



EXPERIMENTATION ANALYSIS ON ENERGY SAVING IN AIR CONDITIONING SYSTEM BY MEANS OF VAPOUR COMPRESSION SYSTEM WITH HEAT PIPE HEAT EXCHANGERS (HPHX)

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ABSTRACT

Energy has evolved into the lifeblood of humanity. HVAC systems, which consume more than 35 percent of energy in residential buildings, are now a vital component for supplying purified air, particularly in medical facilities but also in any modest development. As a result, lowering this proportion or regaining a portion of the energy wasted is a critical challenge in today's energy management settings. The present work focus on a Heat Pipe -Heat Exchanger (HPHX) air-conditioning by means of vapor compression system. Pressures, temperatures at several positions, electrical readings and dissimilar flow rates are some of the critical features studied. To evaluate the performance of the system, following are to constraints analyzed such as $(cop)_{theoretical}$ along with $(cop)_{actual}$, and also useful effect and amount of energy saved by the system using Heat Pipe Heat Exchanger(HPHX).

Keywords: COP, Heat pipe heat exchanger (HPHX), Temperature, energy saving, pressure.

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I. INTRODUCTION

Because of the utility of eliminating contaminated air, the substantial energy expenditure of HVAC results in Energy-Management Systems (EMS) fetching a vital issue for boosting proficiency and offering substantial savings on energy in building, particularly in connection to hospitals [1]. these days EMS has become a main priority in construction projects, with numerous studies on the BEMS (construction Energy-Management System) done over the last decade [2]. Furthermore, statistical results show that the effect of BEMS savings increases from 11.39 percent to 16.22% per year. This is owing to the efforts of ongoing research, which has resulted in improvements in this field [3]. Despite advancements and increased interest in BEMS research, it is believed that 90 percentage (%) of air conditioning arrangements do not work optimally. This illustrates the importance of building systems that are more effective and, more importantly, run at less money in order to guarantee their rapid expansion [4].

The need to reduce fuel use while creating energy has fueled research into renewable energy sources and energy management approaches [5-7]. Heat recovery is a specific path in energy management in which heat generated from diverse applications is primarily captured, as opposed to the capture of wind and solar energies, where natural resources are invested. As a result, heat recovery or collecting heat has received significant attention, specifically when it involves heating water without incurring large expenditures from the use of power, energy sources, and solar power [8-9]. Heat recovery is described as the method of collecting vitality (or heat) since a high-temperature brook and removing it to a low -temperature stream in an efficient and cost-effective manner [10].

The present works aims in evaluating the performance of air condition system with and without HPHX, minimize supply of energy to the compressor which results in globally save energy by the air conditioning system using vapor compression system along with heat pipe and heat exchanger and various refrigerants and flow rates.

II. MATERIAL SELECTION AND PROCEDURE

The VCRs is a more sophisticated sort of air refrigerant cycle that uses a refrigerant as the heat transfer or main working ingredient rather than air. For this purpose, the most widely used refrigerants as ammonia-(NH₃). The previously mentioned functioning ingredient circulates around the entire system, experiencing continual moisture loss and condensation as shown in figure 1.

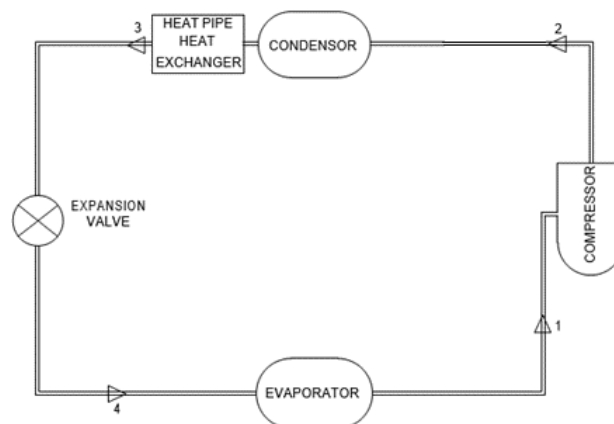


Figure 1: Line Diagram of HPHX air conditioning setup

While choosing a heat pipe material, several variables must be considered, including suitability with the fluid being used, thermal insulation, mass-to-strength ratio, and cost. Upon identifying the heat pipe's usable temperature range, the appropriate working fluid can be selected. The heat pipe's enclosing materials are picked with care to guarantee compatibility with the working fluid.

III. EXPERIMENTATION OF AIR CONDITIONING SYSTEM WITHOUT AND WITH HPHX

Both electrical and hydrodynamic components are used in the experiment. Electrical connections are most likely associated with system control and operation, whereas fluid flow connectivity is associated with the movement of some fluid, presumably a refrigerant in the air conditioning system. The compressor is an essential part of any air conditioning system. It compresses the refrigerant, causing it to heat up and expand. Starting the compressor off and leaving the system to run for a period shows that the system has reached an equilibrium or constant state. Temperature and pressure are measured at several points throughout the system. This information is critical for assessing the efficiency of the air-cooling system. Temperatures appear to be mentioned at several stages (T7 and T8), and the absence of them is caused by the absence of an exchanger for heat. The data gathered is then utilised to evaluate the efficiency of the air conditioner system. Table 1 most likely has the values that have been recorded, while you may have variables like pressure and temperature that are recorded at various locations across the system. T7 and T8 are the temperatures at specified points in the structure, yet they weren't present or measured as the system lacks a heat exchanger. The exchangers therefore devices that carry heat across two fluids and are not included in this experiment. The corresponding COP of the system is without HPHX is shown in figure 2.

Table 1: Observation values of Air condition system without Heat Pipe Heat Exchanger (HPHX)

Description	T ₁ . °C	T ₂ . °C	T ₃ . °C	T ₄ . °C	Air In T ₅ . °C		Air Out T ₆ . °C		P ₁ bar	P ₂ bar	Volt meter (Volts)	Amp meter (Amps)
					DBT	WBT	DBT	WBT				
Case – i: Air Conditioning Experiment without Heat Pipe Heat Exchanger	16	60	43	10	30	27	18	16	8	16	240	7

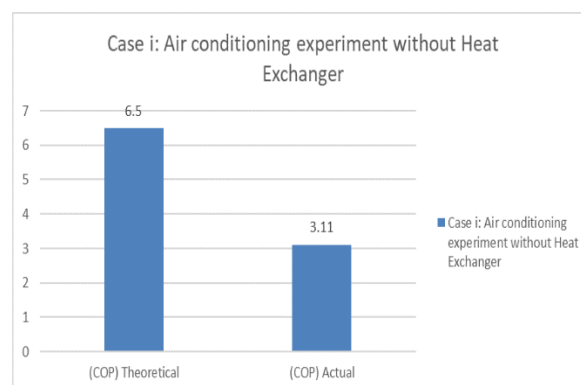


Figure 2: COP of Air conditioning without HPHX

At first, the experiment was carried out without the use of a heat exchanger. This could be used as a starting point or reference for future research with a heat pipe heat-exchanger. Heat pipe heat exchanger is introduced in the following sub-sections of your experiment. A heat pipe is an instrument that uses a phase-change mechanism to efficiently transmit heat from one place to another. The addition of an exchanger is most often intended to improve the efficiency or change the way heat is transferred of the system. The experiment employs a variety of fluids, including Ammonia. This advises looking into the effect of various fluids in use on the functionality of the heat pipe heat exchanger. Different fluids might have different thermodynamic attributes and heat transmission characteristics, which affect the total system efficiency. The study includes flow rate modifications. This parameter has a large impact on the heat transfer velocity as well as the effectiveness of an exchanger. It can be optimise system performance for various operating situations by modifying flow rates and observing how the system responds. The corresponding COP are shown in figures 3.

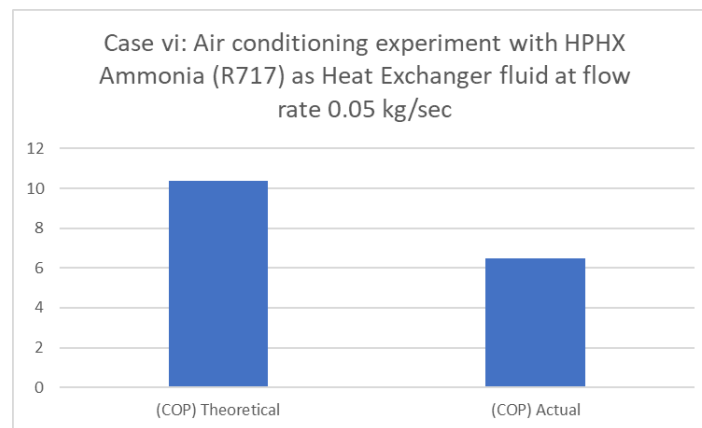


Figure 3: COP of air condition system Ammonia as a exchanger fluid

IV. RESULTS AND DISCUSSIONS

The electrical consumption of a cooling system regardless of HPHX is investigated by taking into account parameters such as COP, useful effect, and power supply to the compressor. Heat-pipe heat exchangers (HPHX) are installed in this procedure to examine the performance. The Coefficient-of-Performance (COP) is a measure of the efficiency of a refrigeration system. The refrigerant and system parameters can influence the relationship between COP and flow rate as shown in figure 4. The amount of heat moving across the network may decrease when the flow rate decreases. Slower flow patterns improve heat absorption or reject in both the evaporator and condenser coils and leading in a more efficient heat exchange process.

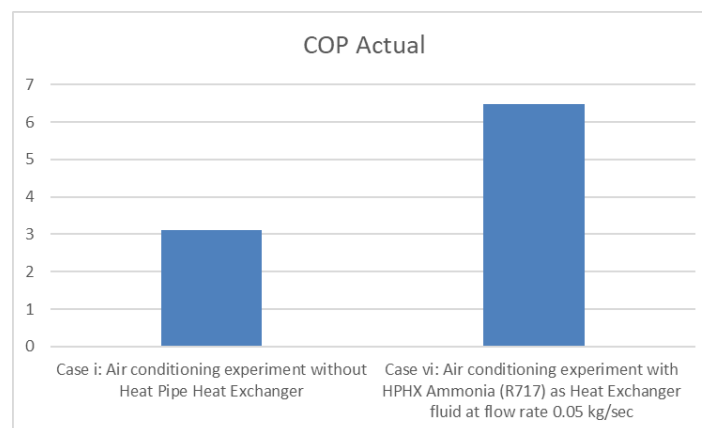


Figure 4: COP actual of air conditioning system with and without HPHX

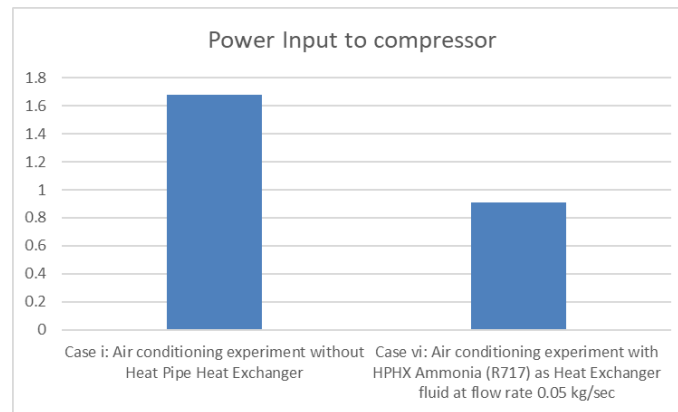


Figure 5: Power input to the compressor with and without HPHX

Reducing the flow velocity can improve the efficiency of heat transfer within the evaporation and condensing. Because of the higher efficiency, the system may generate the desired heating or cooling effect while using less energy, resulting in less consumption of electricity as shown in the figure 5.

V. CONCLUSIONS

A heat exchanger with a lower water flow rate may have a better heat exchange efficiency. Lower rates of flow enable a longer resident duration for water in the heat exchange device, allowing for more heat transfer between the refrigerant and water. As a consequence of this, the system's COP may rise. Ammonia has good thermodynamic properties, and is frequently used in commercial refrigeration systems. The relationship between COP and ammonia flow rate can be influenced by system setup, operational circumstances, and refrigerant characteristics. Engineers can optimise flow rates to achieve the maximum overall effectiveness, including COP and reducing the consumption of power to compressor thereby reducing the annual energy saving of the system.

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