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Experimental Analysis of Waste Heat recovery of Refrigerator to Develop Compact System

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Abstract:
In modern day, refrigerator is most useful device which is generally used for cooling purpose. It is a device used to keep items at respectively or below atmospheric temperature, generally at low temperature to preserve items and it is its main function. We have tried to make this device more useful and efficient, by adding a heat chamber. Heat chamber is an external chamber which is installed over the refrigerator. We have replaced chillier (ice former) with a GI chamber (warm chamber) via refrigerant flow tubes which are coming directly from compressor. In this process, this heat energy is wasted because of dissipation in atmosphere. Our experiment involves utilization of this heat in most useful way. What we are doing is allowing this hot refrigerant to flow through this chamber which is wrapped by the flow tubes by allowing hot refrigerant to flow through this chamber give its heat energy to this chamber making that chamber warm say up to temp 50-60 degree Celsius.

Keywords: Hermetic compressor, Energy efficiency, Compact system, Evaporator, condenser expansion valve, GI chamber, heating chamber.

I. INTRODUCTION

Energy conservation in Refrigerator

A household refrigerator is a common household appliance that consists of a thermally insulated compartment and which when works, transfers heat from the inside of the compartment to its external environment so that the inside of the thermally insulated compartment is cooled to a temperature below the ambient temperature of the room. In most cases, household refrigerator uses air-cooled condenser. Tetrafluoroethane (HFC134a) refrigerant was now widely used in most of the domestic refrigerators and automobile air- conditioners and are using POE oil as the conventional lubricant. Generally, heat from the condenser side is dissipated to room air. If this heat is not utilized, it simply becomes waste heat. If this energy can be utilized effectively then it will be an added advantage of commodity our project aims towards the same goal.

Parts of refrigerator

Compressor- Low pressure vapour refrigerant enters the compressor. The comp compressed this low vapour refrigerant into high pressure vapour at this section the temp is also further increase due to the compression of refrigerator. Now at the end of comp the refrigerant is high pressure high temp vapour refrigerant.

Condenser- The main purpose of condenser is to transfer the heat generated in refrigerant during the compression process. The temperature of the refrigerant entering in condenser is about 40-60^{o}C depending input power of compressor. The atmospheric temperature is about 25-30^{0}C. Due to such large temperature difference heat transfer takes place from condenser to atmosphere. That means this heat is wasted to atmosphere.

Evaporator- The refrigerant absorbs the heat. During the heat absorption process, the refrigerant further evaporates and transforms into pure vapour. A proper heat exchanger is required to carry the cold refrigerant over the body. This heat exchanger is known as an evaporator.

Expansion valves- Expansion valves are devices used to control the refrigerant flow in a refrigeration system. They help to facilitate the change of higher pressure of liquid refrigerant in the condensing unit to lower pressure gas refrigerant in the evaporator. The term "low side" is used to indicate the part of the system that operates under low pressure, in this case the evaporator. The "high side" is used to indicate the part of the system that operates under high pressure, in this case the condenser.

G.I Chamber/heating chamber- The heat dissipated in the surrounding by the condenser is being concentrated in the top chamber by means of copper rods. Heat transfer through the fins or copper rod makes the chamber warm. Temperature is being controlled and ambient temperature is maintained. Temperature indicator is placed at the middle door.

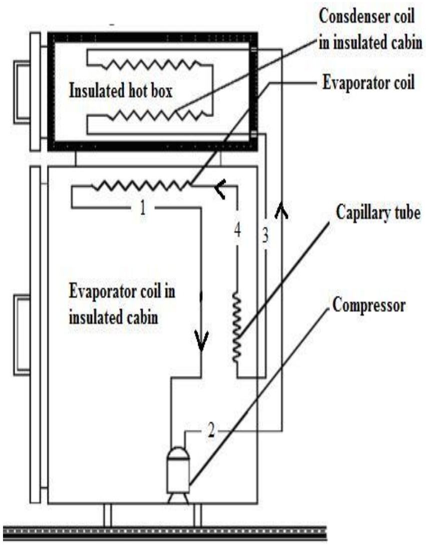

Figure.1. Actual proposed model

II. OBJECTIVE

In this paper we design the refrigerator to utilises maximum amount of waste energy as compare to earlier refrigerator. In this refrigerator we utilise heat energy which is being wasted during the time cooling of refrigerant at the condenser section. This is an idea of utilization of the heat of the refrigerator that is transfer in atmosphere and gone waste during cooling of a refrigerant. This study proves to utilize a combined system rather than a single system, where cooling and heating could be produced continuously in places far away from conventional grid. Most rural and urban area may benefit from this system in years to come.

III. SPECIFICATIONS

Table.1. Properties of refrigerant{R-134a}

S.No.	Properties	R-134a
1	Boiling Point	-26.1^{0}C
2	Auto-Ignition Temperature	770^{0}C
3	Ozone depletion Level	0
4	Solubility In water	0.11% by weight at 25^{0}C
5	Critical Temperature	122^{0}C
6	Cylinder colour Code	Light Blue
7	Global Warming Potential (GWP)	1200

Table.2. Component Name

S.No	Symbol (^{0}C)	Component
1	T1	Condenser box temperature
2	T2	Evaporator temperature at inlet
3	T3	Evaporator temperature at outlet
4	T4	Condenser temperature at outlet
5	T5	Condenser temperature inlet
6	T6	Evaporator box temperature/ice
7	P1	Suction Pressure
8	P2	Discharge Pressure

IV . EXPERIMENTAL CALCULATIONS

Table.3. Data of refrigerator at various parts

S.No	Time (min)	T1 (C^0)	T2 (C^0)	T3 (C^0)	T4 (C^0)	T5 (C^0)	T6 (C^0)
		Cond box	Evap in	Evap out	Cond out	Cond in	Evap box
1	0	29	29	29	29	29	29
2	15	46.5	12.9	24.9	45.2	46.9	-2
3	30	51.8	-1.2	23.9	49.6	51.3	-2.5
4	45	53.9	-1.9	20.5	51.1	53.2	-3
5	60	55.5	-2.6	19.6	52.2	54.3	-4
6	75	56.2	-3	19.4	52.4	54.5	-4
7	95	57.3	-3.4	19	52.7	54.9	-4.3
8	105	58.4	-3.8	18.8	53.5	55	-4.4
9	120	61.5	-4.2	18.5	54.3	55.4	-5

V. RESULTS & DISCUSSION

The graph plotted shows that there is an increase in the condenser box temperature with the increase in time. The temperature rise changes according to load we provided. The power will get consume according to output temperature rise. The overall temperature difference encountered at the end of 120 minutes from room temperature 29^{0}C in condense cabinet exceeds 32.5^{0}C & in Evaporator Cabinet is decreases 34^{0}C and become 61.5^{0}C in Condenser and -5^{0}C in evaporator after 120 minutes. We conclude from this project is that for every increase intime interval the temp also get increases in condenser boxand decrease in evaporator box. Heat transfer rate will reduce with increase in time.

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