EXPERIMENTAL INVESTIGATIONS OF DUAL PURPOSE AIR CONDITIONER & WATER COOLER

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ABSTRACT

Refrigeration and air conditioning have significant role in the daily activities of living species, particularly in the hot regions of the world. They are useful in the preservation of perishable items, storage of pharmaceutical drugs, or effective performance of a scientific process, controlling of an atmospheric environment either for human/animal thermal comfort. This investigation is aimed at the design, construction, performance evaluation of a dual purpose domestic refrigeration system, that can simultaneously function as an air conditioner and as well as water cooler. The refrigeration system employed was a vapor compression system.

The dual purpose Air-Conditioner and Water cooler test setup is designed, fabricated to determine the performance of the system, and analyze the various parameters affecting its performance. The specifications of all the components are mentioned in the document. The performance of an air-conditioner is expressed in terms of co-efficient of performance. For Dual Purpose System i) Air-Conditioner with Water Cooler, COP is 2.07 ii) Air-Conditioner with Water Cooler is 2.28. and there is no much significance reduction of performance when the system is used for dual purpose.

Keywords: *Dual Purpose Air-conditioning and Water cooler System, Coefficient of Performance.*

1.0 Introduction To Refrigeration &Air Conditioning System History Of Refrigeration System

The techniques for generation of icy by mechanical procedures are very later. Long in 1748, William coolen of Glasgow University delivered refrigeration by making fractional vacuum over ethyl ether, But, he couldn't actualize as far as he can tell practically speaking. The principal improvement occurred in 1834 when Perkins proposed a hand-worked compressor machine taking a shot at ether. At that point in 1851 came Gorrie's air refrigeration machine and in 1856 Linde built up a machine taking a shot at smelling salts.

The pace of advancement was moderate in the first place when steam motors were the prime movers known to run the compressors. With the coming of electric engines and resulting higher velocities of the compressors, the extent of utilizations of refrigeration broadened.

One ton of refrigeration is characterized as "the measure of cooling impact delivered by uniform dissolving of one ice from and at 0^0c in 24 hours

One ton of refrigeration is taken as 210 kj/min

1 TR = 210 kj/min

1 TR = 210/60

= 3.5 kj/sec (or) 3.5Kw

History Of Air Conditioning System Cooling:

Cooling path molding of air for keeping up specific circumstances of temperature, relative mugginess and espresso clean degrees inward an encased space.For the most part aerating and cooling is subdivided into mechanical ventilating and extravagance aerating and cooling. The oversaw biological system which offers most extreme solace to the individual is known as comfort ventilating. The oversaw environment that is required for the creating procedure for designing products is known as business cooling.

Fig1.1.Schematic Diagram of Home Purpose Air Conditioning System

Improvement of Mechanical Cooling

In 1758, Benjamin Franklin and John Hadley, a science teacher at Cambridge University, did a test to find the statute of vanishing as an approach to quickly cool a question. Franklin and Hadley affirmed that dissipation of outstandingly flimsy fluids (comprising of liquor and ether) could be utilized to drive down the temperature of a thing past the point of solidification of water. They played out their explore different avenues regarding the knob of a mercury thermometer as their thing and with a roars used to rush up the vanishing. They brought down the temperature of the thermometer knob directly down to −14 °C (7 °F) even as the encompassing temperature move toward becoming 18 °C (sixty four °F). Franklin specified that, immediately when they gave the point of solidification of water zero °C (32 °F), a thin film of ice formed on the floor of the thermometer's knob and that the ice mass was around 6 mm (1⁄4 in) thick once they halted the test after finishing −14 °C (7 °F).

Need for Air-Conditioning

People convey off warmth around a mean of 100 kcal in accordance with hour as indicated by individual, because of what is called 'digestion'. The temperature of around 56.9^0 C (98.4^0F). Be that as it may, the pores and skin temperature changes as indicated by the surrounding temperature and relative mugginess. To consume the warmth produced by methods for digestion with a view to save the body temperature at the standard level, there should be a float of warmth from the pores and skin to the encompassing temperature could be low, as on an icy frigid climate day the expense of warmth skim from the body, thus there can't be float along with warm from the pores and skin to the encompassing, as needs be the individual feels warm. In the kind of situation water from the body temperature. Be that as it may, if the enclosing air isn't generally best hot however genuinely moist as pleasantly, practically zero vanishing of water can take region from the pores and skin floor thus the man or lady feels warm and awkward.

Literature Review

1. K.Adegunand O.V.Obasa, (2016) (1), this paper is gone for the outline and development of a twin reason home refrigeration device, that could all the while work as a cooler and not withstanding an aeration and cooling system from now on called REFACON. The machine utilized 0.620 kg of R 22 refrigerant, with a release weight of 1,355 KPa and suction worry of 360 KPa. The enter power wound up noticeably 1,350 W with a yield cooling impact of 5,280 W. The consolidated cooling load/cooling capability of the device wind up plainly four, 500 W. The results of looks at conveyed affirmed an aggregate warmth rejected of 6,680 W and aggregate

evaporator warm retention of 5,179 W. The Energy Efficiency Ratio wound up plainly 3.91 while the Coefficient of Performance changed into 4.72. This exploration has demonstrated that the design utilized for the glow exchangers transformed into reasonable and Thermal contact protection can't be not noted.

2. Kamlesh Kumar Sharma, R.L. Gupta, Sanjay Katarey (2016) (2) , It spoke to that, In blessing circumstance, diminishment of energy utilization is essential in light of constant development in vitality call for and lessening in worldwide power supply. This paper gives a broad assessment of evaporative cooled condenser utilized as a part of private and business cooling structures. Evaporative cooled condenser builds the warmth dismissal strategy with the cooling effect of vanishing and consequently enhance coefficient of general execution. It is controlled by methods for the utilization of evaporative cooling condenser, the vitality utilization might be diminished up to twenty% and coefficient of execution can be expanded cycle half.

3. Amod A Koyadwar (2015) (3), the consideration of this assess paper is on the advancement of a multi evaporator machine (2 evaporators) to protect the particular working temperature in evaporators with an unmarried compressor, a character extension device and an air cooled condenser. The device incorporates at the same time two multi-working Evaporators. One of them is for Air-molding for territory cooling (car lodge) and the option oblige give the water cooling unit office in auto. The appropriate temperature is 18^0 C in water cooling unit and 22^0C for vehicle lodge or region cooling. An aeration and cooling system compressor of one ton is utilized for the setup intention with R134a refrigerant. There is clear control of temperature through controller valve for each evaporator. Additionally sparing in preparatory cost and space required are the additional endowments with single compressor multi evaporator frameworks.

4. J.H. Wu, L.D. Yang, J. Hou (2015) (4), it gave that, A genuine R22 divider room aeration and cooling system with a cooling limit of 2.4 kW and Energy Efficiency Ratio (EER) of 3.2 is retrofitted with a compressor of a 20% expansive removal to rate R290 and R1270 for execution tests. The outcomes show that for R1270, best embracing an equivalent sort mineral grease of better thickness could supply 2.4% better cooling limit and 0.8% higher EER than those of the remarkable R22 device underneath standard condition, and for R290, receiving the bigger relocation compressor at the same time could furthermore acquire better general execution.

3.0 Design Methodology And Fabrication Of Components

For This Investigated Purpose Using various components these are Rotary compressor, Air-Cooled condenser, Capillary Tube, Water tank and Evaparator. the Design and fabrication process and technical specifications are given below

Fig: 3.1.Photographs of Fabricated Water Cooler cum Air ConditionerUsed for Analysis

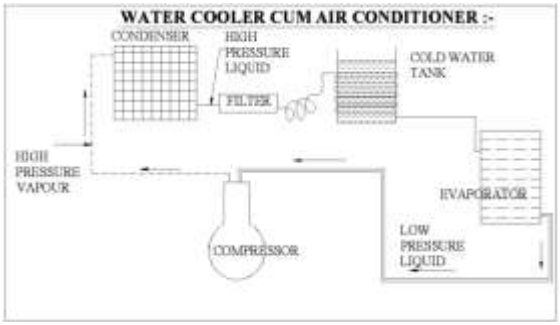


Fig: 3.2.A Line diagram for Water Cooler cum Air Conditioner

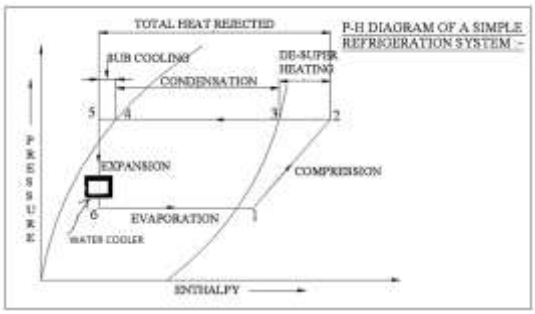


Fig: 3.3.A Line Diagram of P-H

The Rotary compressors are superb relocation compressors. In this compressor the air is caught among surfaces which are in turn and pressed (packed) to slight strain. The turning compressor sucks the low anxiety and espresso temperature refrigerant sooner or later of its suction and conveys it as intemperate anxiety and exorbitant temperature. The rotational compressors are worked in sizes beginning from part horse vitality to various hundred stallion vitality. These are utilized of refrigerant plant going in sizes from 0.25 ton to 100 tons capacity with regards to unit. The for the most part utilized refrigerants are Freon - 12, Freon-22 Ammonia and R-114. Turning compressor is significantly less commotion in operation, free from vibrations and has over the top volumetric effectiveness. It is appropriate for unreasonable speed and espresso temperature applications like in local refrigerants.

Plan and Fabrication of Rotary Compressor:

Revolving compressor is manufactured by utilizing of direct steel material, a sheet of Mild Steel plate 2.24 mm × 1.12 mm transformed into set apart out with the resulting measurements: 2 pieces of.1.423m× 0.60 mand 3 bits of 0.62m×0.62m once set apart out, with scriber and metallic lead, they're removed and all pieces are twisted with 1 inch (25.4 mm) leeway on all sides. Thickness of the plate is 0.4 mm. The compressor capacity 1HP and the refrigerant (R134a) is given into compressor is 0.402kg,

Determination of the Rotary compressor:

1. Kind of compressor:Rotary compressor 1^{th}/8 measure
2. Voltmeter extend: 220 v, 50 Hz
3. Add up to device contemporary: 2.1 A
4. Cooling device:Air-Cooled
5. Limit: 0.746 KW (or) 1 HP
6. Engine utilized: Single stage
7. Speed of the motor :1400 rpm
8. Amountof refrigerant utilized:0.402 kg
9. Material used: Mild Steel
10. Compressor tallness: 160mm
11. Compressor distance across: ø 170 mm

Energy of the Compressor

Amid the pressure method, warm is exchanged rapidly shape the refrigerant vapour to the parcels of the chamber to begin with but since the pressure system might be extremely concise and infer capable temperature is practically normal.

Fig:3.4.A Photograph of Rotary Compressor

Plan and Fabrication of Fin and Tube Condenser:

The glow dismissed inside the condenser is 0.1003 KW, so the outline appeared in

parent 3.5. Underneath ended up noticeably utilized. It is a fined tube game plan with the tubes opposite to the air float between the abutting plates that go about as balances.

Detail of the Fin and Tube Condenser:

1. Type of condenser: fin and tube Condenser,3th/8estimate
2. Condenser Tube estimate: 9.525 mm Distance across
3. Size of the Condenser:230 × 230 mm
4. Width : 40 mm
5. Tube fabric : Copper tubes
6. Fin fabric : Aluminum
7. Length of the loop : 200 mm

Fig: 3.5.A Photograph of the Fin and Tube Condenser

3.0.1 Methodology:

1. Connect to the electrical essential and Switch on the power convey Sufficiently
2. Give amount of refrigerant into the compressor, at that point the rotational compressor will played out the work by methods for utilizing electric power.
3. Now see down the compressor outlet temperature (T2) by methods for the utilization of temperature sensor
4. After completed of the compressor, refrigerant moves through tube into the condenser, again note down the condenser temperature (T3)
5. After gathering framework it save low anxiety, and temperatures then the pipe that is associate with water tank and evaporator.
6. Fill up the beyond any doubt amount of water inside the water tank, know down the water temperatures (TW1 &TW2)
7. In the evaporator, the air sucking and hub fan can be turned and because of the refrigerant it gives cooling sway.
8. Again word down the evaporator outlet temperature (T_4) and compressor gulf Temperature (T_1)
9. Now the use of all temperatures and compute the cooing sway inside the evaporator and cooling capacity of the water tank.
10. Also discover the COP of Air Condition gadget

Materials Used And Estimation:-

Material

Materials Details

Sl. No.	PARTS	Qty.	Material
i.	Compressor	1	Mild Steel
ii.	Condenser	1	Aluminium
iii.	Air Conditioner Blower	1	Aluminium
iv.	Cold Water Tank	1	Steel
v	Copper Tube with Joints	-	Copper
vi	Expansion Valve	1	Copper
vii	Frame	1	Mild Steel
viii	Refrigerant	1	Freon
ix	Fan	1	Mild Steel
xi	Wires	1	Copper

BILL OF MATERIALS:-

Table 3.3: Bill of Materials

Sl. No.	PARTS	Qty.	Material	Amount (Rs)
i.	Compressor	1	Mild Steel	4000
ii.	Condenser	1	Aluminum	900
iii.	Air Conditioner Blower	1	Aluminum	1000
iv.	Cold Water Tank	1	Silver	5000
v	Copper Tube with Joints	-	Copper	2000
vi	Frame	1	Mild Steel	2000
vii	Refrigerant	1	R134a	1000
vii	Fan	1	Mild Steel	800
viii	Water Tap	2	Plastic	50
ix	Wires	-1	Copper	50

Total = Rs 16800 /

4.0 Performance and Analysis of Air Conditioner cum Water Cooler

Fig: 4.1.Photograph of Present work on Water Cooler cum Air Conditioner

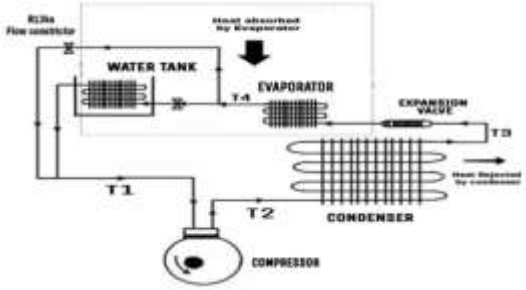


Fig: 4.2.Line Diagram for Water Cooler cum AirConditioner

Design Calculations of Dual Purpose System with Water Cooler:

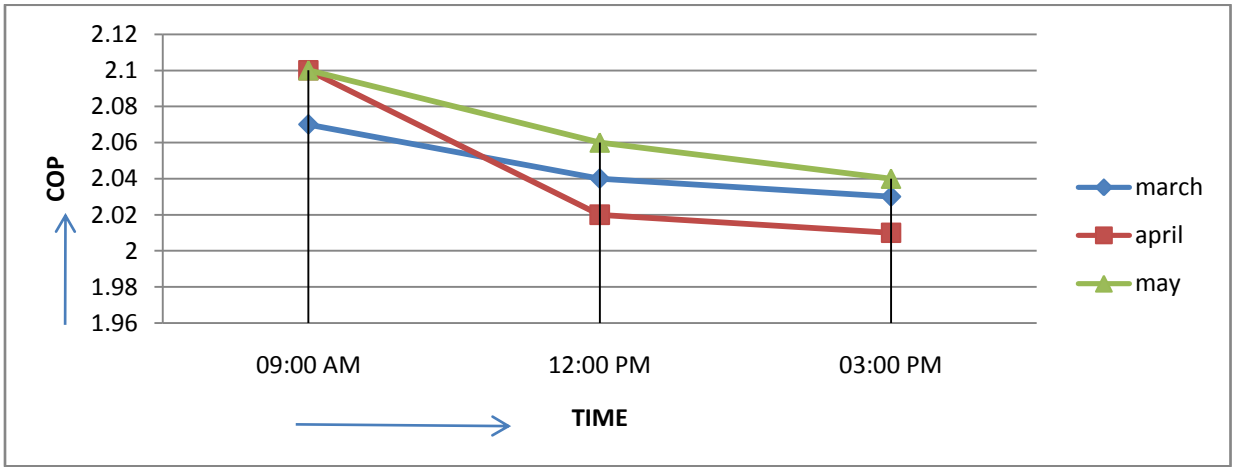
Temperature readings during the month March-2017 were taken and tabulated as below

Recorded values of pressure and temperatures on different dates and times of March '2007

S.No.	DATES	TIME	P_1 (bar)	P_2 (bar)	T_1 (^{0}C)	T_2 (^{0}C)	T_3 (^{0}C)	T_4 (^{0}C)	Tw_1 (^{0}C)	Tw_2 (^{0}C)
1	1.03.17	9.00AM	1.7	11.8	25.1	37	37	25	20	9
2		12 NOON	1.8	11.9	25.2	37.1	37.1	25.2	19.6	9.5
3		3.00PM	1.7	11.6	25.3	37.3	37.3	25.3	19.1	10
4	8.03.17	9.00AM	1.6	11.2	24.8	36.9	37.1	25.1	19.5	9.7
5		12 NOON	1.8	11.9	25.0	37.0	37.2	25.2	19.9	9.8
6		3.00PM	1.8	11.7	25.2	37.2	34.4	25.3	20	9.7
7	15.03.17	9.00AM	1.7	11.6	24.9	36.8	36.9	24.9	19.2	10.1
8		12 NOON	1.8	11.8	25.0	37.1	37.1	25.9	19.7	10.3
9		3.00PM	1.7	11.6	25.3	37.2	37.2	25.1	20.3	9.5
10	22.03.17	9.00AM	1.6	11.2	24.9	36.9	37	24.9	19.8	9.7
11		12 NOON	1.8	11.8	25.0	37.0	37.2	25.1	19.6	9.5
12		3.00PM	1.7	11.5	25.1	37.3	37.3	25.3	19.3	9.4

Recorded values of pressure and temperatures on different dates and times of March '2017

S. NO	MONTH	TIME	P_1 (bar)	P_2 (bar)	T_1 (^{0}C)	T_2 (^{0}C)	T_3 (^{0}C)	T_4 (^{0}C)	Tw_1 (^{0}C)	Tw_2 (^{0}C)	COP
1	Averages Values Of March'2017 at Different Times	9.00AM	1.6	11.6	24.6	36.8	36.6	24.9	19.4	9.4	2.07
2		12 NOON	1.7	11.9	25.7	37.8	37.1	25.9	19.5	9.5	2.04
3		3.00PM	1.6	11.7	25.8	37.9	37.9	25.0	19.5	9.7	2.03
4	March month average		1.6	11.7	25.5	37.8	37.1	25.1	19.5	9.5	2.08



Graph 4.1. The variation of COP with temperatures at different times during months of March, April, May'2017

RESULT AND DISCUSSION

Cooling Capacity of water tank = 0.0286 TR

Cooling capacity of aeration and cooling system = 0.2 TR

Co-Efficient of Performance for Air Conditioner (COP) $_{AC}$= 2.07

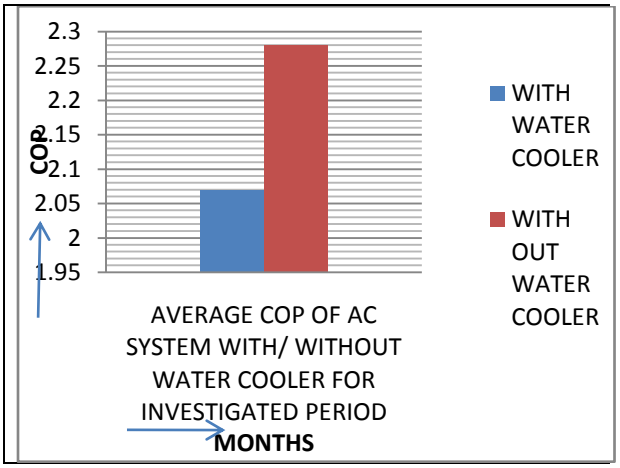
Room Cooling Conditions:

1. The room is to be kept up at 37° C dry globule temperature and half Relative Humidity. These qualities are chosen the utilization of ASHRAE Standard 55 (2004) as a kind of perspective which also suggests an indoor agent temperature assortment of 20 – 27 °C at50 % Relative Humidity. 50 % is picked as a cost since it's miles in the ideal assortment.
2. The Air conditioner part of the device need to keep a room of 9.10 m3volume at 30 °C temperature and half Relative Humidity.
3. Time taken for cooling the room around 15-20 minutes.
4. This wander is done in month of March-May' 2017.

5. This gadget Power admission for each day = 0.8

Tables shows Comparison between with Water Cooler and without Water Cooler of COP

S. No.	Equipment	COP
1	With Water Cooler	2.07
2	Without Water Cooler	2.28



Graph 4.2.The variation of overall COP of Air-Conditioner with/ without water cooler

Designed Model Compared With Some Other Air Conditioners

S. No	Machine	Output Cooling(Kw)	Input Power(Kw)	Power Supply(Φ/V/Hz)	Air Flow Rate (m^3/sec)	COP
1	LG MODEL SC 186 HC	4.98	1.82	1/220-240/50	0.28	4.45
2	Panasonic CW-XC125VPH	3.611	1.21	1/230/50	0.16	3.23
3	REFACON	5.28	1.35	1/280-230/50	0.1905	4.72
4	Designed Model	0.6438	0.746	1/220-240/50	0.115	2.07

6.0 .CONCLUSION

Result and Discussion:

The experimental setup was made by the optimum design of various components for an air-conditioner and water cooler. The operating temperatures are noted at different timings for week days, during peak summer months of March, Apr, and May' 2017 and COP is calculated.

With the experimentation, analysis of dual purpose system, various results can be summarized as follows.

Dual Purpose System with Water Cooler:

- For the month of March' 2017, the operating temperatures are recorded for all the days of month and the average values are calculated at 4 intervals for every week. It is observed that COP has varied accordingly and the values are 2.07, 2.04, 2.03 & 2.08 respectively at 9.00am, 12 noon, 3.00 pm and month average.
- For the month of April' 2017, the operating temperatures are recorded for all the days of month and the average values are calculated at 4 intervals for every week. It is observed that COP has

varied accordingly and the values are 2.10, 2.02, 2.04 & 2.04 respectively at 9.00am, 12 noon, 3.00 pm and month average.

- For the month of May' 2017, the operating temperatures are recorded for all the days of month and the average values are calculated at 4 intervals for every week. It is observed that COP has varied accordingly and the values are 2.10, 2.06, 2.09 & 2.07 respectively at 9.00am, 12 noon, 3.00 pm and month average.
- ***It is observed that overall COP of the system with water cooler for the investigated period is 2.07.***

Dual Purpose System without Water Cooler i.e. only Air-Conditioner:

- For the month of March' 2017, the operating temperatures are recorded for all the days of month and the average values are calculated at 4 intervals for every week. It is observed that COP has varied accordingly and the values are 2.4, 2.2, 2.1 & 2.34 respectively at 9.00am, 12 noon, 3.00 pm and month average.
- For the month of April' 2017, the operating temperatures are recorded for all the days of month and the average values are calculated at 4 intervals for every week. It is observed that COP has varied accordingly and the values are 2.2, 2.0, 2.1 & 2.23 respectively at 9.00am, 12 noon, 3.00 pm and month average.
- For the month of May' 2017, the operating temperatures are recorded for all the days of month and the average values are calculated at 4 intervals for every week. It is observed that COP has varied accordingly and the values are 2.2, 2.1, 2.09 & 2.2 respectively at 9.00am, 12 noon, 3.00 pm and month average.
- ***It is observed that overall COP of the system with water cooler for the investigated period is 2.28.***

Conclusions:

From tests carried out and the results obtained, the following conclusions were made:

The system functioned effectively as an air conditioner. The air conditioner and water cooler components effectively functioned independently as separate parts of the system.

- Capacity of Water Cooling Unit is 0.0286 TR
- Cooling Capacity of Air Conditioner is 0.2 TR
- Co- Efficient of Performance for AC with Water cooler is 2.07
- Co- Efficient of Performance of system without water cooler is 2.28.
- There is no much significance reduction of performance when the system is used for dual purpose.
- From the design, investigation and calculation of dual purpose air-conditioner and water cooler operation is feasible.

REFERENCES

1.K. Adigun And O. V. Obasa,(2016) "Improvement Of A Dual Purpose Refrigeration System For Domestic Use,

2.Kamlesh Kumar Sharma, R.L. Gupta,(2016) Sanjay Katarey "Execution Improvement of AirConditioning System UsingApplications of Evaporative Cooling

3. Amod A. Koyadwar,(2015)A Review On Dual Purpose AutomotiveAir-Conditioning System,

3.J.H. Wu, L.D. Yang, J. Hou, (2015), Experimental Performance Study Of A Small Wall Room Air Conditioner Retrofitted With R290 And R1270,

4. 5. Abdullah A.A.A. Al-Rashid,(2011) "Impact of Evaporator Temperature on Vapour Compression Refrigeration System" Alexandria Engineering Journal 50, 283– 290

6. ChetanPapadeBirannaSolankar,(2016)A Review On Analysis Of Vapour Compression Refrigeration System Using Matrix Heat Exchanger .

7. Kapil Chopra, V. Sahni, And R. S. Mishra (2014) "Thermodynamic Analyses Of Multiple Evaporators Vapour Compression Refrigeration Systems With R410a, R290, R1234yf, R502, R404a, R152a And R134a "

8. JatinderGill,Jagdev Singh (2017) "Exploratory Analysis of R134a/Lpg as Replacement Of R134a In A Vapour-Compression Refrigeration System

9. J.M. Belman-Flores A.P. Rodríguez-Muñoz (2017)"Experimental Study of R1234yf as A Drop-In Replacement For R134a In A Domestic Refrigerator"

10. Refrigeration and Air Conditioning Systems By R.S. Khurmi& J.K. Gupta, S.Chand& Co (1970)