STUDY OF PERFORMANCE PARAMETERS OF INCLINED HEAT PIPE FITTED WINDOW A/C SYSTEM

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Abstract: *This paper principally covers experimental investigation of the impact of fitting a heat pipe in associate air window cooling system. a traditional cooling system consumes 30-35% of energy in reheating the overcooled air. A heat pipe is can be used to reheat the overcooled air gaining heat from the hot air going away from the condenser. this investigation studies the impact of fitting an inclined heat pipe in a very 1.5 Ton window air conditioning. the heat pipe is fabricated using copper pipe as the container, R-11 as the fluid and cotton as wick material. it's been discovered that use of heat pipe in air conditioning has substantial impact if used at correct location.*

IndexTerms - Heat pipe, Window AC, Heat addition & removal, Performance Analysis.

Nomenclature

DBT – Dry Bulb Temperature

WBT - Wet Bulb Temperature

RH - Relative Humidity

KWH - Kilo-Watt Hour

Tr - Room Temperature

Te - Evaporator Temperature

Tc - Condenser temperature

Ta - Ambient Temperature

Wc –Compressor work.

Qa -Heat Absorbed.

Qr -Heat Rejected.

Qe - Heat absorbed in Evaporator.

Qc - Heat rejected in Condenser.

COP -Coefficient of Performance

1.1 INTRODUCTION-

The idea of heat pipes was given 1st by Gaugler (1994) General Motor Company in 1942. the primary heat pipe was designed and made by Grover (1966) in National research laboratory, Los Alamos, within the America in 1964. Since then, heat pipes are being employed in several applications such as: heat exchangers (air pre-heaters or systems that use economizers for waste heat recovery), cooling of electronic parts, solar power conversion systems, space vehicle thermal management, cooling of turbine rotor blades, etc.

Nowadays, surroundings pollution and limitations in energy resources have appeared as a significant world crisis. Therefore, energy conservation and energy potency are necessary for all told energy consuming devices as well as the air conditioning systems. As an economical heat exchanger, heat pipe heat exchangers are taking part in a substantial role in numerous fields together with air conditioning systems. Heat pipes are easy heat transfer devices with high, effective thermal conduction and therefore the capability to move an outsized quantity of heat over appreciable distances[1.2].

1.2 LOCATION OF HEAT PIPE

The location of heat pipe in the system is such that maximum heat can be extracted and supplied without any heat loss. One end of heat pipe (evaporator) is placed behind the condenser; at bottom left corner and the other end i.e. condenser end is placed in the cold air stream supplied to the room. The inclination angle of heat pipe with the horizontal is 45 ^{0}.

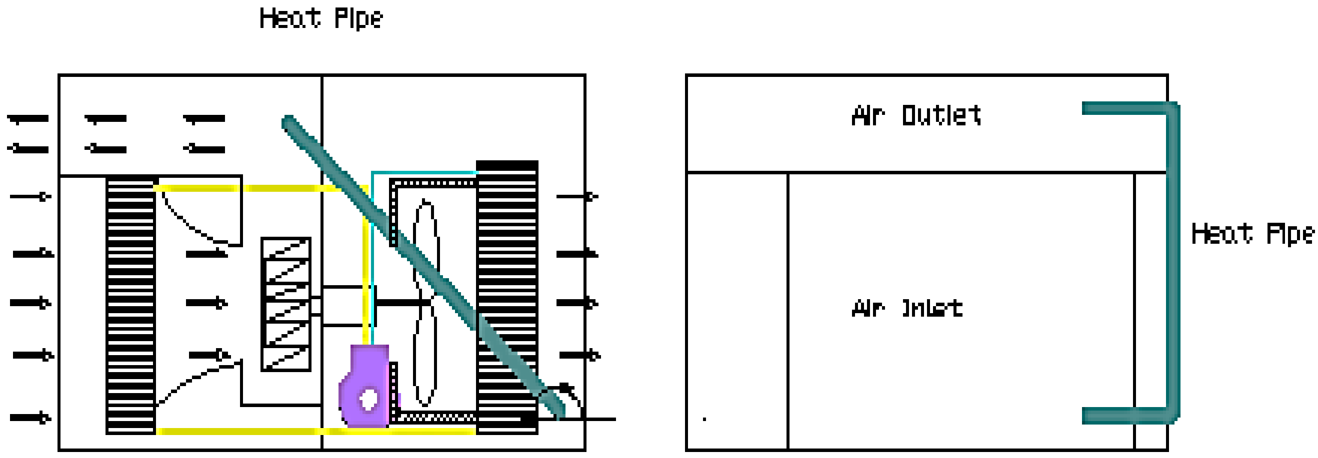


Fig 1.1 Experimental setup (Location of Heat Pipe in air conditioner)

1.3 METHODOLOGY

The first step was to measure the data by taking trial on window air conditioner.

1) The initial space temperatures dry bulb and wet bulb were measures with the assistance of mercury thermometers.

2) The temperatures of cold air coming out from air conditioner were also measured using mercury thermometers.

3) The condenser temperature was measured using a portable digital temperature indicator.

4) The energy meter reading was recorded in KW.

5) The velocities of air at evaporator outlet and condenser exit were measured using a digital anemometer in m/s.

6) The heat pipe was designed and fictitious as per the need. The data is collected for each the cases, while not heat pipe and with heat pipe.

1.4 CALCULATIONS PERFORMED

For given ambient and room conditions, it is possible to obtain the instantaneous room cooling load using the thermodynamic model of the room. Using the condenser temperature T (cond), ambient temperature T(ambient), it is possible to determine the heat rejection at the condenser. Once the heat rejection at the condenser and the heat removed in the evaporator are known, the compressor work may be determined using the energy balance condition.

The difference between the instantaneous cooling capacity and the instantaneous cooling load can be considered to be the capacity available to lower the room temperature. To obtain an accurate estimate of the heat flows involved, it is necessary to know not only the dry bulb temperature of the room at any time, but also the corresponding wet bulb temperature (or relative humidity). The psychometric model of the room, which relates the sensible heat ratio of the room loading line and the supply condition enables determination of the wet bulb temperature of the room at any given dry bulb temperature (assume that the increase in temperature continually happens on the sensible heat ratio line).

1) Coefficient of performance (COP) = $\frac{T_C}{T_C - T_e}$

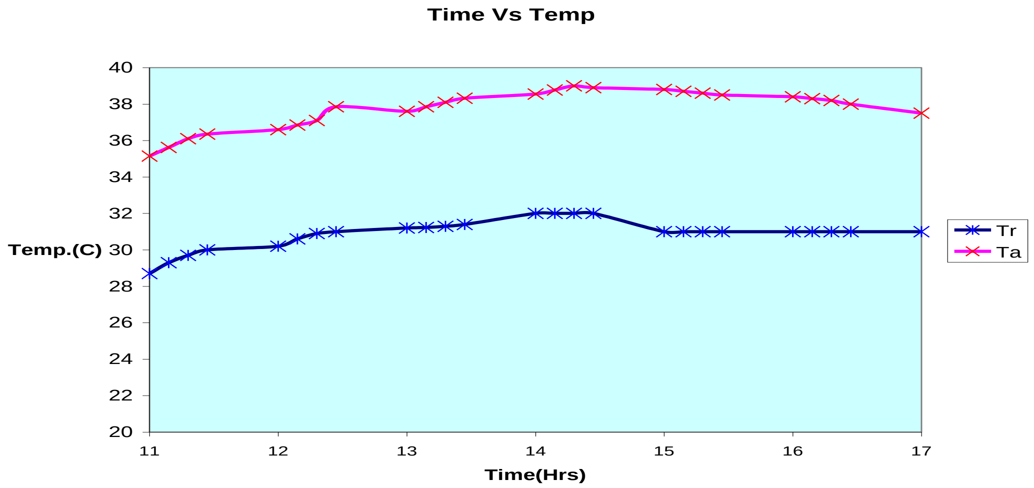
2) Heat Absorbed (Qa) = $M_a * C_{pa}(T_r - T_e)$

3) Heat Rejected (Qr) = $M_a * C_{pa}(T_c - T_a)$

4) Compressor Work =Heat Absorbed-Heat Rejected = $(Q_r - Q_a)$

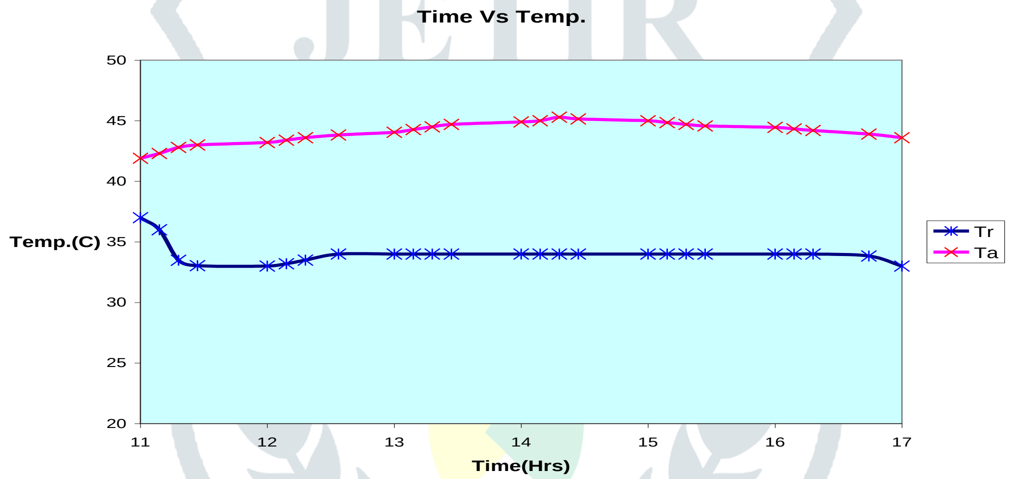
1.5 RESULTS ANALYSIS

This chapter main concentrates and discusses the results obtained after conduction of various trial on window air conditioning system fitted with heat pipe and w/o heat pipe.



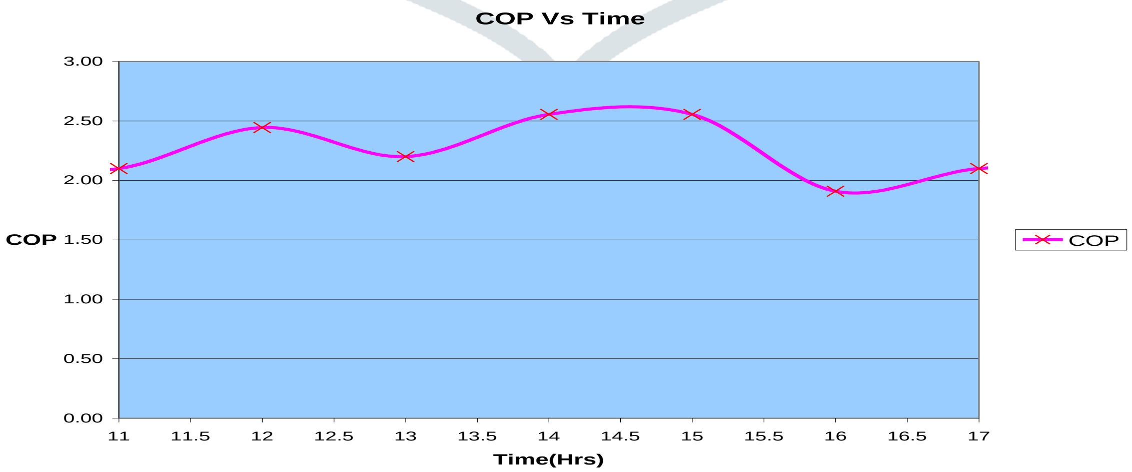
Graph. 1.1 Variation of temp. (°C) Vs time w/o heat pipe

Graph 1.1 shows the variation of room temperature and ambient temperature with time without heat pipe. As the ambient temperature increases with time the room temperature stabilizes after initial rise.



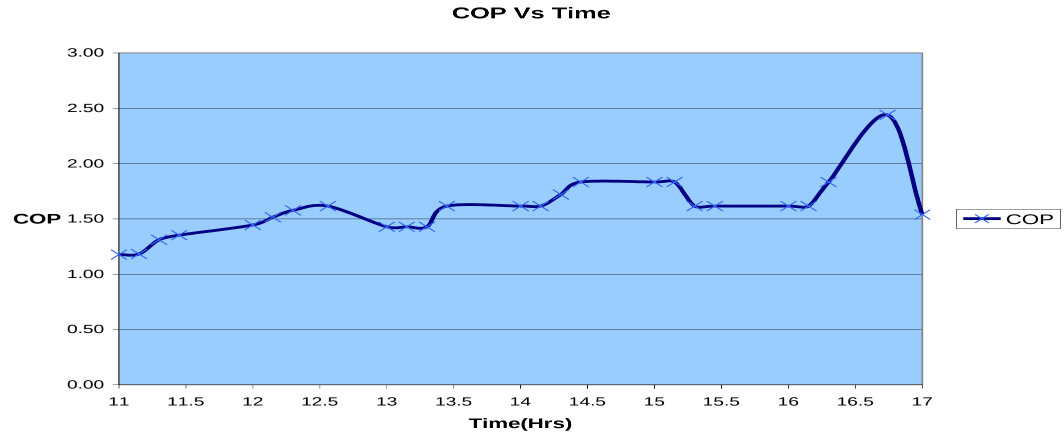
Graph. 1.2 Room temp. (°C) Vs time with heat pipe

Graph 1.2 shows the variation in room temperature and ambient temperature with time after the fitment of heat pipe. The graph shows that the room temperature shows a decreasing trend initially but it again stabilizes due to addition of heat by heat pipe at the latter stage.



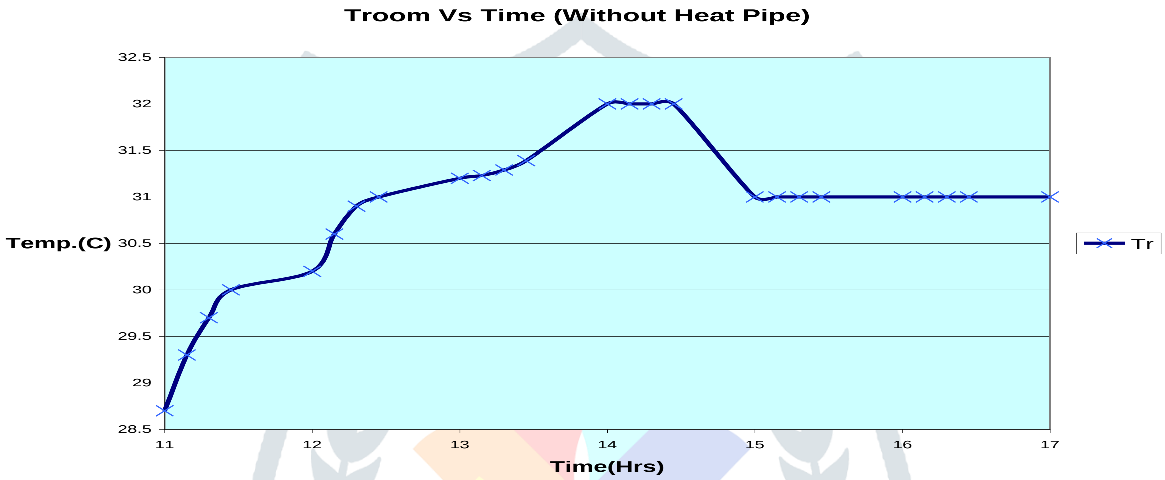
Graph. 1.3 COP Vs time w/o heat pipe

Graph 1.3 does not present a fair view about the trend of COP possibly due to intermittent opening of door of the room and the power break downs. However, the trend is stable one.



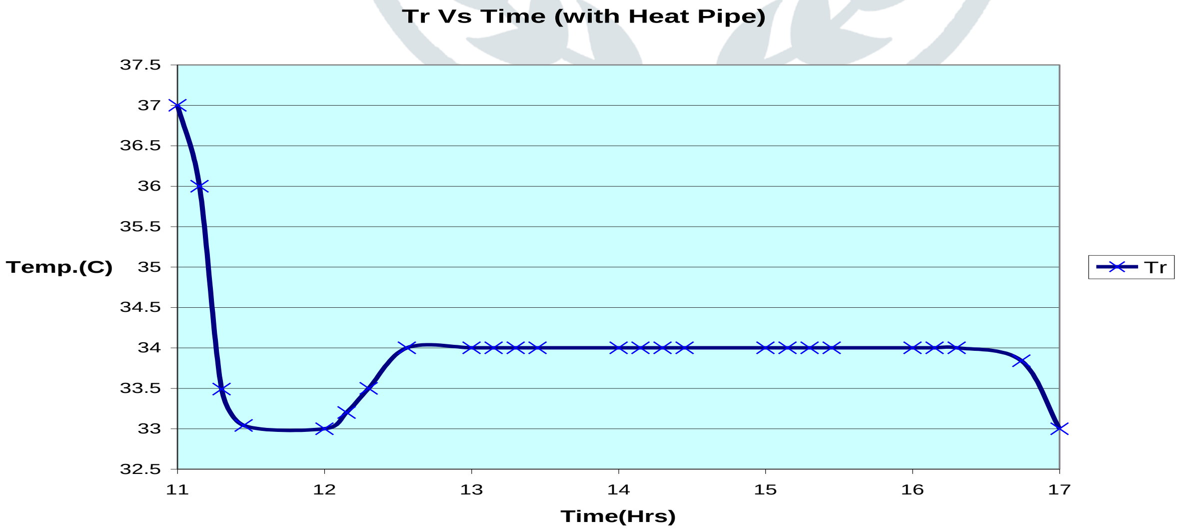
Graph. 1.4 COP Vs time with heat pipe

Graph. 1.4 shows the variation of COP with time after the installation of heat pipe. Though the graph is quite fluctuating in nature, it is showing an increasing trend in COP of system.



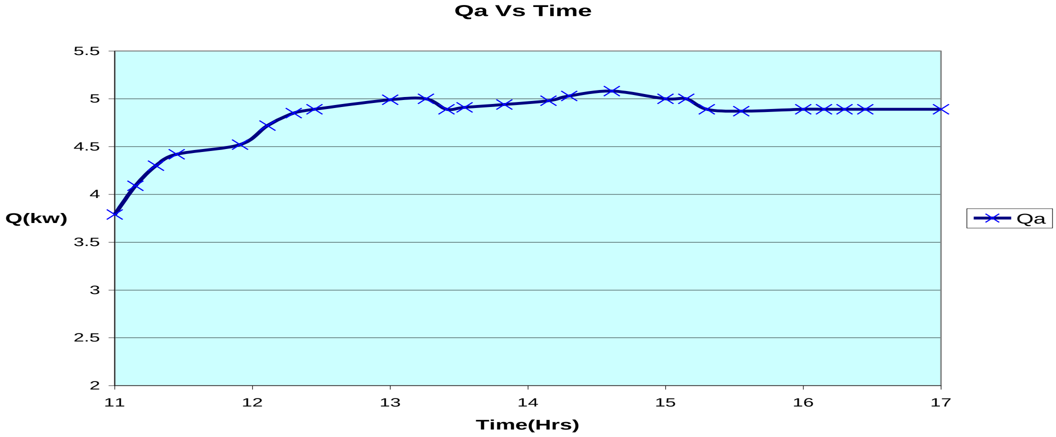
Graph. 1.5 Room temperature(ºC) Vs time w/o heat pipe

Graph 1.5 shows the variation of room temperature with time. It goes against the general trend of decreasing room temperature. But in the latter part of graph it shows the decreasing trend. The graph shows that the ac was unable to meet the load in the earlier stage but managed to overcome in the latter part of the graph.



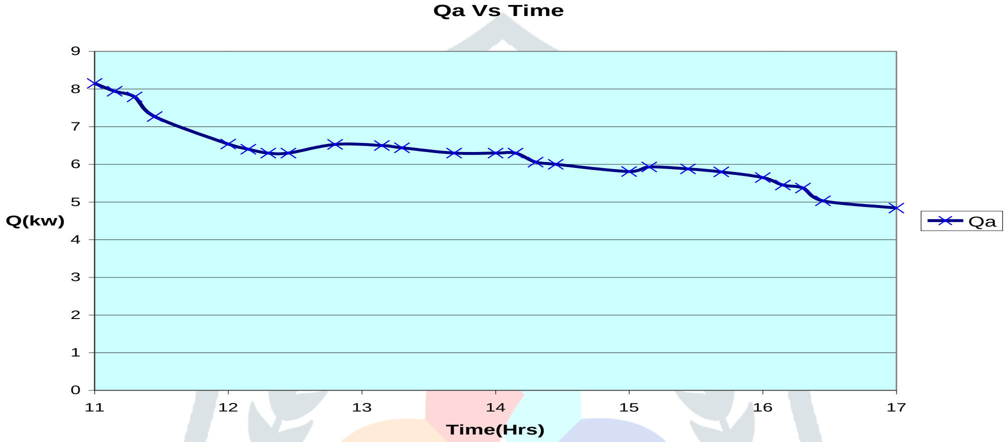
Graph. 1.6 Room temperature(ºC) Vs time with heat pipe

Graph 1.6 shows the variation of room temperature with time after fitting heat pipe. Differing from the earlier graph, this graph shows reducing trend in the room temperature. There is steep decrease in the room temperature, and then there is slight increase in room temperature due to heat addition by heat pipe. The temperature stabilizes and shows again a reducing trend at the end.



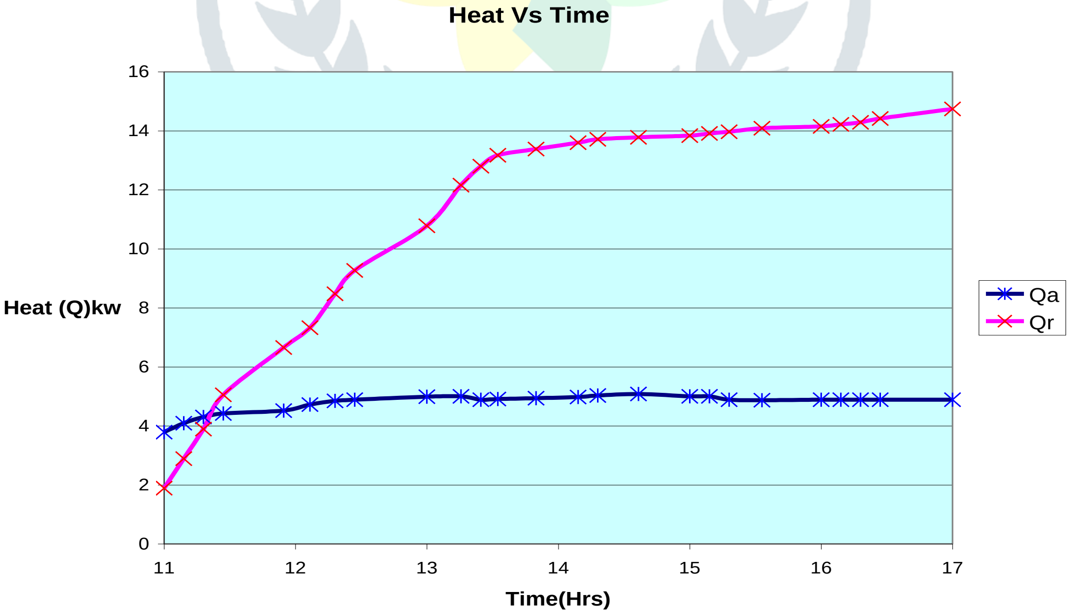
Graph. 1.7 Variation of Heat absorbed Vs time w/o heat pipe

Graph 1.7 shows the variation in heat absorbed with time. The graph shows a increasing trend in the earlier stage with some fluctuations it stabilizes in the end. This shows that the heat extraction was additional at the initial stage because of higher temperature difference within the space and ambient temperature.



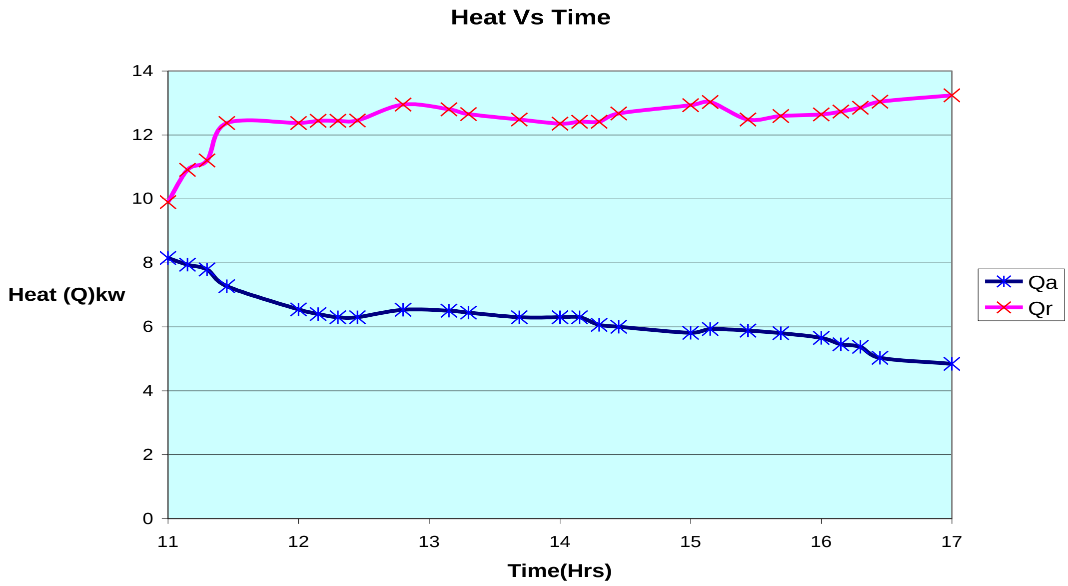
Graph. 1.8 Variation of Heat absorbed Vs time with heat pipe

Graph 1.8 shows the variation in heat absorbed after fitting the heat pipe in the system. the graph shows a negative trend in heat absorption possibly due to constant heat addition by heatpipe.



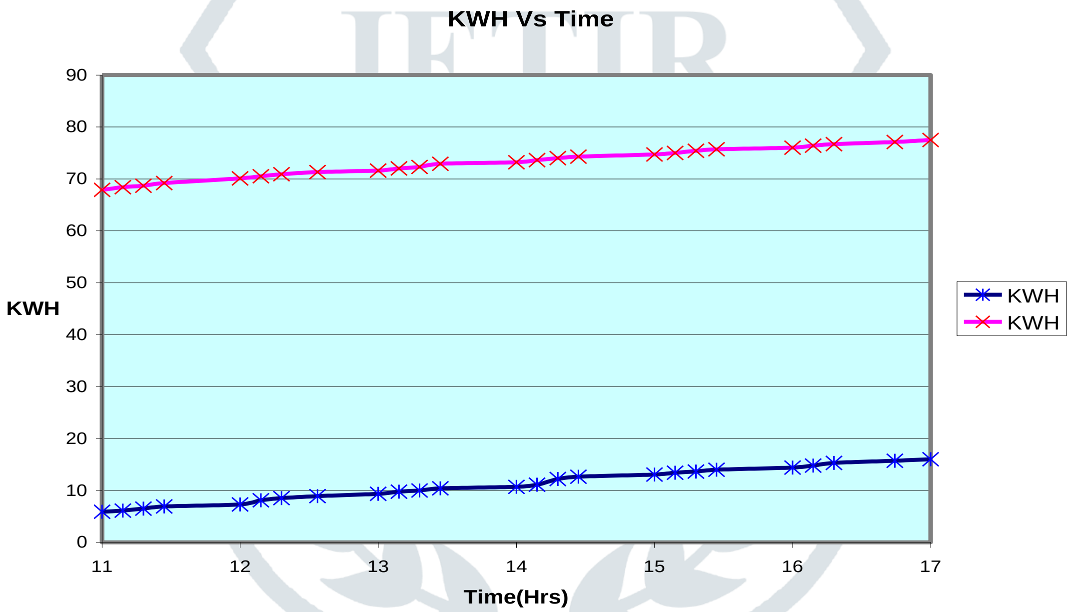
Graph. 1.9 Heat Vs time w/o heat pipe

Graph 1.9 shows the difference in heat absorbed and heat rejected by the system without heat pipe. The graph shows that the heat absorption was higher as compared to heat rejected in the initial stage. Later on heat rejection rose considerably because the condenser temperature increases.



Graph. 1.10 Heat Vs time with heat pipe

Graph 1.10 shows variation of heat with heat pipe. Heat absorbed shows a decreasing trend and heat rejected shows a increasing trend with the fitment of heat pipe.



Graph. 1.11 Power consumption Vs time

Graph 1.11 shows the variation of power consumed with time. Blue line shows power consumption pattern of unit without heat pipe. Magenta line shows power consumption with heat pipe.

1.6 CONCLUSION

An air conditioning of capability 1.5 Tons was chosen and purchased from the market. The maintenance was done to create the unit prepared for experimentation. Trial of the unit was conducted and information was gathered from the preliminary trial of the unit. As per demand the detail design of heat pipe was done. once the design of heat pipe is complete, the fabrication of heat pipe was done.

Referring to the graphs, it had been seen that there's slight rise in air temperature delivered by the air conditioning because of heat added by heat pipe. Heat pipes are often effectively used to reheat the cold air to bring it back to comfort temperature. a standard air conditioning consumes 30-35% of energy in reheating the overcooled air.

A heat pipe is used to reheat the overcooled air gaining heat from the hot air leaving the condenser. the present investigation studies the impact of fitting a heat pipe in a 1.5 Ton window air conditioning. the heat pipe is fabricated using copper pipe as the container, R-11 as the operating fluid and cotton as wick material. it's been observed that use of heat pipe in air conditioning has substantial effect if used at correct location.

1.7 REFERENCES-

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