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Experimental Investigation of 1.5 Tonne Air Conditioning System by using Heat Pipe

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ABSTRACT

Energy is one of the basic requirements for existence and performance of human life. Heat pipe are popular in applications such as air conditioning, space technology, electronics, cooking etc. An exhaustive review on heat pipe for split air conditioning system is conducted in the present project. This project deals with the experimental investigation of 1.5 tonne air conditioning system by using heat pipe heat exchanger. Based on this study, the application of a heat pipe heat exchanger in the conventional air conditioning systems is recommended as an efficient means for energy savings and simultaneous room space cooling and water heating to maintain acceptable room conditions. This Project gives the idea about various parameters and methods that used for water heating, heat recovery applications and energy saving. The experimental result showed that the heat pipe heat exchanger is capable for producing 100 liters of hot water in one hour of time with temperature of 52^{o}c.

Keywords-- Project, environment, temperature

I. INTRODUCTION

This Energy saving is one of the key issues not only from the view of energy conservation but also for the aegis of global environment. Waste heat is the heat generated all along most of the operations of system and then it is dumped into the surroundings even though it could be still utilized for some other beneficial and remunerative purposes. Waste heat is usually correlated with waste streams of air or water and it put into the environment. Recovery of waste heat is a hefty research area among majority of scientists. The temperature of the thriftiness heat plays a hefty role in recovery of waste heat. Waste heat which is repudiated from a process at a temperature higher than atmospheric temperature can be dexterously and efficaciously procured and bestowed for some other profitable work. The technique of culling the waste heat relies upon the temperature of waste heat and the purpose for which the heat is extracted. Due to scorching summer in India people suffer a lot and most of the people would aggrandize Air conditioning system for their comfort. Air conditioner consumes lavish amount of electricity and so it rejects voluminous amount of heat in the condenser. There are millions and billions of Air conditioning system in the universe. So the heat rejected from the air conditioners would be the root cause for global warming. On concentrating in this issue, we came across the effective and expedient solution. The solution is that usage of waste heat which is repudiated from the condenser of the air conditioning unit. This solution uses the heat efficaciously for some other beneficial work and also bulwark the environment. For this water cooled condenser is employed in the air conditioning system.

This project focuses on production of hot water for various applications using waste heat repudiated by the air conditioning system. We designed a system for effective Apprehending of waste heat which goes to the surroundings. Circulating chamber is erected and the tube is fitted between circulating chamber and water cooled condenser. Insulated tank is implemented for cumulating of the hot water for later use. The insulated pipes are fitted which connects the circulating chamber and insulating tank. Researchers are going on in the field of waste heat recovery. Our confabulation is about waste heat recovery in 1.5 TR air conditioning systems by heat pipe heat exchanger.

The considerable amount of heat is repudiated from the condenser unit and it is utilized for the generation of hot water and it is supplied where the demand of hot water exists. Results of the production of hot water and production time and temperature are briefly deliberated and explained. Establishes a vapor flow pattern. Capillary action within the wick returns the condensate to the evaporator (heat source) and completes the operating cycle. This system, proven in aerospace applications, transmits thermal energy at rates hundreds of times greater and with a far superior energy-to-weight ratio than can be gained from the most efficient solid conductor.

A heat pipe is a device that efficiently transports thermal energy from its one point to the other. It utilizes the latent heat of the vaporized working fluid instead of the sensible heat. As a result, the effective thermal conductivity may be several orders of magnitudes higher than that of the good solid conductors.

A heat pipe consists of a sealed container, a wick structure, a small amount of working fluid that is just sufficient to saturate the wick and it is in equilibrium with its own vapor. The operating pressure inside the heat pipe is the vapor pressure of its working fluid. The length of the heat pipe can be divided into three parts viz. evaporator section, adiabatic section and condenser section. In a standard heat pipe, the inside of the container is lined with a wicking material. Space for the Vapor travel is provided inside the container.

II. EXPERIMENTAL SET-UP

Construction:-

The experimental set-up mainly consists of 1.5 tonne air conditioner with a Rotary compressor, evaporator, water cooled condenser, compressor, water tank. The overall experimental set-up is shown in Figure 1 as a block diagram.

Fig.1:- Experimental Setup

A water cooled condenser recovers waste heat from the system also functions as a heat pump or a heat pipe.

The whole experimental set-up used for the experimental study is shown in Figure.1 In the present experimental investigation, refrigerant R-22 is used as a refrigerant for the system. Suction pressure, temperature, discharge pressure and temperature of the refrigerant of the system with water cooled condenser is measured by pressure gauges and temperature sensors which are fitted at both the ends of the compressor as shown in Figure.2 Power consumption by the compressor is found by using an energy meter. Regarding the water cooled condenser, it consists of copper tube coils which are immersed in the hot water tank. The water tank is made of plastic. The dimensions of the water tank were chosen the dimensions of condenser. As shown in Figure, the copper coils are submerged in the water cooled condenser. The plastic pipe is of length 3 feet, and diameter 180 mm capacity.

Evaporator is placed in the room. Room temperature is kept at 30^0c, 28^0c and 26^0c. The suction pressures, temperatures, discharge pressures, temperatures at the compressor inlet and outlet for the different conditions of indoor temperature are noted. The temperature at the condenser outlet is also noted to calculate the heat rejected in the condenser for the same conditions. The power consumption by the compressor is determined by the wattmeter by noting the number of revolutions from it. For every 10 minutes readings are noted experimentally from the system. The power consumption and COP of the system with air cooled condenser and water cooled condenser is determined by adopting the above procedure separately for the systems with air cooled condenser water cooled condenser respectively. The COPs of the both the systems determined were compared. The initial and final temperatures of the water in the tank were noted. Thus the rate in which the water is heated is calculated for three different conditions of indoor temperature. The influence of water temperature on the COP of the system was investigated. The above processor for water cooled condenser after fitting the water tank.

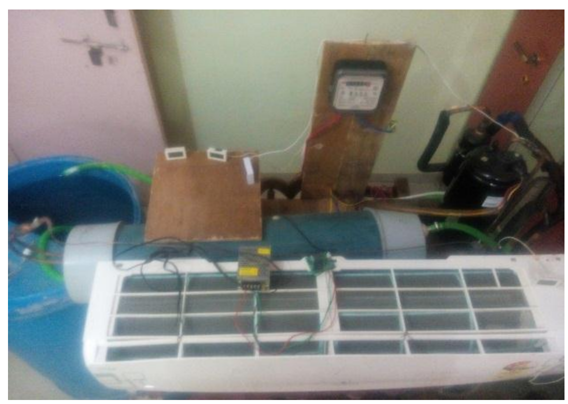

Fig.2:-Experimental Investigation of 1.5 tonne air coinditioning system.

Working:-

The whole system deals by utilizing the waste heat energy discharged by the condenser. This system consists of several processes to achieve the desired output. An Air Conditioner mainly consists of four parts as Condenser, Expansion valve, Evaporator and Compressor. In normal Air Conditioning the process proceeds by compressing the working substance where the input energy is fed to the Air Conditioner and this working substance then enters the condenser where the heat energy releases at a certain rate. Then it is subjected to expansion valve where isentropic process takes place and the temperature and pressure of the working substance is drastically reduced. This will absorb the heat energy in the leeway and which takes place in the cooling coil and the air in the leeway is also ventilated and which is then compensated by letting the fresh air in a desired mass flow rate.

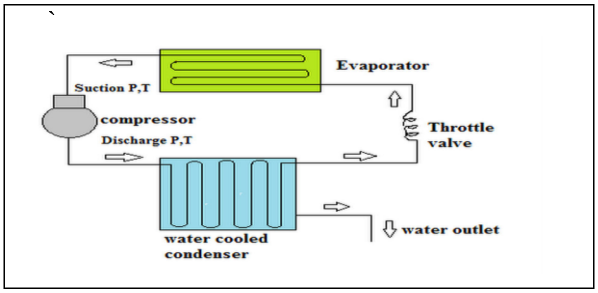

Fig.3:- Block Diagram

In the process stated above this paper mainly focuses on utilizing the waste heat discharged at the outlet. The waste heat is utilized by transferring the heat to the water and using it in many ways. In the first stage the calculated quantity of water is filled in the tank via inlet and the volume of the water remains fixed until it reaches the calculated temperature. The water from the tank is then circulated in a water cooled condenser. Condenser coil is placed in the condenser. Circulating water absorbs the heat rejected by the condenser and the heat is added by constant volume process. The temperature of the circulating water increases to the calculated temperature. When the desired temperature is reached in the circulating water it is then drained into the separate insulated storage tank. Suddenly fresh water will be filled into the tank as mentioned in the first stage and this process continues as whenever the Air Conditioner operates. Thus this large quantity of water is stored in the storage tank. Pipes can be connected from the tank to the household appliances. Thus the vegetables and raw materials for cooking can be washed cleanly in the hot water. This hot water is obtained by the waste heat rejected by the condenser. Thus is more economic process of obtaining the hot water. Water is the main course in each and every cooking. Hence utilizing hot water will save energy such as Liquefied Petroleum Gas, electrical energy in case of using an induction stove. This system can also applied in the hospitals for washing the patients clothes in hot water will save energy and also reduces the cost of washing. Furthermore if need for the temperature of the water is high then one should have a good refrigerant as a working substance otherwise the water to be drained in the insulated tank should be raised to a temperature of a desired level.

- Mass flow rate of refrigerant = capacity in KW/(h_1-h_4)
- Refrigeration Effect (Re) = (h_1-h_4)
- Compressor work (W)= mr×(h_2-h_1)
- Heat rejected in compressor = mr×(h_2-h_3)
- Power consumption by the compressor (w)=300×n /3600×t
  N = number of revolutions of compressor.
  T = time taken for n revolution in seconds.
- Coefficient of performance(COP)=$(h_1-h_4)/(h_2-h_1)$

Where,
h_1=Enthalpy at the beginning of compression in KJ/Kg
h_2= Enthalpy at the end of the compression in KJ/Kg
h_3= Enthalpy at the beginning of the expansion in KJ/Kg
h_4= Enthalpy at the end of the expansion in KJ/Kg
By using the above formula the COP, power consumption of the system with air cooled condenser and water cooled condenser is found out.

- Heat transfer in tank Q = m ×Cp ×(T2-T1)

M = mass flow rate in water in kg/sec
Cp=specific heat capacity of water in KJ/Kg K
T2 = final temperature of water in ^{o}C
T1 = initial temperature of water in ^{o}C

III. RESULTS AND DISCUSSION

Table 1

TIME Vs. HEAT TRANSFER :-		30 DEGREE

Heat Transfer rate of water cooled condenser at 30^{0}c				
Room Temp	10 min	20 min	30 min	40 min
30 Degree	40.9	44.1	46.8	50

TIME Vs. HEAT TRANSFER :-		28 DEGREE

Heat Transfer rate of water cooled condenser at 28^{0}c				
Room Temp	10 min	20 min	30 min	40 min
28 Degree	41	44.5	47.3	50.7

TIME Vs. HEAT TRANSFER :-		26 DEGREE

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Heat Transfer rate of water cooled condenser at 26^0c				
Room Temp	10 min	20 min	30 min	40 min
26 Degree	38.7	42	44.3	47.7

Heat Transfer Calculation :-		30 DEGREE

Table 2

TIME	m	Cp	t_2	t_1	$Q=m\times Cp\times(t_2-t_1)$
10 min	7	4.187	40.9	33.6	213.9557
20 min	7	4.187	44.1	35.8	243.2647
30 min	7	4.187	46.8	38.5	243.2647
40 min	7	4.187	50	41.2	257.9192

Heat Transfer Calculation :-		28 DEGREE

TIME	m	Cp	t_2	t_1	$Q=m\times Cp\times(t_2-t_1)$
10 min	7	4.187	41	33.5	219.8175
20 min	7	4.187	44.5	35.8	254.9883
30 min	7	4.187	47.3	38.3	263.7812
40 min	7	4.187	50.7	41.1	281.3664

Heat Transfer Calculation :-		26 DEGREE

TIME	m	Cp	t_2	t_1	$Q=m\times Cp\times(t_2-t_1)$
10 min	7	4.187	38.7	31	225.67
20 min	7	4.187	42	33.2	257.91
30 min	7	4.187	44.3	35.2	266.71
40 min	7	4.187	47.7	38.3	284.29

ENERGY METER READING :- 30 DEG

Table 3

Room Temp	10 min	20 min	30 min	40 min
30 Degree	0.2 kwh	0.2 kwh	0.3 kwh	0.4 kwh
Reading	5.8 to 6.0	6.0 to 6.2	6.2 to 6.5	6.5 to 6.9
1.2 Units				

ENERGY METER READING :- 28 DEG

Room Temp	10 min	20 min	30 min	40 min
28 Degree	0.2kwh	0.4kwh	0.3kwh	0.3kwh
Reading	7.0-7.2	7.2-7.6	7.6-7.9	7.9-8.2
1.2 Units				

ENERGY METER READING :- 26 DEG

Room Temp	10 min	20 min	30 min	40 min
26 Degree	0.3 kwh	0.2 kwh	0.3 kwh	0.4 kwh
Reading	8.5-8.8	8.8-9.0	9.0-9.3	9.3-9.7
1.2 Units				

Room Temp 30 Degree	h_1	h_2	h_4	COP=$(h_1-h_4)/(h_2-h_1)$
water temperature 40.9^0C	261000	265000	260000	0.25
water temperature 44.10C	261000	265000	260000	0.25
water temperature 460C	261000	265000	260000	0.25
water temperature 50^0C	261500	266000	260000	0.33

Room Temp 28 Degree	h_1	h_2	h_4	COP=$(h_1-h_4)/(h_2-h_1)$
water temperature 41^0C	261000	265000	260000	0.25
water temperature 44.5^0C	261000	264000	260000	0.33
water temperature 47.3^0C	261000	264000	260000	0.33
water temperature 50.7^0C	261000	264000	260000	0.33

Room Temp 26 Degree	h_1	h_2	h_4	COP=$(h_1-h_4)/(h_2-h_1)$
water temperature 41^0C	260000	266000	259000	0.16
water temperature 44.5^0C	260000	267000	258000	0.28
water temperature 47.3^0C	260000	266000	258000	0.33
water temperature 49.7^0C	260000	266000	258000	0.33

From Figure 4 and table no 2 it is observed that the time taken for heating of water is less for a lower room temperature of 26°C, when compared to higher room temperatures of 30°C, 28°C. This is due to the reason that, a large amount of heat is rejected from the water cooled condenser for a lower room temperature of 26°C, when compared to higher room temperatures. So the rate of heating of water occurs at a faster rate for a lower room temperature than for higher room temperatures. The water temperature increases with the increase in time. It is seen that with the increase in room temperature the rate of heating of water decreases.

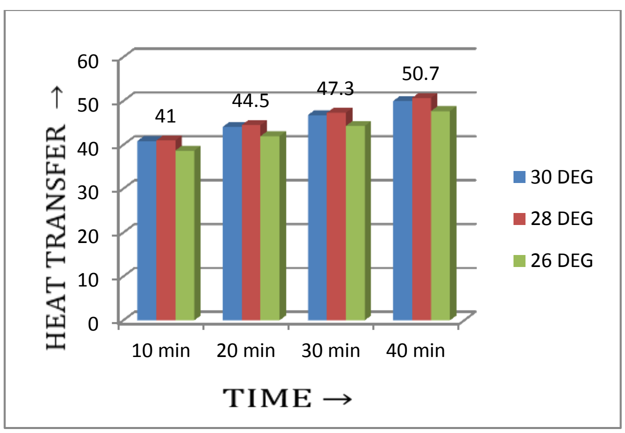

Fig. 4: - Time Vs. Outlet Temp of water

Form the Figure 5, and table no 4 it can be seen that the compressor power for room temperature of 30°C is higher than that for room temperatures of 28°C and 26°C. With the increase in room temperature and hot water temperature the compressor power consumption of system with the water cooled condenser increases. For higher room temperatures the work done by compressor is high, so the power consumption of the compressor is high for high room temperature. The compressor power increases with the increase in water temperature.

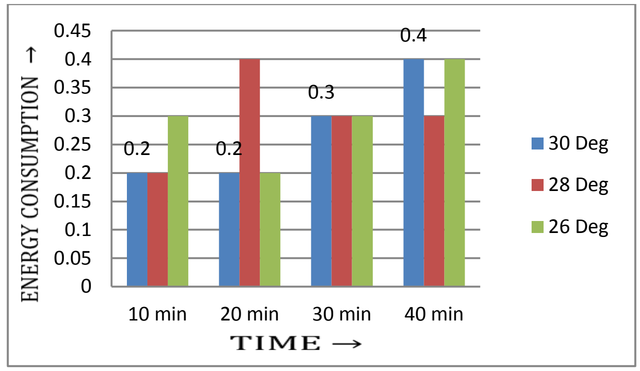

Fig. 5:- Time Vs. Energy Consumption

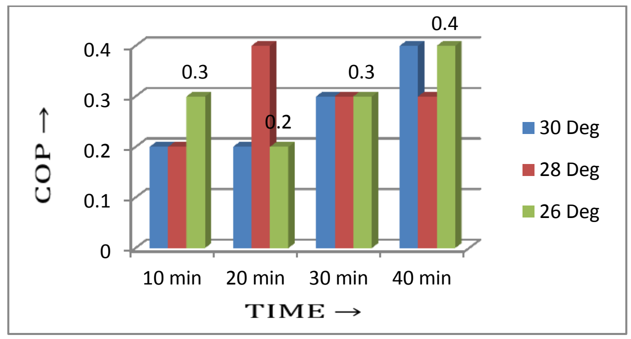

Fig: - 6 Time Vs. COP

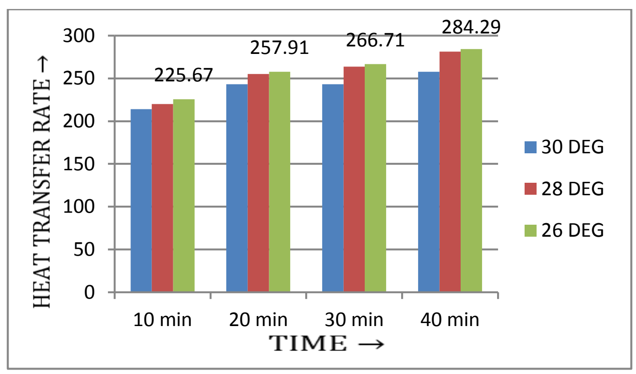

Fig. 7: - Time Vs. Heat Transfer

From the Figure 6, and table No it is clear that for room temperatures of 30°C, 28°C, 26°C COP of the system decreases gradually with the increase in room temperature. The COP of the system is higher for a room temperature of 30°C than for 28°C and 26°C. The COP of the system is higher for a higher room temperature when compared with lower room temperature. With the decrease in room temperature, the COP of the water cooled condenser decreases.

IV. CONCLUSION

During the experimental investigation on the performance of the water cooled condenser (heat pipe) using waste heat recovery from a 1.5 tonne air conditioning system, the results showed that the water cooled condenser is capable of producing 100 litres of hot water in one hour of time with a temperature of 52°C. The COP of air conditioner with water cooled condenser is more than the COP of air conditioner with air cooled condenser till the water in the tank attains a temperature of 37°C. But after 37°C of temperature of hot water, due to improper condensation of refrigerant the COP of the system with water cooled condenser decreases and becomes less than the COP of air conditioner with air cooled condenser. The COP of the system with water cooled condenser decreases with the increase in temperature of the water in tank.

The power consumption of air conditioner with water cooled condenser is less than that of the air conditioner with air cooled condenser till the water in the tank attains a temperature of 37°C. After 37°C of temperature of hot water, the power consumption of air conditioner with water cooled condenser increases than that of the air conditioner with air cooled condenser. The rate in which the water is heated is maximum for minimum room temperature due to maximum heat rejection from the condenser at that condition. This water heater could also eliminate the need for a separate water heater and there by an enormous energy can be saved. By using this device, energy efficiency can be improved by cutting the costs for heating water.

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REFERENCES

[1] T. S. Jadhav, M. M. Lele, (2015), Theoretical energy saving analysis of air conditioning system using heat pipe heat exchanger for Indian climatic zones, *Engineering Science and Technology, an International Journal*, 18, 669-673.

[2] Liang CH, Zhang LZ, Pei LX, (2010) Independent air dehumidification with membrane based total heat recovery, modeling and experimental validation, *International Journal of Refrigeration*, 33, 398–408.

[3] M. Ahmadzadehtalatapeh, (2013), An Air-conditioning system performance enhancement by using heat pipe based heat recovery technology, *ScientiaIranica*, 20 (2), 329-336.

[4] Ehsan Firouzfar, Mohammad Soltanieh, S. HossienNoieand M. Hassan Saidi, (2011), Application of heat pipe heat exchangers in heating, ventilation and air conditioning (HVAC) systems, *Scientific Research and Essays*, Vol.6(9), pp. 1900-1908.

[5] Y.H. Yau, M. Ahmadzadehtalatapeh, (2010), a review on the application of horizontal heat pipe heat exchangers in air conditioning systems in the tropics, *Applied Thermal Engineering*, 30, 77-84.

[6] Wang Yu, You Yuwen, Zhang Zhigang. Experimental Investigations on a Conventional Air conditioner Working as Air-water Heat Pump. Procedia Engineering. 2011; 23: 493–97.

[7] Ming Liu Jiang, Jing Yi Wu, Yu XiongXu, Ru Zhu Wang. Transient characteristics and performance analysis of a vapor compression air conditioning system with condensingheat recovery. Energy and Buildings. 2010; 42:2251–57.

