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Waste heat recovery in Domestic Refrigerator

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ABSTRACT

Energy crisis all over the world compelled us to take necessary steps to reduce energy consumption. By saving energy we balance the demand & supply of electricity. Basically domestic refrigerator is used to store perishable goods like vegetables, fruits, milk and other beverages etc. All domestic refrigerators use air cooled –finned condenser on backside. As domestic refrigerators reject large heat inside room which make us uncomfortable in summer due to temperature rise inside the room. So it is now essential to reject this heat outside the room or utilize it for different purposes. Rejected heat is used for keeping food hot , heating water which may be used for different purposes.

Keywords:**Domestic refrigerator, Waste heat recovery, COP, Air cooled condenser, Insulated hot box**

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I. INTRODUCTION

All domestic refrigerators use air cooled –finned condenser on backside. As domestic refrigerators reject large heat inside room which make us uncomfortable in summer due to temperature rise inside the room. So it is now essential to reject this heat outside the room or utilize it for different purposes. Rejected heat is used for keeping food hot , heating water which may be used for different purposes.1. To recover heat rejected from condenser of domestic refrigerator.2. To utilize rejected heat from condenser of domestic refrigerator as food and snacks warmer , water heater , grain drier.3. Energy conservation in domestic refrigerator condenser.4.To Compare Coefficient of performance of present and proposed Domestic Refrigerator. Literature review indicates waste heat from condenser is used for heating or drying applications in oven. Waste heat recovery is new future trend in refrigeration and most promising technology to enhance the performance of a residential refrigerator .It gives rise to more efficient and effective refrigeration system and adopted to domestic refrigerator and then to high capacity commercial refrigeration systems.

II. EXPERIMENTAL WORK

Air cooled condenser is used in present domestic refrigerator. In proposed work air cooled condenser replaced by condenser coil inside insulated hot box . New condenser design is essential so following theoretical work is essential:

1. To select condenser tube material considering various heat transfer modes and media .
2. To determine diameter & length of condenser tube for waste heat recovery.
3. To design shape of condenser for heat recovery.
4. To calculate theoretical condenser effectiveness for as per experimental work with heat recovery.
5. To calculate theoretical coefficient of performance of existing refrigerator and proposed refrigerator.
6. To design condenser of proposed refrigerator for easy maintenance practices.
7. To determine required quantity of refrigerant in proposed refrigerator.
8. To prepare mathematical model for proposed refrigerator with waste heat recovery system.

Coefficient of performance and overall efficiency of both domestic refrigerator with air cooled condenser and with proposed insulated hot box condenser for waste heat recovery is compared , analyzed to determine energy efficient system. To determine heat recovered in insulated hot box of proposed waste heat recovery system of domestic refrigerator.

Results of theoretical and experimental work are compared as follows:

1. Compare theoretical and actual condenser effectiveness of existing and proposed condenser.
2. Compare Coefficient of performance of existing domestic refrigerator(air cooled condenser) and proposed domestic refrigerator (with waste heat recovery system)
3. To determine energy efficient refrigerator from comparison of both present and proposed refrigerator.

III. EXPERIMENTAL SET - UP

It is made up of domestic refrigerator with selector valves to connect air cooled condenser and insulated hot box condenser (waste heat recovery system). By selection valve choose any one condenser and performance parameter determined with measuring instrumentation mounted on refrigerator.Existing domestic refrigerator with following specification is to be used :

Capacity in Liter: 180

Power Rating: Single phase 220-240 volt, 50 Hz , A.C. supply . 220 W

Refrigerant type: 134 A (CF3CH2F)

Condenser:External, Finned Air cooled

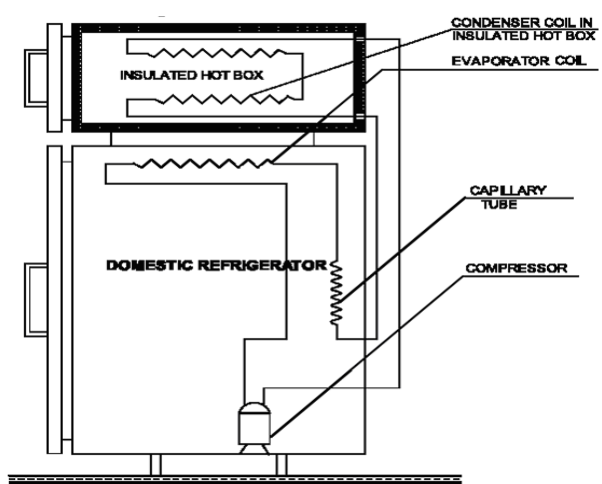

Fig 1

IV. RESULTS AND DISSCUSSION

The coefficient of performance (COP) is the ratio of heat extracted in refrigerator to the work done on refrigerant. Readings of temperatures of evaporator , condenser , insulated hot box are taken for time interval of 15 minute . COP for each readings are calculated as follows:-

COP actual = Heat extracted in refrigerator / Work done by compressor .

COP waste heat recovery = Heat extracted in refrigerator / (Work done by compressor - Waste heat recovery achieved)

It is observed that COP of domestic refrigerator was 1.1 without waste heat recovery and 1.22 after waste heat recovery through hot insulated box. So from calculations COP improved by 10.91 %. Heat recovered in insulated box where temperature increased by 18 degree centigrade.

Observation table :

Time in Minutes	Insulated box temperature
0	29
15	32
30	33
45	35
60	37
75	38
90	40
105	42
120	45
135	47

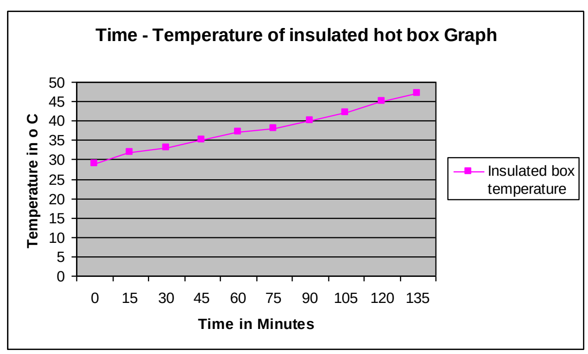

Fig 2

V. CONCLUSION

Waste heat recovery is very important now a days due to energy crisis. From experimental work carried out in laboratory as mentioned in this paper heat is recovered by increase in temperature of insulated hot box which may be utilised for keeping food and beverages warm , to warm water which may be feed water to water heater or other domestic applications such as washing utensils etc. So energy is saved and COP of domestic refrigerator is also improved. Heat load in kitchen due to heat rejection in room is also reduced which indirectly reduced energy required to cool the room.So following are main conclusions :

1. Suitable waste heat recovery system for domestic refrigerator.

2. Increase in overall effectiveness of domestic refrigerator and saving in energy

3. Increase in Coefficient of performance of domestic refrigerator.

4. Efficient and economical combination of refrigerator and food / water warmer.

5.Simulated for medium to large systems or multiple domestic refrigerators.

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