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FABRICATION & PERFORMANCE ANALYSIS OF A DOMESTIC REFRIGERATOR (COUNTER FLOW)

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ABSTRACT:

Majority of refrigerator works on vapor compression refrigeration system. The system consists of compressor, condenser, expansion valve and evaporator. The performance of the system depends on the performance of all components of the system. The main objective of the present study is to study the performance of a domestic refrigerator by placing shell and tube type heat exchanger between compressor and condenser to extract more amount of heat by sub cooling process by using ammonia as an external cooling media. And flow of water from is counter flow the refrigerant and liquid flows in opposite direction and finds the cop of the refrigerant.

KEYWORDS:

REFRIGERATOR, REFRIGERATION SYSTEM, COMPRESSOR, CONDENSER, EXPANSION VALVE, EVAPORATOR, DOMESTIC REFRIGERATOR, HEAT EXCHANGER, AMMONIA, COUNTER FLOW, REFRIGERANT.

I. INTRODUCTION

The health, welfare, comfort and productivity of nations with new development in both the refrigeration and air-conditioning fields. Refrigeration is essential for the preservation of foods, the production and safe storage of medicines and numerous other applications. Through refrigeration, better controls of industrial processes are possible. Dimensional accuracy is improved, new materials may be developed and processed and other production processes may be increased. Refrigeration is needed to produce correct climatic conditions for domestic as well as certain manufacturing processes. For example, cool cutting fluid helps in machining operations by lowering the temperature of the work piece to prevent overheating.

In the fields of refrigerating units are used to store, process and test many chemical and biological materials. Refrigeration as a quick cooling process, speeds production, cuts moisture losses in foods and other engaged in the preparation, marketing and purchasing of foods, all depend on refrigeration,

Important studies of exact nature of electron movement slow down to a point where it may be deserved has also wide application in submarine ships, aircraft and rockets. Component design is another important area. There is scope for improving all aspects, including developing more efficient condensers and evaporators. Expansion valves motor drives and fan controls.

Investment and management costs differ for the various options available. Investing in improved design will lead to decreasing costs. The installation of super heat pumps, however, may need large investment. In the general, the investment costs for new refrigeration systems are considered to be comparable with, or lower than, currently installed system, if system design analysis is applied. Costs are estimated to be slightly lower than for conventional

refrigeration systems.

Units of Refrigeration:

The practical unit of refrigeration's is expressed in terms of ' tone of refrigeration' (briefly written as TR). A tone of refrigeration is defined as the amount of refrigeration effect produced by the uniform melting of one tone (1000

kg) of ice from at 0^{O} C in 24 hours.

Since the heat of ice is 335 kj/kg, therefore one tone of refrigeration, ITR = 1000×335 kj in 24 hours

$$= \frac{1000\times335}{24\times60} = 232.6\ \text{kj/m}$$

In actual practice, one tone of refrigeration is taken as equivalent to 210 kj/ min or 3.5kW (i.e.3.5. kj/s).

REFRIGERATION CYCLE

The term 'refrigeration' may be defined as the process of removing heat from a substance under controlled conditions. It also includes the process of reducing and maintaining the temperature of a body below the general temperature of its surrounding. In other words, the refrigeration means a continued extraction of heat from a body whose temperature is already below the temperature of its surroundings.

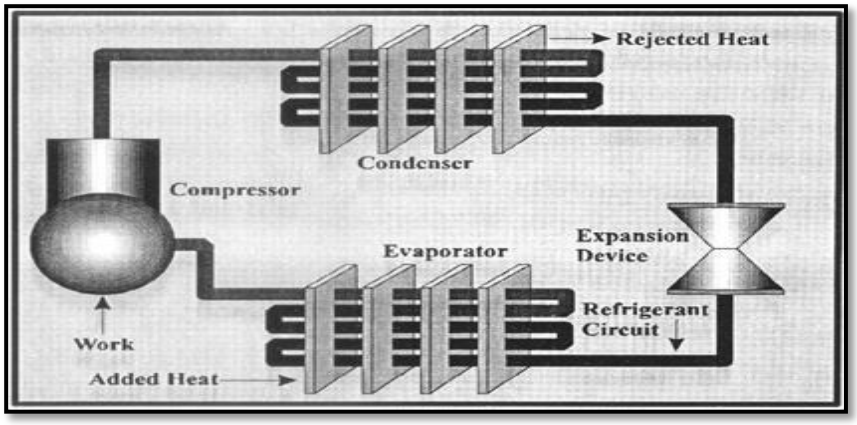


FIG.1. VAPOR COMPRESSION REFRIGERATION CYCLE

Theoretically, a refrigerator is a reversed heat engine or a heat pump which pumps heat from a cold body and delivers it to hot body. This substance, which works in heat pump to extract heat from a cold body and to deliver it to a hot body, is called a refrigerant.

As scientists, technicians and crafts person experiment at still lower and temperatures, approximately (-273^{o}C), the new science of cryogenics (refrigerants) will reveal materials in a state that is a neither a solid, liquid nor a gas.

System design can be improved by the use of new components, e.g. the development of super heat pumps with high COPs of greater than seven. Another major trend is the drive to reduce the amount of refrigerant used and to develop new working fluids. Traditionally, the most common working fluids for compression heat pumps have been ammonia and CFCs, but energy saving of 2-20% have been reported when using alternative working fluids such as halogen refrigerant mixtures, and natural refrigerants such as air and CO2. Systems that use compact and cost-effective components have reported 20% higher coefficient of performance values than conventional CFC systems.

Absorption refrigeration offers considerable scope for energy saving when driven by waste heat. When configured correctly in conjunction with CHP, it can

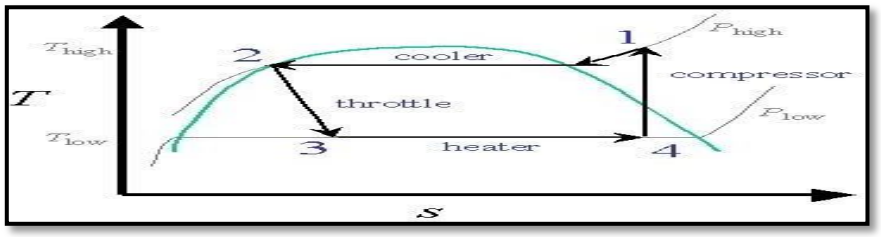


FIG.2. T-S DIAGRAM OF VAPOUR COMPRESSION CYCLE

Actually increase the viability (and also viable size) of CHP plant, by providing a productive use for the heat, especially during summer periods. Despite these benefits, in practice only heating capacity is discussed in the relevant literature.

A cooper compression refrigeration system is an improved types of air refrigeration system in which a suitable working substance, termed as termed as refrigerant, is used. It condenser and evaporates at temperature and pressure close to the atmospheric conditions. The refrigerants usually used for this purpose are ammonia (NH3) carbon dioxide (CO2) and sulphur dioxide (SO2). There refrigerant used, doesn't leave the system, but is circulated throughout the system alternately condensing and evaporating, the refrigerant absorbed its latent heat from the brine (salt water) which is used for circulating it around the cold chamber, While condensing, it gives out its latent heat to the circulating water of the cooler.

II. LITERATURE SURVE

Richjer C.Jordon & Gay Leb. Priester, The object of the project is to design, fabricate and assemble an economically priced '' domestic refrigeration unit'' having, aesthetic look efficient and small in size. This unit is unique in the sense that it body is in the form of a bucket which works as an evaporator and easy in transport from one place to another place. This unit can be utilized in a heavy duty manufacturing shop consist 25 to 35workers as a sources cold water and to store eatables things. The basic idea behind refrigeration is to slow down the activity of bacteria (which all food contains) so that it takes longer for the bacteria to spoil the food [1].

B.O. Bolaji, This paper presents the design, construction and performance testing of a refrigeration system for use as experimental apparatus for demonstrating vapour compression refrigeration cycle and basic concepts of thermodynamic principles. The apparatus shows the visual

observation of all-important processes. The experimental data were analyzed using the first and second laws of thermodynamics to determine the refrigerating effect, the net heat rejected from the system, the compressor work input and coefficient of performance (COP). During the test, the COPs of the system and Carnot cycle were found to be 3.87 and 6.96, respectively. Also, the steady state discharge pressure and the average refrigeration capacity obtained were 830 kPa and 915.8 W, respectively, while the relative and isentropic efficiencies obtained from the system were 55.6 and 86.7%, respectively[2]. Akintude MA.2004 Rajeev Satsangi Refrigerant is a substance used in a heat cycle usually for enhancing efficiency, by a reversible phase transition from a liquid to a gas. Traditionally, fluorocarbons, especially chlorofluorocarbons, were used as refrigerants, but they are being phased out because of their ozone depletion effects. R134a is an inert gas used primarily as a "high-temperature" refrigerant for domestic refrigeration and automobile air conditioners. Contact of R134a with flames or hot surfaces has toxic and hazardous effect on the humans and environment [3].

Sudhanshunk Pathak, SK Bharti For evalution of shell and tube heat exchanger, thermal performance and pressure drop and depended on the path of fluid flow and different orientation respectively. Increasing the complexity of fluid flow enhances heat transfer. a review on the FEA simulations carried out on shell and tube type heat exchanger with creating the extended surface on the tube wall[4] .

III. WORKING MODEL

FIG.3. WORKING MODEL OF A DOMESTIC REFRIGERANT

TOOLS REQUIRED

- Electrodes
- Welding machine
- Grinding machine
- Cutter
- Hammer
- Carpentry Tools
- Charging Line Gauge
- Energy meter
- Thermocouples
- Pressure gauges
- Chipping hammer
- Heat exchanger
- Motor
- Pipes
- Water tub

SPECIFICATIONS

Materials	*Application*
➢ Compressor	1/8 half HP

➢ Pressure gauges	Blue – for low pressure, Red – for high pressure
➢ Thermocouples	For Temperature Readings
➢ Energy Meter	For Power consumption Readings
➢ 5/6' copper tube	For evaporator
➢ Capillary tube	For expansion
➢ Condenser Air-cooled	For condensing the liquid
➢ Thermostat	Automatic defrost control
➢ Indicator lamps	Red- for main supply, Green- for automatic defrost
➢ Glass wool	Insulator
➢ ¼ tubes	Joining the tubes
➢ Gas R134a	Used as Refrigerant
➢ Oil	For lubrication
➢ Wires	For electrical connections the wires
➢ Tin sheets	To cover the base part of the table
➢ Electrode	For welding of table
➢ Heat exchanger	For cooing of liquid flowing in condenser with water circulation

CALCULATIONS

WITH HEAT EXCHANGER (COUNTER FLOW)

TABULAR COLUMN

TABLE NO. 1. VALUES OF PRESSURE AND TEMPERATURE WITH HEAT EXCHANGER (COUNTER FLOW)

S.NO	P1	P2	T1	T2	T3	T4	T5	EM TIME FOR 20 BLINKS	DURATION
	PSI	PSI	^0C	^0C	^0C	^0C	^0C	SEC	MINUTES
1	48	155	34	42.3	35.1	16.5	20.8	164.92	10
2	48	155	35.2	46.6	34.6	16.3	17.2	192.36	20
3	48	155	35.8	48.6	34.2	16.9	13.9	195.04	30
4	48	155	36.5	49.2	33.9	17.7	12.4	201.32	40
5	48	155	37.4	51.4	33.9	17.8	11.0	206.68	50
6	48	155	38.1	52.1	33.9	18.1	11.0	211.88	60

WITHOUT HEAT EXCHANGER

TABULAR COLUMN

TABLE NO. 2. VALUES OF PRESSURE AND TEMPERATURE WITHOUT HEAT EXCHANGER

S.NO	P1	P2	T1	T2	T3	T4	T5	EM TIME FOR 20 BLINKS	DURATION
	PSI	PSI	℃	℃	℃	℃	℃	**SEC**	MINUTES
1	48	155	34	42.0	37.6	13.9	20.8	161.96	10
2	48	155	35.2	46.8	37.7	11.5	17.2	181.84	20

3	48	155	35.8	47.9	37.6	9.4	13.9	189.36	30
4	48	155	36.5	51.7	37.7	8.0	12.4	194.56	40
5	48	155	37.4	52.9	37.7	6.8	11.0	200.57	50
6	48	155	38.1	53.3	37.7	6.8	11.0	209.8	60

Temperatures &Pressures of refrigerant @

T_1 = inlet of compressor in ℃

T_2 = outlet of compressor in ℃

T3 = outlet of Condenser in ℃

T4 = outlet of Expansion Valve in ℃

T5 = cabin Temperature in ℃

P1 = Compressor inlet Pressure in PSi

P2 = Compressor outlet Pressure in PSi

IV. Results & Discussions

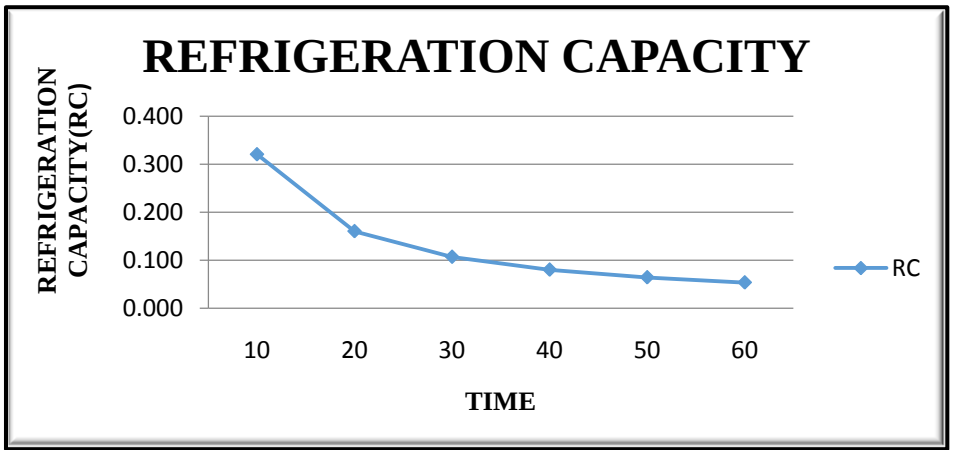


FIG.4. REFRIGERATION CAPACITY VS TIME WITH HEAT EXCHANGER

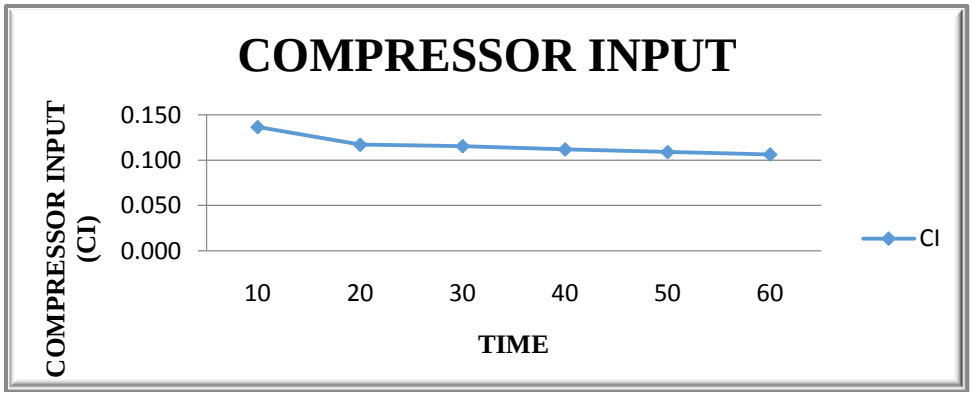
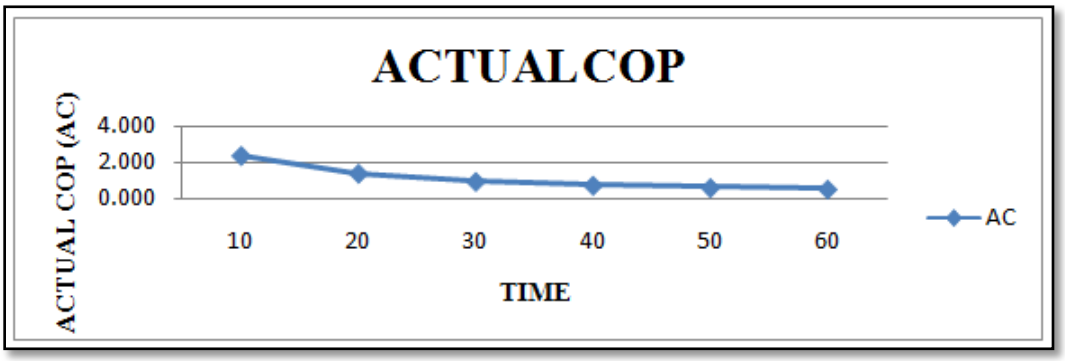


FIG.5. COMPRESSOR INPUT VS TIME WITH HEAT EXCHANGER

FIG.6. ACTUAL COP VS TIME WITH HEAT EXCHANGER



V. CONCLUSION

Majority of refrigerator works on vapor compression refrigeration system. The system consists of compressor, condenser, expansion valve and evaporator. The performance of the system depends on the performance of all components of the system. The main objective of the present study is to study the performance of a domestic refrigerator by placing shell and tube type heat exchanger between compressor and condenser to extract more amount of heat by sub cooling process by using ammonia as an external cooling media. And flow of water from is counter flow the refrigerant and liquid flows in opposite direction and finds the cop of the refrigerant.

Finally we find the COP Values of the Refrigerant,

- Without Heat Exchanger the COP of the Refrigerant is 0.4258
- With Heat Exchanger the COP of the Refrigerant is 0.5028.

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