A Review: Design and Experimental Analysis of Waste Heat of Condenser in VCR System

Yogesh Kamble[1] Dipak Patil[2]
[1]M.Tech. Student [2]Assistant Professor
[1,2]Department of Mechanical Engineering
[1,2]G.H Raisoni College of Engineering and Management, Wagholi, Pune, India

Abstract— Increasing demand of energy and global warming is the current issue before us. Substantial increase of energy demand compelled us to think on waste heat utilization perspective. To mitigate the energy crisis and to save our environment recovery of waste heat is utmost necessary. Our main objective to present this paper is to show the percentage of waste heat utilization possible from condenser of a household refrigerator. The condenser of refrigerator acts as a heat pump and discharge heat inside room hence increases the room temperature. This discarded waste heat can be reutilized for number of domestic purposes such as heating water, maintaining food hot, cloths and grain drying. Experimentally we have shown that with waste heat recovery the overall COP of the system increases. By installing the waste heat recovery unit with domestic refrigerator it has become a multipurpose refrigerator fulfills both cooling and heating requirements.

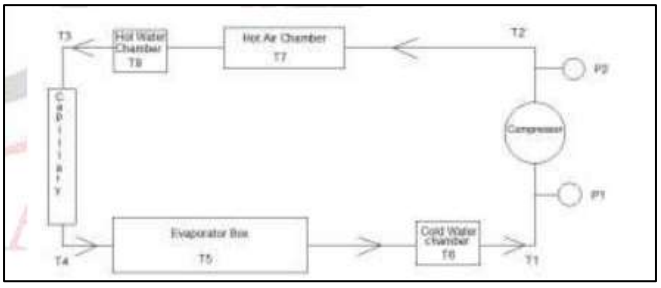
Keywords: VCR System, Hot Box, Waste Heat Recovery System, Continent in Saving Energy

I. INTRODUCTION

Energy demand and to mitigate the demand is the prime challenge before our civilized society. All types of usable energy are comes from conversion of other unusable energy of the nature. Transfer of energy always takes place from higher temperature to lower temperature. Hence all heat transfer processes involve systems at temperature gradient are brought into contact. Therefore, they obey the first as well as the second law of thermodynamics. Heat transfer is a fundamental and very important area that deals with energy and has long been an essential part of mechanical engineering curricula all over the globe. Heat transfer processes are involved in a large number of engineering applications such as waste heat recovery systems. It is important for mechanical engineers to understand the principles of thermodynamics and heat transfer and be able to use right equation that govern the amount of energy being transferred. By retro fitting a waste heat recovery system this waste heat can be recovered and can be utilized for water and air heating purpose. The hot water and dry air thereby produced can be used for several household purposes. The hot water can also be stored in a tank for later use. The modified system results in energy saving due to non-usage of electricity for heating water and air thus cost saving by combining both utilities (refrigeration and heating) in one system. A 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. R134a refrigerant is now widely used in most of the domestic refrigerators and automobile airconditioners 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. Refrigerator has become an essential commodity rather than need. Very few of us are aware about the fact that lot of heat is wasted to ambient by the condenser of refrigerator. If this energy can be utilized effectively then it will be an added advantage of commodity our project aims towards the same goal. Refrigeration in simple language is absorption of heat from the place at a low temperature and dissipation of heat to the place at a high temperature.

II. FABRICATION OF EXPERIMENTAL SETUP

The experimental setup is used to recover the waste heat from the condenser of the refrigerator. The setup consists of an insulated hot air chamber works as a microwave oven, the hot water chamber for water heating, a cold water chamber and the refrigerator cabin for cold storage. The superheat after compression is trapped in the hot insulated chamber for food heating. A portion of Condenser coil is mounted inside the hot chamber. The extension of the condenser coil is then mounted inside the hot water chamber. After passing the hot water chamber condenser coil is attached with the capillary tube for throttling. After throttling the refrigerant passes through the evaporator chamber of the refrigerator taking the heat of storage media and then the extension of evaporator tube goes to the cold water chamber for producing drinkable cold water. Exit of the cold water chamber is attached with the compressor inlet of the refrigerator. After compression the superheated refrigerant inters the hot air chamber again. This experimental setup is made for multipurpose use by utilizing the waste heat of the condenser of the domestic refrigerator. It is a feasible setup which will provide the four effects to serve four purposes of domestic use such as cold storage, cold water, hot oven and hot water



III. Details of the Experimental Setup with Procedure

A. Hot Air Chamber

Hot air chamber is mounted at the top front side of the refrigerator body. A fan is also mounted at the back side of the chamber for the force circulation. This hot air chamber is an old microwave oven body with proper ventilation for escaping of moisture. To fulfill the requirement of desired temperature attainment the door plays an important role while in closed condition and gives an elegant look. Due to small size of the compartment for this low capacity refrigerator it is limited for keeping food in hot condition only but for large capacity refrigerator it may serve for grains and cloths drying. Concept behind this experimental setup is to assemble this heating device with the refrigerator which runs on waste heat of this refrigerator. This chamber is mounted in such a way that the overall height of this setup should not exceed a desired limit that can prevent it for easy utilization by an average height person. A switch is also provided for on/off of the fan according to the requirement of the hot air distribution inside the chamber.

Material	GI sheet
Length	24 Inch
Width	20 Inch
Height	10 Inch

IV. Results and Discussion

In order to describe the experimental outcomes, graphs are plotted between different parameters obtained from number of observations. Figure 09 shows the variation of hot water temperature with time for both conditions i.e., when hot air chamber door is kept open and when hot air chamber door is closed. As the condenser temperature increases the water at hot water chamber gets heat from condenser and hence its temperature increases. After a span of one hour time hot water temperature reaches a temperature of 40.7 for open door condition of hot air chamber and a temperature of 47.3 for closed door condition of hot air chamber then becomes saturated for both the conditions. It is cleared from graph that when hot water temperature required is more, hot air chamber door should be closed. ϖ Figure 10 shows the variation of hot air chamber temperature with time, when the door of hot air chamber is closed then more temperature can be obtained as compared to door open condition. Depending upon the requirement of inside temperature of hot air chamber, the door can be kept close or kept open. When high temperature is required in short time for food heating, hot air chamber door should be closed. ϖ Figure 11 shows the variation of evaporator box temperature with time, when hot air chamber door is kept open lower the temperature can be obtained but when hot air chamber door is closed the cooling capacity of evaporator decreases. Since the heat of condenser coil is trapped due to door closed condition the cooling capacity decreases. Hence if more cooling is required in less duration of time the door of hot air chamber should be kept open

V. Conclusion

This experiment shows that the recovery of waste heat from the condenser of a refrigerator is possible up to 45% It has been seen that after experiment, the COP of the refrigerator has increased by heat recovery system and efficiency of the system also improves. ϖ It reduces the consumption of electricity by providing same power of electricity to compressor to run evaporator and condenser. ϖ It has been assumed that the condenser of the refrigerator can be work as an oven by storing the escaping heat from the condenser to the environment and reduce the rise in temperature of environment to stop the effect of global warming. ϖ Finally, this could be surrogate for water and air heater and fulfils all of the applications of hot water and dry air, which furthermore, could tackle the requirement of LPG gas and thus, safer in environmental aspects.

VI. Future Scope

This setup will work as a combination of a refrigerator, a geyser and a microwave oven. With this system the domestic purposes of a refrigerator and a hot water as well as food heating will be served. The system is feasible and hence it will satisfy the need of mankind with less energy consumption and there will be no effect on the global environment.

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