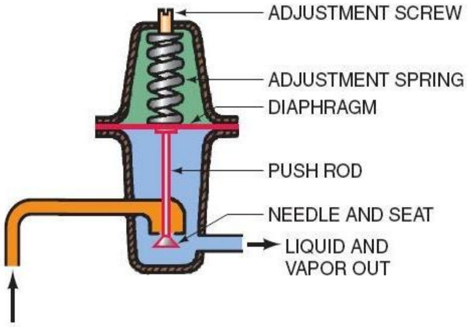


Fig. Back Pressure Valve

3.6 Diffuser Valve

The three units are installed in a single unit and hence for effective working of these units, it is important some mechanism is used to be installed which would control the amount of the refrigerant into the system. For these purpose capillary tubes of different diameter are connected in diffuser valve. Thus, diffuser valve maintains the correct quantity of the refrigerant in three compartments.

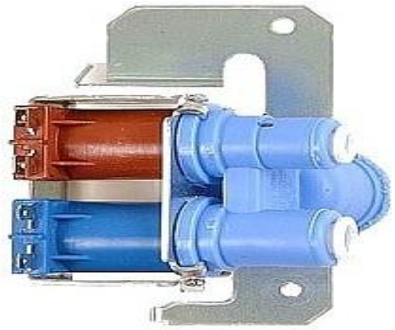
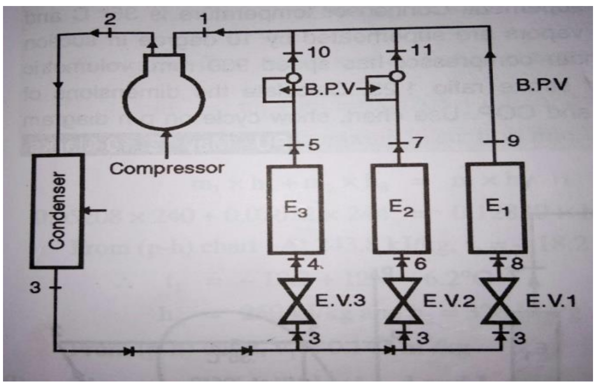


Fig. Diffuser Valve of water cooler

4. Experimental set up layout



E: evaporator
E.V: expansion valve
B.P.V: back pressure valve

Fig: combined refrigeration system

- Compressor converts the low pressure and low temperature vapour refrigerant to high pressure and high temperature vapour refrigerant.
- In condenser, high pressure and high temperature vapour refrigerant gets converted to high pressure and low temperature liquid refrigerant.
- Diffuser valve maintains the flow of the refrigerant in the respective compartment.
- In expansion valve, high pressure and low temperature liquid refrigerant gets converted to low pressure and low temperature liquid refrigerant.
- In evaporator, these low pressure and low temperature liquid refrigerant gets converted to low pressure and low temperature vapour refrigerant, which is again feed to compressor and thus cycle repeats itself.
- Back pressure valve maintains the equal proportion of the refrigerant to avoid load on the compressor.

5. DESIGN SPECIFICATION

5.1 HEAT TRANSFER BY CONDEENSER

Heat transfer by condenser is given by

$$Q=KA\ (tco - tci)$$

Where,
A= surface area of the condenser=πD
D=diameter of the condenser tube
K= Thermal conductivity of the copper tube=386w/mk
Tco=condenser outlet temperature
Tci=condenser inlet temperature

Therefore,
$Q=386*(\pi*0.01)\{30-16.6329\}$
$Q=162.09677W$
But
We know that
$Q=MCP\ (tco - tci)$
Where C_p= specific heat at constant pressure
Therefore
$162.09677=M*1.022*1000(30-16.6329)$
$M=0.01186Kg/s$

5.1.1 AREA OF THE CONDENSER TUBE

$A=\pi DL$
Where
L=length of the condenser tube
A=cross sectional area of the condenser tube
Therefore
$A=\pi*0.1*7$
$A=0.2199\ m^2$

5.2 EVAPORATOR SPECIFICATION

Heat transfer by evaporator is given by

$$Q=K*\pi d*(te_0-te_i)$$

Where
K=thermal conductivity of the copper tube=386W/m2k
Teo= outlet temperature of the evaporator
Tei=inlet temperature of the evaporator
Q=386*π*6.35*10^-3*{16.6329-(-7)}
Q=181.9817W
But we know that
$Q=mcp\ (te_0-te_i)$
Where cp= specific heat at constant pressure
Therefore
181.9817=m*0.960*1000*{16.6327-(-7)}
M=0.0083236 Kg/s

5.2.1 AREA OF THE EVAPORATOR TUBE

Area of the evaporator tube is given by
A=πdL
A=π*6.35*10^-3*11
A=0.2194 m²

5.3 SPECIFICATION OF THE COMPRESSOR

Compressor KCJ511HAE B420
230V-50Hz-1P-LRA25-R-22

Thermally protected hermetically sealed compressor is selected.

6. PERFORMANCE CHARACTERISTICS THROUGH COOL PACK SOFTWARE

6.1 SPECIFICATION OF THE CYCLE THROUGH COOL PACK SOFTWARE

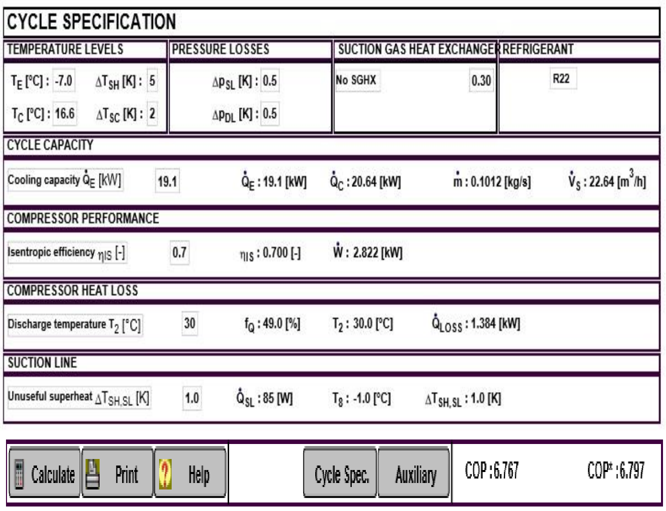


Fig: cycle specification

6.2 Diagrammatic representation of R22

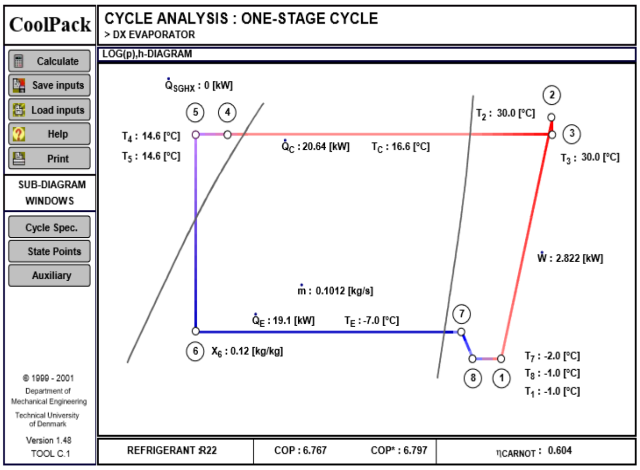


Fig p-h graph of R-22

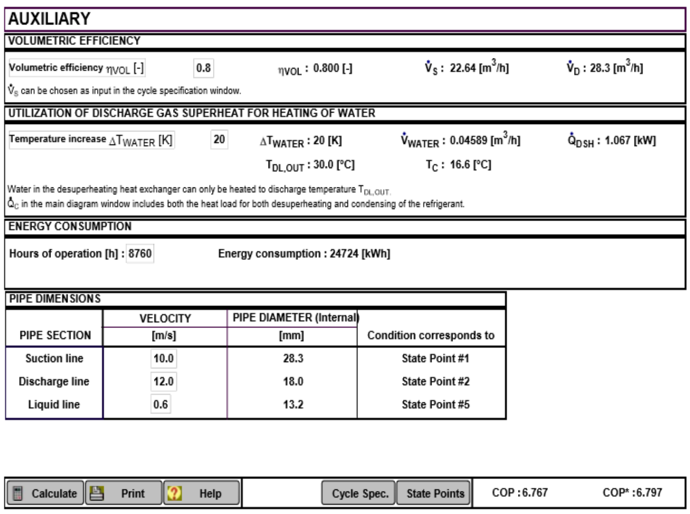
6.3 Various State Points

STATE POINTS

STATE POINT	TEMPERATURE [°C]	PRESSURE [kPa]	ENTHALPY [kJ/kg]	DENSITY [kg/m³]
1	-1.0	386.4	251.6	16.1
2	30.0	838.6	265.8	33.0
3	30.0	826.7	266.1	32.4
4	14.6	826.7	62.1	1233.2
5	14.6	826.7	62.1	1233.2
6	-7.0	393.2	62.1	-----
7	-2.0	393.2	250.8	16.5
8	-1.0	386.4	251.6	16.1

Fig: temperature, pressure at various points

6.4 Other Auxiliaries Information through Cool Pack



6.5 ADDITIONAL INFORMATION

Pressure ratio	P2/P1=2.170
(Discharged temp.)reversible and adiabatic compression	36.8*C
(Discharged temp.)real and adiabatic compression	47.6*C

Fig: Additional information of the process

7 RESULTS AND DISCUSSION

7.1 WORK DONE BY THE COMPRESSOR

Considering mass 1 kg

W_C= (h2-h1)
W_C= (421.9-402.8)
W_C=19.1W

7.2 HEAT REJECTED BY THE CONDENSER

Heat rejected by the condenser is given by

$Q_{rejected}$ = (h2-h3)
$Q_{rejected}$ = (421.9-219.923)
$Q_{rejected}$ = 201.977W

7.3 REFRIGERATION EFFECT

Refrigeration effect is given by

R.E. = (h1-h4)
R.E. = (402.8-219.923)
R.E. = 182.877W

7.4 COEFFICIENT OF PERFORMANCE (C.O.P.)

C.O.P.=R.E./Wc
C.O.P.=182.877/19.1
C.O.P. =9.57

Considering compressor to have isentropic efficiency of 70%

Therefore, C.O.P. of the system is (9.57*0.7) =6.69

C.O.P. =6.69

8. CONCLUSIONS

From the above prototype the three in one system is one of the reusable and eco-friendly projects which can be implemented in our day to day life for the effective management of power consumption factor. Hence it plays the major role for the people who are living in the desert regions. This is one maiden venture in the field of the refrigeration system from the stream of mechanical engineering as terms lead to change in the recent trend to the favor of ecological systems.

9. ACKNOWLEDGEMENTS

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