HEATING AND COOLING EFFECT USING VAPOUR COMPRESSION CYCLE

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ABSTRACT

Heat is energy, so energy saving is one of the key matters from view point of fuel consumption and for the protection of global environment. So it is necessary that a significant and concrete effort should be made for conserving energy through waste heat recovery too. The main objective of this paper is to study "Waste Heat recovery system for domestic refrigerator". An attempt has been made to utilize waste heat from condenser of refrigerator. This heat can be used for number of domestic and industrial purposes. In minimum constructional, maintenance and running cost, this system is much useful for domestic purpose. It is valuable alternative approach to improve overall efficiency and reuse the waste heat. The study has shown that such a system is technically feasible and economically viable.

I. INTRODUCTION

Today the world has made impressive progress in the field of industry, agriculture, communication, transport, and other sectors. Due to this rapid development and population growth world's thirst of energy has increased tremendously. We all want to brighter tomorrow but to accomplish this we need to be a little brighter about how we make use of energy effectively at work and at home. The best is that by helping ourselves we help others and help to secure brighter future of world. As we know a significant amount of energy is wasted in every field of application. So, valuable alternative approach for improving overall energy efficiency is to capture and reuse the lost or 'Waste Heat' (Energy). We can say energy saved is as good as energy generated. In modern era percentage of educated people is more. However the literacy about energy saving while consuming it is quite essential and must be widely spread for brighter tomorrow. This can be best achieved by setting examples starting from our home, as charity begins from home. This should be achieved without spending addition money and without additional work load in the fast moving world of today. With this intension only we have planned to construct waste heat recovery system for domestic refrigerator. So our project is a helping hand for such people and also it can throw light on energy consumption. 'Waste Heat Recovery from Condenser of Domestic Refrigerator' is a valuable alternative approach to improve overall efficiency and reuse the lost or waste heat.

This is definitely going to increase COP of the refrigerator. In this we are going to utilize waste heat from condenser of refrigerator for various household applications like hot pot, oven, dryers, etc. In minimum constructional cost as well as minimum running and maintenance cost, our project is much applicable for domestic purpose.

II. PROBLEM STATEMENT

A lot of heat is wasted from the condenser of refrigerator. This lost heat creates warming of kitchen. Also due to waste of heat the COP of the refrigerator decreases which hinders the refrigerating effect of refrigerator. Heat wasted is responsible for global warming. An energy crisis is the biggest issue incurring due to waste heat. To overcome these problems waste heat recovery is carried out.

III. OBJECTIVE

The main objective of this project is to study “Waste Heat recovery system for domestic refrigerator”. An attempt has been made to utilize waste heat from condenser of refrigerator. This heat can be used for number of domestic and industrial purposes. In minimum constructional, maintenance and running cost, this system is much useful for domestic purpose. It is valuable alternative approach to improve overall efficiency and reuse the waste heat. The study has shown that such a system is technically feasible and economically viable.

IV. METHODOLOGY

A typical vapor compression system consist of four major components viz. compressor, condenser, expansion device and an evaporator are depicted schematically in.Figure 1 is a thermodynamic diagram of the process where the numbered points correspond to the numbered points in Figure1.The operation cycle consist of compressing low pressure vapor refrigerant to a high temperature vapor(process 1-2); condensing high pressure vapor to high pressure liquid (process 2-3); expanding high pressure liquid to low pressured super cooled liquid (process 3-4); and evaporating low pressure liquid to low pressure vapor (process 4-1). The heat absorbed from evaporator in process 4-1 is rejected to outside ambient during condensation process 2-3 and is generally a waste heat. The condensation process can be divided in 3 stages viz. desuperheating2-2a, condensation and sub cooling. The saturation temperature by design is anywhere from ten to thirty degree above the heat sink fluid temperature, this ensure the heat sink fluid can extract heat from the refrigerant. The superheat can be as much as 100 F or more above the saturation temperature. This so-called superheat is a part of waste heat that can be recovered for useful purposes through the use of a heat recovery unit. A heat recovery unit is special purpose heat exchanger specifically designed to:

1.Remove heat represented by 2-3 in figure 1.

2. Improve overall system efficiency by using water cooled condenser.

3. Use thermo syphon system to circulate water to minimize pumping cost.

4. Protect against contamination of portable water via double wall construction.

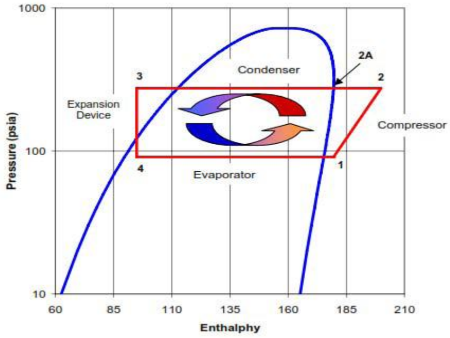

Fig.1 P-H diagram

V. LITERATURE REVIEW

1] **Raut Digambar M, Narawade Kiran H, Karale Vidur S, Pardeshi Kiransing V, Kabudke P.D** evaluated the contribution towards the waste heat recovery in the paper "HEAT UTILIZATION FROM REFRIGERATOR CONDENSER USING WATER HEATER AND HOT BOX".The purpose of this paper is to recover condenser heat by implementing in water heater and hot box. This project describes the development and use of new type of "multipurpose refrigerator- a refrigerator with hot box and water heater". Normal refrigerator works on VCC, extract heat from substance to be cooled and exert that heat to the atmosphere through the device called condenser. That refrigerator which is been previously made to exert a lot of heat through condenser is modified to overcome this wastage of heat. For recovery of that waste heat we decide to develop a machine which utilizes that waste heat for heating hot case and heating water with the use of water heater. The main important thing in our model is, it does not require any kind of additional power supply for its working operation. As the energy saving plays vital role in development, our model has lot of importance from that particular point of view. Another interesting thing in this project is that it performs operation without disturbing original refrigerator working.

2] **S. C. Walawade, B. R. Barve, P. R. Kulkarni** had explained the waste heat recovery system in the paper "DESIGN AND DEVELOPMENT OF WASTE HEAT RECOVERY SYSTEM FOR DOMESTIC REFRIGERATOR".Heat is energy, so energy saving is one of the key matters from view point of fuel consumption and for the protection of global environment. So it is necessary that a significant and concrete effort should be made for conserving energy through waste heat recovery too. The main objective of this paper is to study "Waste Heat recovery system for domestic refrigerator". An attempt has been made to utilize waste heat from condenser of refrigerator. This heat can be used for number of domestic and industrial purposes. In minimum constructional, maintenance and running cost, this system is much useful for domestic purpose. It is valuable alternative approach to improve overall efficiency and reuse the waste heat. The study has shown that such a system is technically feasible and economically viable.

3] **J.K. Gupta, M. Ram Gopal** has worked on hot well condenser in the paper "MODELING OF HOT-WALL CONDENSERS FOR DOMESTIC REFRIGERATORS".

A mathematical model of hot-wall condensers that are commonly used in domestic refrigerators is presented. The model predicts the heat transfer characteristics of condenser and the effects of various design and operating parameters on condenser tube length and capacity. In the present model, the condenser tube is divided into

elemental units, with each element consisting of adhesive aluminum tape, refrigerant tube and outer metal sheet. The heat transfer characteristics of the condensers are then analyzed by
considering the heat transfer through the tube wall, aluminum tape and the outer sheet. Variations in inner heat transfer coefficient and pressure drop are considered depending on temperature, fluid phase, type of flow and orientation of tube. Variation in ambient heat transfer coefficient is also taken into account. Results obtained are very much in accordance with the physics of the problem and agree fairly well with the published experimental data on hot-wall condensers. The study shows that the aluminium tape used to stick the condensing tube to the outer sheet plays a significant role in heat transfer from condenser to environment. The model presented here can thus be used for accurate design and analysis of hot-wall condensers.

4] **Gustavo Pottker, Pega Hrnjak** has explained the effect of subcooling in the paper “EFFECT OF THE CONDENSER SUBCOOLING ON THE PERFORMANCE OF VAPOUR COMPRESSION SYSTEMS”.

This paper presents a theoretical study about the effect of condenser subcooling on the performance of vapour-compression systems. It is shown that, as condenser subcooling increases, the COP reaches a maximum as a result of a trade-off between increasing refrigerating effect and specific compression work. The thermodynamic properties associated with the relative increase in refrigerating effect, i.e. liquid specific heat and latent heat of vaporization, are dominant to determine the maximum COP improvement with condenser subcooling. Refrigerants with large latent heat of vaporization tend to benefit less from condenser subcooling. For an air conditioning system, results indicate that the R1234yf (þ8.4%) would benefit the most from condenser subcooling in comparison to R410A (7.0%), R134a (5.9%) and R717 (2.7%) due to its smaller latent heat of vaporization. On the other hand, the value of COP maximizing subcooling does not seem to be a strong function of thermodynamic properties.

VI. WORKING PRINCIPLE

As a part of project we had planned to use water cooled condenser replaced by air cooled condenser. The aim of using water cooled condenser is that to get more and more heat for water heating for continuous flow, maintain optimum level of water in a hot pot and proportional draining float is used.

Whenever there is no need of hot water, at that time hot pot can be kept empty and the lid may be exposed to atmosphere for air circulation. Thus, the refrigerator works normally.

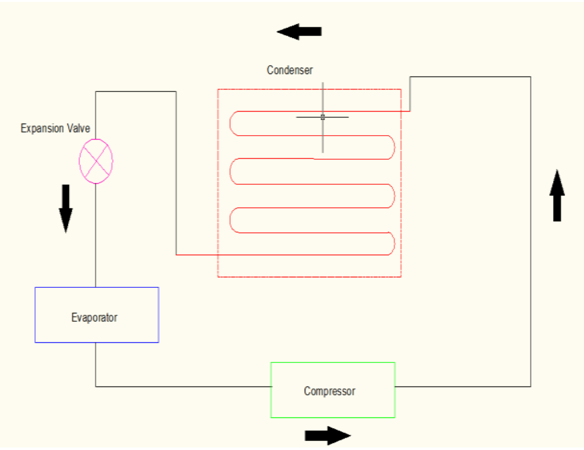

Fig.2 Working Principle of Vapour Compression System

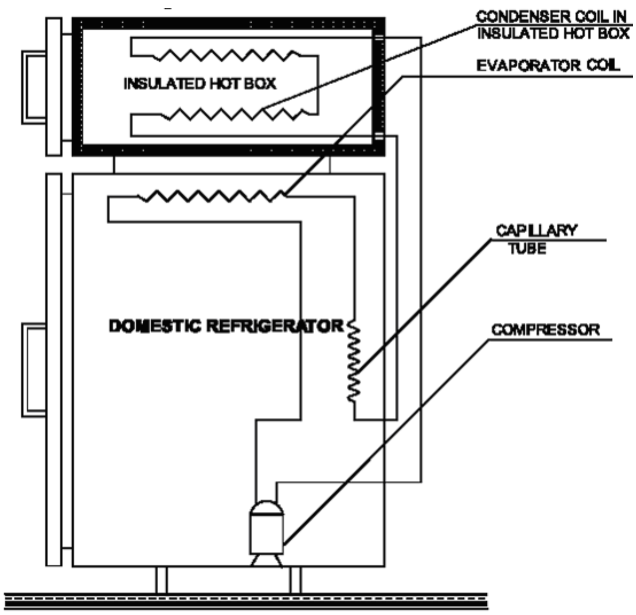

Fig 3. Experiment setup.

VII. FABRICATION OF CABIN

The insulation pot is made up of:-

1. Inner box of pot
2. Insulation material
3. Outer box of pot

1. Inner box of pot-

a. Readymade inner box (i.e. oil container of 15 ml) is used.
b. The standard dimension is – 22X22X26 cm.
c. And this cabin is painted by silver colour

2. Insulation material-

Insulation material is essential to minimize the heat transfer between cabin and surrounding. Best insulation material for our project purpose is PUF (polyurethane foam)

Fig. 4 Inner Box of Pot

3. Outer box of pot-

a. Outer box is fabricated in stainless steel as per our design which is outsourced.

b. The size of outer box is 30X30X36 cm

Fig. 5 Outer Box of Pot

VIII. CALCULATION FOR INCREASED RATE OF WASTE HEAT

Heat Recovery Achieved (Q) = Heat absorbed by water + Heat absorbed by hot pot – Rejected heat in air

Part [I]:

Heat absorbed by water (Q_1)

Given data:

Mass of water input (M) = 12.1 = 12100 gm

Specific heat of water = 4.184 J/gm°C

Initial temperature of water = 31.7°C

Final temperature of water =

Time required for reading (t) =

Heat absorbed by water (Q_1) = MCp*(difference in temperature/t)

Part [II]:

Heat absorbed by hot pot (Q_2)

Length of hot pot (L) = 30cm

Breadth of hot pot (B) =30cm

Height of hot pot (H) = 38cm

Initial temperature of water = 31.7°C

Final temperature of water =

Air/Room Temperature = 32.2°C

Area of hot pot:-

A = 2 (LB + BH + HL)

A = 2 (30 X30 + 30 X 38 + 38 X30)

A = 6360cm^2

A = 0.636m^2

Thermal Conductivity of Composite Hot Pot-

1/u = b1/k2 + b2/k2 + b3/k3

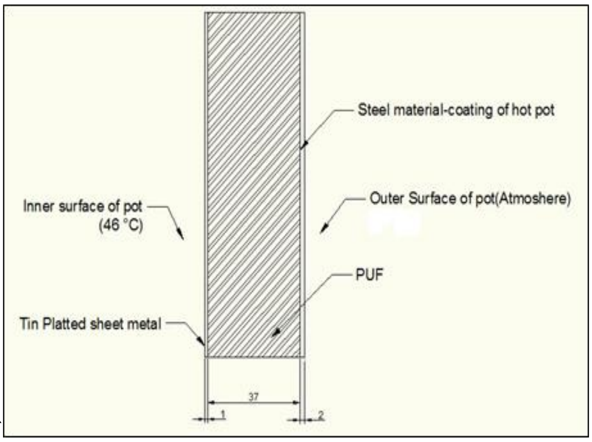

Fig. 6 Thermal Conductivity of Composite Hot Pot

Heat absorbed by hot pot (Q_2):

Q_2 = ua *(difference in temp/ dx)

Part [III]:

Heat rejected through condenser in atmospheric air(Q_3)-

Let us assume that, there is 5% loss in air through condenser.

Therefore,

Q_3 = 5% Of (Heat absorbed by water + Heat absorbed by hot pot)

Part [IV]:

Heat Recovery Achieved (Q) = Heat absorbed by water + Heat absorbed by hot pot – Rejected heat in air

IX. FUTURE SCOPE

It enhances efficiency of system. Waste heat that is rejected by the fridges, coolers in large commercial areas like industries, hotels, health care centers, it can be used to utilize the worm water to wash the cans in dairy, figure bowl water etc.

Further using same project the heat generated in the kitchen will be less as it is utilized for heating water. It can also help in reducing kitchen temperature & make kitchen more comfortable to some extent.

The hot pot can also be used as dryer. The snacks, food, grains can be warmed by keeping the utensils in empty hot pot.

X. CONCLUTION

"Waste heat recovery system" is an excellent tool to conserve available energy. If this can be started from individual level then it can sum up and enormous effect can be obtained. Thus with small addition in cost if we recover and reuse the waste heat, then definitely we can progress towards energy conservation and simultaneously achieve our day today function.

As indicated in our project this waste heat can be utilized in various ways. In the fast moving world of today where time is short we can use this as food and snacks warmer, water heater, grain dryer. So we can save lot of time and energy also.

In present situation where everybody in a home is moving out this combination of refrigerator and water heater is definitely a boom to efficient house wife & commercial

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REFRENCE

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