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Review of heat recovery from refrigerating equipments

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ABSTRACT

In order to fulfill surviving demands of people have taken into advantage the natural resources, they could use neglecting the possibility of resources extinction in future terms. The exploitation to a great extent of these resources has led to critical point where there is an urgent need to reconsider the term of energy and focus to sustainable energy. Inefficient use of energy is a waste of valuable resource and contributes to global warming. This paper presents opportunities to have refrigerating equipments waste heat utilization for water heating or air heating without spending additional energy. Refrigeration equipments works on vapour compression cycle. The heat absorbed refrigerating space and the compressor work added to refrigerant is rejected to ambient through a condenser is partially recovered and can be utilized effectively to produce hot water . our aim is to recover waste heat from condenser unit. The hot water can be used household as well as industrial application. This results in energy saving due to the non-usage of electrical water heating or gas water heaters.

***Keyword:*Heat Recovery, Refrigerator, Air cooled condenser, Vapour compression cycle.**

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I. INTRODUCTION

In the days of power crisis much more importance should be given to power saving and energy conservation. Efforts being concentrated on finding the new resource of energy or method of saving energy. For example in automobile catalytic converter, in the same sequence we are trying to develop the method to utilize the waste heat in domestic refrigerator. Our aim is to have refrigerator and water heating side by side without spending additional energy. 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 toward the same goal.The design and development of this type of system will highlight the basic requirement of modification in conventional system to reduce the consumption of electricity the performance analysis of a system will definitely give the platform to modify the conventional system using water heating. The COP is increased definitely but we have to select the perfect of heat exchanger.

A. Vapour compression refrigeration cycle

Compression refrigeration cycles take advantage of the fact that highly compressed fluids at a certain temperature tend to get colder when they are allowed to expand. If the pressure change is high enough, then the compressed gas will be hotter than our source of cooling (outside air, for instance) and the expanded gas will be cooler than our desired cold temperature.

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In this case, fluid is used to cool a low temperature environment and reject the heat to a high temperature environment.Vapour compression refrigeration cycles have two advantages. First, a large amount of thermal energy is required to change a liquid to a vapor, and therefore a lot of heat can be removed from the air-conditioned space. Second, the isothermal nature of the vaporization allows extraction of heat without raising thetemperature of the working fluid to the temperature of whatever is being cooled. This means that the heat transfer rate remains high, because the closer the working fluid temperature approaches that of the surroundings, the lower the rate of heat transfer.

The refrigeration cycle is shown in Figure:

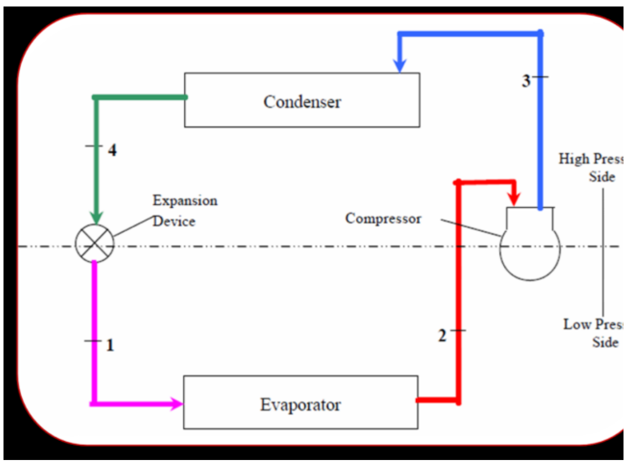
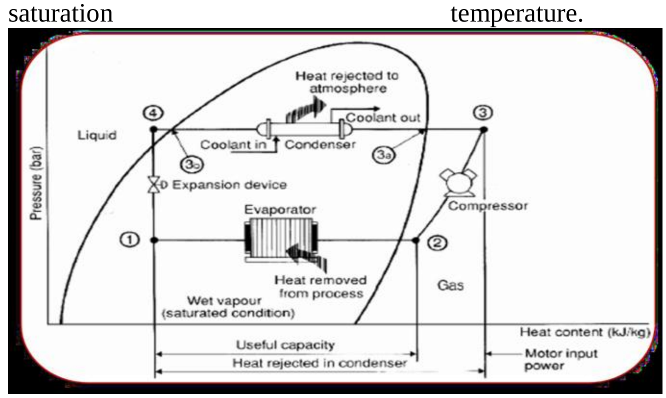


Fig 1. Schematic diagram of simple vapour compression system

B.Heat recovery

Vapor compression air conditioning systems service residential, commercial and industrial comfort cooling requirements. A typical vapor compression system consists of four major components viz. compressor, condenser, expansion device and an evaporator. The operation cycle consists of compressing low pressure vapor refrigerant to a high temperature vapor (superheated condition: process 2-3); condensing the high pressure vapor to high pressure liquid (phase change: process 3-4); expanding high pressure liquid to low pressure super-cooled liquid (process 4-1) and evaporating low pressure liquid to low pressure vapor (phase change: process 1-2). For heat recovery, the process of interest is the compression 2-3 which increases the pressure and temperature of the refrigerant gas; this is known as Heat of Compression.The heat absorbed from air to be conditioned in process 1-2 is rejected to outside ambient during condensation process 3-4 and is generally a waste heat. The condensation process can be divided in 3 stages viz. desuperheating 3-3a, condensation and sub-cooling. The compression work (2-3) done on the gas is dependent upon several factors; refrigerant type and the efficiency of the compression process being two of them. This gas is also known as a superheated gas because it exits the compressor at a temperature significantly higher than heat sink fluid temperature, this ensures the heat sink fluid can extract heat from the refrigerant. The superheat can be as much as 100ºF or more above the saturation temperature.



A part of waste heat that can be recovered for useful purposes(usually to heat process water) through the use of a Heat Recovery Unit. The amount of waste heat recoverable in any installation is dependent upon many factors.Among them are: (1) The discharge temperature of the compressor {largely determined by the ambient conditions or ì sink temperature i.e. the temperature of the outside air (if air cooled) or the temperature of the process water (if water cooled)}, (2) The number of hours per day and days per year that the air conditioning operates and (3) The amount of hot water that can be utilized at the site. The first two factors are common sense; the last is not so obvious.

C. Mathematical Relations:

a. Heat rejected in condenser

$Q_r = m_{cw} \times C_{pw} \times \Delta T$

b. Heat absorption in evaporator

$Q_a = m_{ew} \times C_{pw} \times \Delta T_{ew}$

c. Work input in compressor

W_{in} = Energy meter reading.

d. Coefficient of performance

$COP = Q_a / W_{in}$

e. Power per Ton of Refrigeration

Power TR = $(3.5 \times W_{in}) / Q_a$

II. Literature Review :

Akbarzadeh et al. [1] Explains a loop thermosyphon heat exchangers is used for heat recovery system is more efficient than shell and tube heat exchangers. The heat energy recovered from the flue gas was used to heat up the proofing oven providing duct work is done so economy is achieved. A plate fined tubes are used instead of shell and tube heat exchangers.

Shao et al. [2]Have presented an inverter air cooling heat pump system with domestic hot water. Comparison is done with traditional system and a new design which is able to reduce energy consumption and decrease thermal pollution that is contributing to the global warming. A water reheater is used between compressor and condenser to get a hot water so that it can be use for domestic purpose.

Abumulaweh et al. [3] Havepresented a thermosyphon heat recovery apparatus a heat recovery form an air condition is done by thermosyphon and use of thermosyphon has reduced use of circulating pump. Heat transfer processes are encountered in heat recovery system demonstrates heat transfer principles and concept of thermo-siphon heat recovery system.

Mustafa et al. [4] Have shown that of effectiveness of heat pipe heat exchanger is close to the optimum effectiveness at fresh air in let temp near the refrigerant operating temperature of heat pipes. The heat pipes can be used for heat recovery and effectiveness of heat pipes heat exchanger is investigated for air conditioners.

Gupta et al. [5] Presented a mathematical model of hot wall condensers used in domestic refrigerators. The model gives information about heat transfer characteristic of condensers and effect of various design and operating parameters on condenser tube length and capacity. The heat transfer characteristic of the condensers analyzed by considering heat transfer through the tube wall, aluminum plate and outer sheet.

Guglielmoneet et al. [6] Have made the heat recovery unit (HRU is) which operate with air conditioning and refrigeration systems to harvest excess heat which would otherwise be lost , thereby improving overall energy efficiency and yielding useful heating . A heat recovery unit is kept between compressor and condenser and this way a load on condenser is reduced.
Lee et al. [7] Explained a hybrid cooler which is combination of vapour compression cycle and natural circulation cycle. The hybrid cooler works on vapour compression cycle mode at higher temperatures but works on natural circulation mode, at lower temperatures by the thermo-siphon principles. And the performance of hybrid cooler is studied in both modes.
Thu et al. [8] Investigated silica gel water based absorption desalination method cycle with internal heat recovery between condenser and evaporator. A mathematical model was developed and performance data were compared with the experimental results the adsorption desalination cycle is able to produce specific hot water production. And it is almost twice production that of conventional adsorption desalination cycle.
Yoon et al. [9] Investigated a two circuit cycle with parallel evaporators for a domestic refrigerators energy saving potential compared with conventional cycle with single loop or serial evaporators. When a parallel cycle is optimized in terms of refrigerant charge and capillary tube diameter the energy consumption was reduced by large percentage.
Zhu et al [10] Explains the heat could be recovered from the condenser for useful wok and explained about a integral heating and cooling unit can save a ample amount of energy this device can be use to improve thermal efficiency as well. A domestic cooling and heating unit has all functionality of the existing home air conditioners and refrigerators and it also heat to reduce the environmental impact of the devices.

III. Conclusion

Few researchers have reported that the methods of heat recovery of waste heat from the condenser of the vapour compression refrigeration system.Few researchers have reported that a thermosyphon can be used for heat recovery.It is not reported that how much heat would be recovered from condenser unit of a refrigeration system and what improvement in the refrigeration system is possible.

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