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MULTIFUNCTIONING OF AC BY RECOVERY OF LOST HEAT

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ABSTRACT:
A lot of heat energy is wasted in the condenser of an air conditioner system. Basically air conditioning system works on Vapour compression. Lot of heat energy is rejected from the condenser. In this project we are going to recover heat from the condenser by means of heat exchanger. Energy consumption is one of the key issues in air conditioning system. In this project we are going to get hot water and cold water by consuming same amount of energy as that of the original system. This project works by recovering the heat lost to the atmosphere from the condenser and evaporator by means of heat exchanger.
This project experimental investigation of the performance split air conditioner with and without combined coil as heat pump water heater. The coil is a heat exchanger that is placed between the compressor and the condenser by utilizing the heat rejection.

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. Our aim is to have air conditioner and water heating side by side without spending additional energy. Air conditioner 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 and evaporator of air conditioning system.

If this energy can be utilized effectively then it will be an added advantage of commodity our project aims towards the same goal. In this project heat is recovered by using heat exchanger after condenser and evaporator.

Heat energy once degraded to lower temperature, it will not be of any use. Though atmosphere contain tremendous amount of energy but it will not be converted into high grade energy like electrical or mechanical work. This heat rejection must takes place at atmospheric temperature in order to obtain maximum possible work from the device. Also heat is transferred from one body to another body when there is a finite temperature difference exists. If these two mediums are at same temperature then heat transfer will not be possible. High temperature heat rejection will cause useful energy losses to surrounding. Otherwise this energy if supplied to heat engine will produce work.

LITERATURE REVIEW

This section reviews the current literature on heat recovery it explores the concept of heat recovery and gives basic information about all the work done in the area of heat recovery.

According to **ASHRAE, Fundamental volume 2001** explains the heat could be recovered from the condenser for useful wok.

According to **S.C. Kaushik's** investigation It is found that in general, a heat recovery factor of the order 2.0 and 40% of condenser heat can be recovered through the Canopus heat exchanger.

H.I. Abu-Mulaweh [8] designed and developed a thermosyphon heat recovery system which can recover heat from a window air conditioner

Kang et al. [1] Have explained the procedure to find heat transfer coefficient during condensation of a refrigerant

Dr. M.S.Tandale[11] presented a case study on Super Heat Recovery Water Heater At Worli, Dairy. They used R717 Kirloskar Reciprocating Compressor having refrigeration system capacity of270 TR (950KW). The Inlet & Outlet temperature of Refrigerant are 115 & 60°C.

Wijeysundera et al. [3] Have illustrated the design procedure of a helical coil heat exchanger.

Romdhane ben slama[5] developed a system that can recover heat from the condenser of the refrigerator. In this work air-cooled conventional condenser is replaced by another heat

Michael Guglielmoneet al. [4] 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 .

Concluding remark

1.Few researchers have reported that the methods of heat recovery of waste heat from the condenser of the vapour compression refrigeration system.

2.The literature was reviewed on different waste heat sources such as heat recovery from the refrigeration, air conditioning equipment's and electronics components.

3.It reveals that there is a considerable scope to recover partly or completely the condenser heat in vapor compression systems using waste heat recovery systems. From this compressor power can be saved by heat recovery.

Problem defination-

As in vapor compression systems, maximum research is in the waste heat recovery from air conditioning systems. Therefore there is wide scope to work on waste heat recovery from house hold Air Conditioning systems.

The waste heat recovery from Air Conditioning systems will be beneficial to satisfy the domestic hot water as well as cold water demand if it is utilized to heat the water.

The literature reveals that in refrigeration systems condenser is the best source for heat recovery. It gives an idea about the types of condensers used in vapor compression systems.

METHODOLOGY

Review the literature to study existing work done in the area of heat recovery from refrigerator.
Calculation of parameters in different components of the system.
Calculation of thermal load on each component by using water as a load.
Calculation of effectiveness of the heat exchanger.
Comparison between existing and modifying refrigeration systems.
Development of test rig as per the design
Collecting the experimental performance data from the system for different water loads.
Analysis of collected experimental data.
Comparison between results obtained from the system and conventional VCR system
Collecting and analysis of results and conclusion.
Interpretation of results.
Conclusion and documentation.

WINDOW AIR CONDITIONING SYSTEM

Window air conditioners are one of the most commonly used and cheapest type of air conditioners.
Window air conditioner units are reliable and simple to install solution to keep a room cool while avoiding the costly construction of a central air system.
Hence the window air conditioning system is used for the project.
The figure below shows the actual flow of air in window air conditioning system.

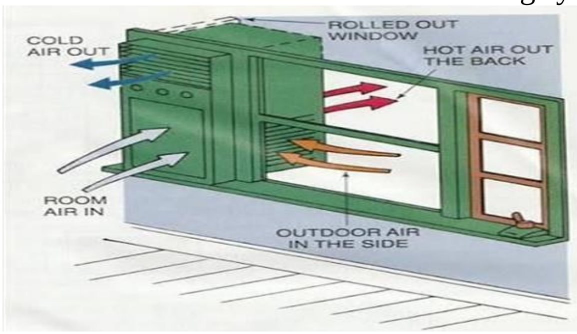


Figure: Actual Flow Diagram

Standard Vapor Compression Refrigeration Systems (VCR)

As mentioned, vapor compression refrigeration systems are the most commonly used among all refrigeration systems. As the name implies, these systems belong to the general class of vapor cycles, wherein the working fluid (refrigerant) undergoes phase change at least during one process. In a vapor compression refrigeration system, refrigeration is obtained as the refrigerant evaporates at low temperatures. The input to the system is in the form of mechanical energy required to run the compressor. Hence these systems are also called as mechanical refrigeration systems. Vapor compression refrigeration systems are available to suit almost all applications with the refrigeration capacities ranging from few Watts to few megawatts. A wide variety of refrigerants can be used in these systems to suit different applications, capacities etc.

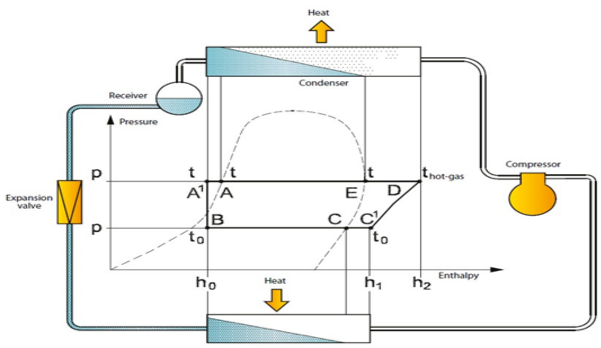
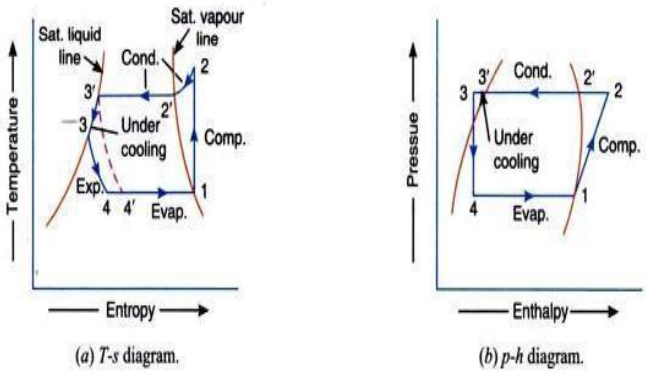


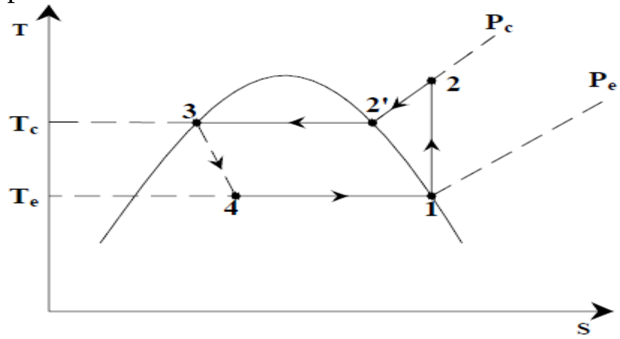
Figure:-Combined Diagram VCR Cycle & P-H Diagram



P-H & T-S diagram

The actual vapor compression cycle is based on Evans-Perkins cycle, which is also called as reverse Rankin cycle. Before the actual cycle is discussed and analysed, it is essential to find the upper limit of performance of vapor compression cycles. This limit is set by a completely reversible cycle. Figure 3.1 shows the schematic of a standard, saturated, single stage (SSS) vapor compression refrigeration system and the operating cycle on a T s diagram. As shown in the figure the standard single stage, saturated vapor compression refrigeration system consists of the following four processes.

In the refrigeration cycle, heat is transported from a colder location to a hotter area. As heat would naturally flow in the opposite direction, work is required to achieve this. A refrigerator is an example of such a system, as it transports the heat out of the interior and into its environment.



line diagram of VCR system & T-S diagram

Process 1-2: Isentropic compression of saturated vapor in compressor.
Process 2-3: Isobaric heat rejection in condenser.
Process 3-4: Isenthalpic expansion of saturated liquid in expansion device.
Process 4-1: Isobaric heat extraction in the evaporator.

WORKING OF WINDOW AC

The air is moving inside the room and in the front part of the air conditioner where the cooling coil is located is considered to be the room air. When the window AC is started the blower starts immediately and after few seconds the compressor also starts. The evaporator coil gets cooled as soon as the compressor is started.

The blower behind the cooling coil starts sucking the room air, which is at high temp. and also carries the dirt and dust particles. Then this air is passes through the filter where the dirt and dust particles from it get removed.

Hot air in the compressor which is at high pressure is passed to the condenser where heat is rejected, these rejected heat is utilized to heat the water by means of heat exchanger.

Low temperature air is then passed to expansion device where pressure is further reduced.

This low pressure and low temperature air is passed over the evaporator coil.

This air at low temperature and low humidity is sucked by the blower and it blows it at high pressure. The chilled air then passes through small duct inside the air conditioner then the chilled air enters the room and maintain the room at low temp. And low humidity

This cooled refrigerant is then used to cool the water by using heat exchanger after the evaporator.

The cool air inside the room absorbs the heat and also the moisture and so that it's temp. And moisture content becomes high. This air is again sucked by the blower and cycle repeats

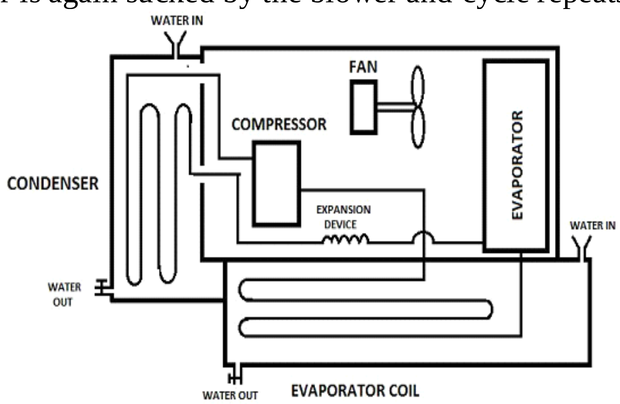


Figure: Block diagram of modified AC

DESIGN & DEVELOPMENT OF WASTE HEAT RECOVERY SYSTEM

A Videocon Window Air Conditioner is selected for the development of waste heat recovery.

Actual design of the water tank :-

The design the following water tanks takes place in the actual design of the waste heat recovery system.

1.Tank for the storage of water placed on the AC

2.Tank for the hot water of waste heat recovery system

3.Tank for the storage of the water placed on the AC

The material used for the design of the water tank is galvanized iron which gives the high strength for the tank. This tank is placed on the upper side of the AC to give the water for hot and cold water tank.

The dimensions of water storage tank are as follows:- The length of the tank(L)= 53.7cm

Height of the tank(H) = 17 cm

Width of the tank (W) = 25 cm

Tank for the storage of the hot water

This tank actual provides the hot water from the waste heat of the Window Air Conditioning system. The fig shows the actual design of the hot water storage tank

Photograph 2 Hot Water storage tank.

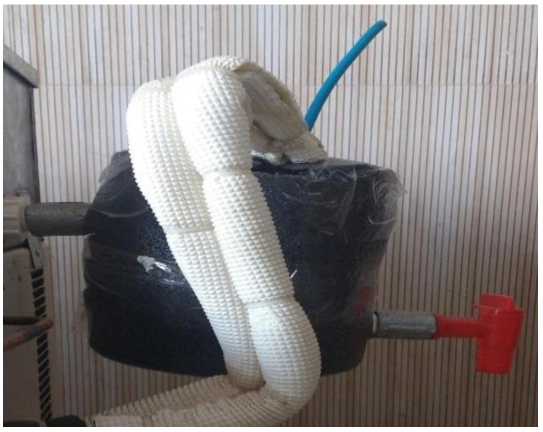
The dimensions of the tank are as follows:-

The diameter of tank = 15 cm

Height of the tank = 17cm

Tank for the cold water of waste heat recovery system.

This tank actual provides the cold water from the waste heat of the Window Air Conditioning system. The fig shows the actual design of the cold water storage tank, the dimensions of this tank are as that of hot water storage tank



Photograph 3 Cold water storage tank

Sizing the tubes:

The tubes used are all of ½ inch diameter; hence they cant be inserted one into another directly. To do this, tube sizing method is used. This is done by first clamping the tube in the tube clamp. Then the diameter of one tube is increased just so that other tube will get fixed into it.

TESTING AND PERFORMANCE EVALUATIONS OF WHRS

Test Procedure:
The test includes following parameters
1.DBT and WBT at inlet air section
2.DBT and WBT at outlet air section
3.Suction pressure (Before compressor)
4.Discharge pressure (After compressor)
5.Temperatures after compression, condensation, expansion and evaporation.
6. Manometer reading.

Operating procedure:
Connect the supply cable to regulate /stabilized power supply.
2.Switch on the main switch.
3.Put ON the AC.
4.Let the AC run at least for 10 minutes before taking first set of readings.
5.Record the DBT and WBT at the inlet and at the outlet of the air passage.
6.Record the energy meter reading.
7.Record suction and discharge pressures.
8.Record refrigerant temperatures at various locations viz; before and after compression and before and after expansion.

Leak test:-
It is very important to conduct the leakage test after fabricating the modified Window AC circuit. This leakage test helps us to confirm that the system is leak proof. If the system is leak proof the experimental results will give some meaningful results. During the leakage test all the brazed joints were checked properly. The soap solution was utilized for the test. The refrigerant is filled in the circuit at proper quantity and discharge valve is closed properly. The system is started and the soap solution is applied on all brazed, flared joints and refrigerant circuit. If the bubbles are observed then the location of the bubbles is marked for the repairing.
The leakage has been removed from the identified location by proper methods and the system has been again checked for the leakage test. After completion of this it is confirmed that there is no leakage and the system was made ready to perform the test. In this way the leakage test was carried out and a leak proof assembly was fabricated.

Payback period:
Additional expenditure on waste heat recovery system is cost of heat exchanger and fabrication charges are around 16000 Rs.
For case 1
Cost of LPG can be saved is Rs 9856.
Payback period = Expenditure / saving per year
= 16000 / 9856
= 16 months
For case 2
Electricity bill can be saved is Rs 8640 Payback period =
Expenditure / saving per year
= 16000/8640 = 20 months

Conclusion:
"Waste heat recovery system" is an excellent tool to conserve available energy. An attempt is made to recover the waste heat from 1TR window air conditioner for domestic and commercial purpose. Recovered heat can be utilized as water heater, grain dryer food and snacks warmer, so one can save lot of time and energy also. The study provides the following conclusions:
1.Suitable heat recovery system can be designed and developed for every window air conditioner

2.The experimentation has shown that such a system is practically feasible.
3.The hot water outlet temperature can be achieved up to 550C.
4.The cold water outlet temperature can be achieved up to 150C.
5.Technical analysis has shown that it is economically viable.
6.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 to day function.
7.The operating pressure of the compressor is reduced; hence the power consumption of window air conditioner is also reduced. Therefore it can be said as energy efficient system.

FUTURE SCOPE

This system can be employed where the vapor compression refrigeration is used at domestic and at industrial levels.
1. We can increase the tank size of the WHRS but it will take time for cooling and heating
2. By using automatic water level control system we can keep the water level constant.
3. The Performance of the system can be increased by using water cooled condenser

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