ISSN No:-2456-2165

Performance Analysis of VCR System with Mixture of Water - Monoethylene Glycol Cooled Condenser

Adarsh Parmar[1], Dharmesh Parmar[2], Harsh Patel[3]
[1,2,3]Student Scholars, Birla Vishvakarma Mahavidyalaya
Gujarat, India

Abstract:- Now a day energy is a fundamental need of everyone and saving of energy is the main aim of an engineer. So more practical emphasis work should be carried out on main two approaches, to save the energy and keep the environment clean and human comfort is also a fundamental need in the present scenario. Vapour compression refrigeration system is widely used in small and big projects for cooling purpose. In vapour compression refrigeration system, Coefficient of Performance (COP) is very important factor. In a company where more area is required to cool, there electricity bill is more. So, more efficient system must used in that place for more savings in electricity bill. Generally, water cooled condenser is used in the field for heat transfer. But if we use cooling fluid other then water than COP might be increased. Here in this research work, mixture of Water – Monoethylene glycol is used in different proportion and conclusion is carried out for different 6 proportions. From this research work, we concluded that at 40% water – 60% monoethylene glycol maximum COP is found which 5.35% more than 100% water is.

Keywords:- *Vapour Compression Refrigeration System, COP, Electricity Bill.*

I. INTRODUCTION

There are basic 4 components in vapour compression refrigeration system. These are compressor, condenser, expansion device, and evaporator. As electricity is more important factor of every project, researches are going in refrigeration and air conditioning field. Inverter technology is successful in air conditioning field of domestic field. In big project, Water cooled condenser is used instead of Air cooled condenser. But if other fluid is used other than water, then we might come up with more fruitful result than using water as a fluid. With this aspect after going through literature review, and different fluids, we decided to work on mixture of water and monoethylene glycol.

II. LITERATURE REVIEW

- Sheetal Narayan Sheety & Prashanth Kamath of Canara Engineering College conducted experiment on water cooled condenser refrigerator system and COP of the refrigeration system by using water as the cooling medium instead of air for condenser system was calculated, and comparison was made between the COP of air and water cooled condenser refrigeration system to find the percentage increase in COP. According to experiment conducted by them COP (Air) was 6.28 and COP (water) was 9.5. Means COP of refrigeration system increased by 51.27% when water was used as cooling medium.
- Mohmedtausif Basir Patel, Chauhan Dhaval, Mehta Parthiv, Patel Rajatkumar, and Parmar Janish performed experiment on domestic refrigerator by changing the shape of existing condenser coil. Also they used water and air as cooling medium for condenser to find out in which condition performance is better. They performed experiment on existing coil air cooled condenser, helical coil air cooled condenser, existing coil water cooled condenser and helical coil water cooled condenser. Water was used as cooling medium in condenser because the heat transfer coefficient of water is almost four times the air. After comparing the results for different system, COP for helical coil water cooled condenser was highest and COP for existing air cooled condenser was lowest. Also compressor work was reduced when water was used.

III. METHODOLOGY

- We read literatures to see what actually is in existing systems and what modification is done on existing system. Then we decided which fluids we will use in the experiment. We decided to perform experiment by mixing water and monoethylene glycol in different proportions. We decided to take total of 6 readings. Starting from 100% water, 80% Water – 20% Monoethylene glycol, , 60% Water – 40% Monoethylene glycol , 40% Water – 60% Monoethylene glycol, 20% Water – 80% Monoethylene glycol, and 100% Monoethylene glycol.

- After deciding fluids, we did modification in existing VCR system present in our laboratory of Mechanical Engineering department. Here condenser is of helical type and contains in a shell. Different types of mixture ratios are prepared in bucket and passed it in condenser with the help of submersible pump. In parallel flow of refrigerant is performed. Refrigerant in annulus side and Mixture of Water - Monoethylene glycol is on tube side is performed. To analyze results from the experiment, four thermometers are placed to obtain temperature at evaporator inlet, evaporator outlet, condenser inlet, and condenser outlet. Also two pressures are obtained one at refrigerant condenser inlet and other at refrigerant condenser outlet. Extra two temperature readings are found one is of inlet mixture of Water - Monoethylene glycol in the system and other

is outlet mixture of Water - Monoethylene glycol from the system. From electric meter of the system, indirectly power used in the system is calculated.

➢ *During experiment, we took 9 readings which are,*

- T1 = Temperature of refrigerant at evaporator outlet (^{0}C)
- T2 = Temperature of refrigerant at condenser inlet (^{0}C)
- T3 = Temperature of refrigerant at condenser outlet (^{0}C)
- T4 = Temperature of refrigerant at evaporator inlet (^{0}C)
- T5 = Inlet Temperature of water/glycol (^{0}C)
- T6 = Outlet Temperature of water/glycol (^{0}C)
- P1= Pressure of refrigerant at condenser inlet (psi)
- P2= Pressure of refrigerant at condenser outlet (psi)
- Power inlet (Time for 10 pulse revolution)

After taking reading, we calculated compressor work and COP of the system of all the 6 proportion readings and then conclusion is made.

Fig 1

Fig 2

Fig 3

ISSN No:-2456-2165

	T_1 (^{0}C)	T_1 (^{0}C)	T_1 (^{0}C)	T_1 (^{0}C)	T_1 (^{0}C)	T_1 (^{0}C)	P_1 (psi)	P_1 (psi)	Power inlet (Time for 10 revolution)
100% Glycol	26	68	39	20	28	41.5	143	138	34
80G - 20W	25	67	35	18.5	27	42.5	139	134	34.8
60G - 40W	26	63	34	21	27	40	135	125	35.1
40G - 60W	25.5	66.5	30.5	19.5	26	34	132	125	40.44
20G - 80W	26.5	67	31	20.5	27.5	32	130	125	41
100% Water	26.5	68	29.5	21	28	30.5	128	122	41.2

Table 1

IV. RESULT ANALYSIS

After finding requires readings for compressor work and COP of the system, calculation is done to find compressor work and COP of the system. Following is the sample calculation of 100% water system.

Here,
- h1= Enthalpy at compressor inlet (kJ/kg)
- h2= Enthalpy at condenser inlet (kJ/kg)
- h3= Enthalpy at condenser outlet (kJ/kg)
- h4= Enthalpy at evaporator inlet (kJ/kg)

From p-H chart of R-134a,
- h1= 415 kJ/kg
- h2= 451 kJ/kg
- h3= 240 kJ/kg
- h4 = 240kJ/kg = h3

COP of Refrigeration system,

(COP)〗_R=(h_1-h_4)/(h_2-h_1)
= (415-240)/(451-415)
= 4.86

COP of Heat Pump,
(COP)P = 1 + (COP)R
= 1 + 4.86
= 5.86

For Compressor work,
3000 rev = 1 kWh
So, 10 rev = 12 kJ

Compressor Work = 12/time in second
= 12/41.2
= 0.2913 kW

Similarly calculating COP and Compressor Work for all proportion we will get,

	h_1 (kJ/kg)	h_2 (kJ/kg)	h_3 (kJ/kg)	h_4 (kJ/kg)	$(COP)_R = \frac{h_1 - h_4}{h_2 - h_1}$	$(COP)_P$ = 1 + $(COP)_R$	Heat in condenser (kJ/kg)	Compressor Work (kW)
0% Glycol	415	451	258	258	4.36	5.36	193	0.3529
80%G - 20%W	416	450	250	250	4.88	5.88	200	0.3448
60%G - 40%W	415	447	251	251	5.12	6.12	196	0.3419
40%G - 60%W	416	450	248	248	4.94	5.94	202	0.2961
20%G - 80%W	414	453	248	248	4.26	5.26	205	0.293
100% Water	415	451	240	240	4.86	5.86	211	0.2913

Table 2

ISSN No:-2456-2165

V. CONCLUSION

By performing experiment on VCR system with the help of different mixtures of water and monoethylene glycol, Coefficient of performance (COP) and Compressor work is calculated. Following are the conclusions made,

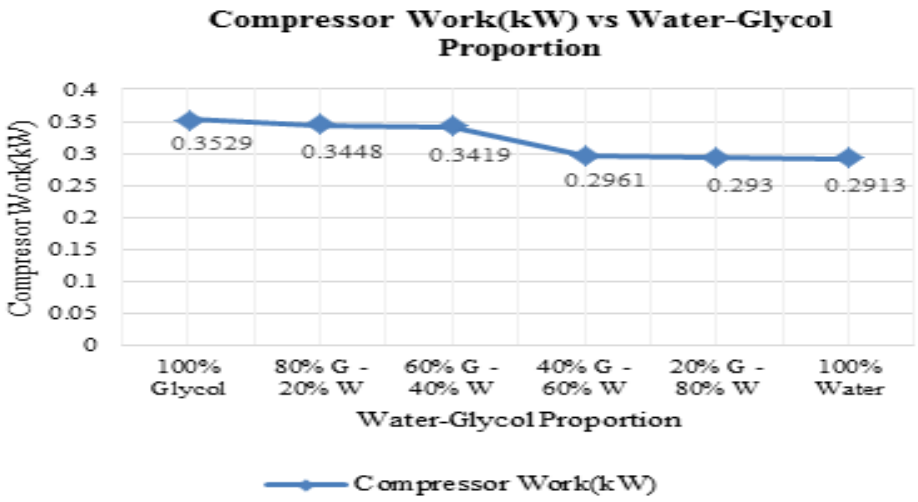

Fig 4

➢ *Conclusion*

As proportion of water increases in Water – Monoethylene glycol mixture, compressor work decreases. Because of more viscosity of glycol compared to water.

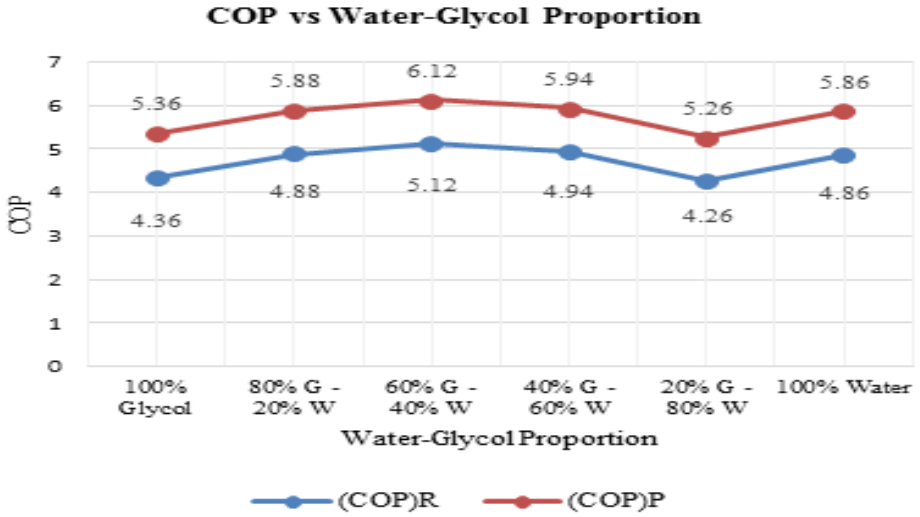

Fig 5

➢ *Conclusion*

As per the experiment, maximum COP of system is obtained at 60% Monoethylene glycol - 40% Water which is 5.35% more compared to existing 100% water cooled condenser. Because for Water - Monoethylene glycol mixture, value of convective heat transfer coefficient is maximum at about 40% Water – 60% Monoethylene glycol mixture.

REFERENCES

[1]. Sheetal Narayan Shetty, Prashanth Kamath, "Performance Assessment of Water Cooled Condenser Refrigeration System.", 2017, Scientific and Academic Publishing

[2]. Mohmedtausif Basir Patel, Chauhan Dhaval, Mehta Parthiv, Patel Rajatkumar, and Parmar Janish, "Development and Modification of Refrigeration System", June 2015, International Journal of Advance Engineering and Research Development.