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Experimental Analysis of A Multi-Purpose Refrigerator System

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ABSTRACT

Refrigerators used in daily life are one of the indispensable tools. Uninterrupted power should be supplied to the refrigerators in order to maintain cooling service. Domestic refrigerator may be operating continuously to maintain proper food storage condition. The continuous operation of this equipment accounts more electrical consumption. A significant amount of waste heat is rejected by the condensers of refrigerator. The main objective of the present paper is to provide a multipurpose warming apparatus utilizing the waste heat generated by the domestic refrigerator and to provide additional facility in the domestic refrigerator in the form of Warm chamber. A domestic refrigerator was modified for the experiments in which the waste heat, generated by the refrigerator, was utilized to maintain the temperature of a warm chamber above atmospheric temperature. The waste heat is the loss of heat by which the temperature of the room increases and it results into discomfort of human beings. So by this paper the waste heat is extracted and the temperature of the room does not rise and leads to comfort. The results showed that the use of oven is greatly reduced as the food can be warmed with the same power and leads to reduction in overall power consumption.

Keywords- Air Cooled Condenser, Domestic Refrigerator,

I INTRODUCTION

Refrigeration is a process of removing heat from one location to another. The work of heat transfer is traditionally driven by mechanical work, but can also be driven by heat, magnetism, electricity, laser, or other means. Refrigeration has many applications, including, but not limited to: household refrigerators, industrial freezers, cryogenics, and air conditioning .Heat pumps may use the heat output of the refrigeration process, and also may be designed to be reversible, but are otherwise similar to refrigeration units [1]. Refrigeration has had a large impact on industry, lifestyle, agriculture and settlement patterns. The idea of preserving food dates back to the ancient Roman and Chinese empires. However, refrigeration technology has rapidly evolved in the last century, from ice harvesting to temperature-controlled rail cars. The introduction of refrigerated rail cars contributed to the westward expansion of the United States, allowing settlement in areas that were not on main transport channels such as rivers, harbors, or valley trails. In most developed countries, cities are heavily dependent upon refrigeration in supermarkets, in order to obtain their food for daily consumption [2]. The

increase in food sources has led to a larger concentration of agricultural sales coming from a smaller percentage of existing farms. Farms today have a much larger output per person in comparison to the late 1800s. This has resulted in new food sources available to entire populations, which has had a large impact on the nutrition of society. The ideal vapor-compression refrigeration cycleand temperature entropy diagram is shown in the Fig. 1and Fig. 2.

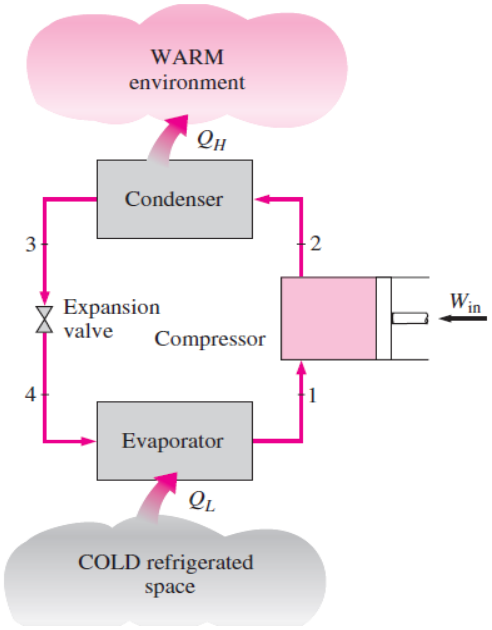

Fig 1: Schematic diagram for the ideal vapor-compression refrigeration cycle. [8]

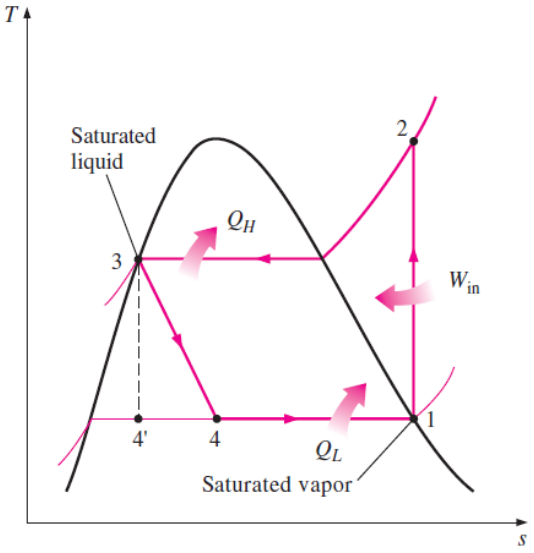

Fig. 2: T-s diagram for the ideal vapor-compression refrigeration cycle. [8]

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II EXPERIMENTAL SETUP

Schematic of the multipurpose refrigerator is shown in Fig. 3. The main parts are; (i) Heating chamber, (ii) Compressor,(iii) Condenser, (iv) Expansion valve, (v) Evaporator, (vi) Thermostat, (vii) Refrigerant.

A warming chamber is placed at the top of the refrigerator. A warm chamber houses the heat exchanger coil (condenser coil) outside the refrigerator as the heating element of the warm chamber. A cabin was installed on a domestic refrigerator with condenser coils of refrigerator serving as heating coils inside the cabin. The heat exchanger coils form the heating element of this chamber. The top, left and bottom heating elements are the heat exchanger coils of the refrigerator and the compressor acts itself as the right side heating element. The warm chamber housing and the heat exchanger coil (condenser coil) were being the top, left and bottom heating elements of the Warm chamber. The Warm chamber is heated by the heat exhausted by the heating coil (condenser coil). The heat exchanger coil forms the heating element of this chamber. The top, left and bottom heating elements are the heat exchange coils of the refrigerator and the compressor itself forms/acts as the right side-heating element [6].

The maximum temperature of the chamber can be as high as 50 ° C, and the average temperature will be around 40 ° C, which is more than sufficient for most of the domestic food warming kind of applications.[4]

Fig.3 Experimental setup

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Table 1: General Configuration

Refrigerant	R-134a
Mass of refrigerant	200-225g
Pressure of refrigerant	110PSIG
Material of tubes	Copper
Length of tube in condenser coil	720 cm
Temperature in Evaporator (After 1 Hour)	-12° C
Length of warming Apparatus	50 cm
Breadth of warming Apparatus	41.5 cm
Height of Warming Apparatus	35 cm
Length of Condenser Tube	350 cm
Thickness of Glass Wool	4 cm

III RESULTS AND DISCUSSION

A multi-purpose refrigerator relates to multipurpose warming apparatus utilizing the waste heat of a domestic refrigerator. The multipurpose warming apparatus is constructed as an additional part of the refrigerator and as an additional facility and heated using the waste heat generated by the refrigerator has several household uses like food warming, domestic fermentation purposes like curd making, fermentation for Indian dishes like Idli, Dosa etc., fermentation to grow yeast and to make Western food like bread, pizza, burger etc. The general configuration and general observation of the system are shown in Table 1 and Table2.

The multipurpose refrigerator relates to multipurpose warming apparatus utilizing the Waste heat of a domestic refrigerator [7]. More particularly it relates to a chamber, which is heated using the waste heat generated by domestic refrigerator. Table 1 shows general configuration of the set up while table 2 shows general observation. The multipurpose Warming apparatus is constructed as an additional part of the refrigerator and as an additional facility and heated using the waste generated by the refrigerator has several household uses like food Warming.

Table 2: Temperature observations with time

S.No.	Time	Room Temp	Condenser Temp.	Hot Chamber	Cold Chamber
		º C	º C	º C	º C
1	10:40	29	40.3	45	03
2	11:10	29	43.9	50	-01
3	11:40	29	41.3	40.1	-02
4	12:40	30	51.6	49.5	-03
5	13:10	31	52.3	48	-04
6	14:00	32	44	48	-06

3.1 Advantages of multipurpose refrigerator

- It provides a multipurpose warm chamber as an additional facility of a domestic refrigerator.
- The warm chamber is useful for good warming that is for keeping the cooked food warm for sufficiently long duration before consumption as well as warming the food removed from the refrigerator before consumption.
- The warm chamber is also useful for curd making, fermentation for making Indian dishes like Idli, Dosa etc.,making western food items like bread, pizza, burger etc. and growing yeast.
- It utilizes the waste heat generated by the domestic refrigerator and does not need and additional power supply.
- The waste heat generated by the refrigerator is the loss of heat by which the temperature of the room increases and results to discomfort to the human being. So by this project as the waste heat is extracted and the temperature of the room does not rise and leads to comfort.
- The use of oven is greatly reduced as the food can be warmed in the same power and the use of oven is greatly reduced and leads to reduction to electricity bills.

3.2 Limitations

Heating water requires much more energy than keeping food warm or making the curd. The amount of waste heat dissipated by the refrigerator may not be really useful for heating water as claimed in some patients; it may be useful for keeping the water warm.

IV CONCLUSION

From above setup of we can use the extracted heat from heat removing device(condenser) and we can see that at normal room temperature(29 º C) refrigerants absorbs heat from system and on average release heat at 45 º C in surroundings. By storing this heat we may warm a chamber at average temp (45 º C) and this warm chamber is fixed at top of the refrigerator. form table 2 we can conclude that hot chamber temperature is varying between 45 to 50 º C. this temperature range is very much sufficient for domestic fermentation purposes like curd making, fermentation for Indian dishes like Idli, Dosa etc., fermentation to grow yeast and to make Western food like bread, pizza, burger etc.

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