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On the performance of air conditioner with cold coil for cooling in the condenser

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Abstract. The improvement on living standard of the human makes inefficient energy consumption, like use of air conditioners. Application of utilization cold pipe using condensate water instead of air-cooled condenser is proposed in this paper as an efficient way to solve the problem. Experimental results show that the air conditioning system of the utilization of cold pipes using condensate water-cooled air condenser has a significant effect on the performance improvement of the vapor compression cycle and the rate of improvement is based as ambient air temperature decreases across to hot coil condenser. Power consumption can be decreased up to 6.4 % and total performance can be improved around 7.3% of the system.

Keynote : performance, air conditioners, cold coils, condensor

1. Introduction

Utilizing air conditioning systems are very necessary for humans. It can be conditioned in accordance with the needs of both its temperature, humidity, and cleanliness so that a comfortable condition can be obtained. The condition makes people more productive and creative. The air conditioning could applied at high rise buildings, factories, hospitals, hotels, and office buildings. In the last few years, many large buildings account for about half of the total cost of constructing the facilities needed, for example for mechanical and electrical systems, approximately 30 to 50 percentis needed for air refreshment systems.

Many reasoning in choosing an Air conditioning (AC) unit. But to day the big concern is that the used over power consumption and cooling capacity. Power consumption is major concer in Air conditioning (AC) system. This system was cooled by the air-cooled condenser. The air-cooled condenser temperatura depends on the ambient temperature. The high temperature has a negative impact on thesystem. The temperatura environment has effect directly to the system. In high environmental temperatura conditions, pressure, and temperature in the condenser will increase and it made the compressor will be work hard. Increase condenser temperatura caused the performance (COP) of the air conditioning unit lower and making cooling capacity decrease [1].

Recently, modification in AC system performance are continuing, to obtain benefits withless energy usage. Many researchers modified condenser of the vapor compression cycle to get the optimum cooling capacity and bring down the power consumption. Hajidavalloo and Eghtedari [2] applied the wáter condensate cooling condenser. It has significant effect on the performance improvement of the cycle, the power consumption reduced up to 20 % and the coefficient of the



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performance can be improved around 50 %. Ardita and Subagia [3] investigated the **additional cooling media intermittently in condenser of a split air conditioning**. It showed that, the use of condensate can increase the performance of the system up to 7 % and cooling capacity about 4 %. Semeru et al. [4] investigates the performance of residential air conditioning using condensate water as a compressor discharge cooler to generate sub cooling. The effect of condensate water can increase the performance (COP) up to 21.7 %. Salem *et al.* [5] developed the condensate recovery system. The purpose is to give the knowledge of water conservation and clean and sustainable energy resources, the domain of HVAC condensate recovery and utilization has significant scope for research. Paisarnnaphon [6] studied the heat pipe of the air conditioning system for cooling air. Mostafa et al. [7] studied the effect of heat pipe exchanger for heat recovery in air conditioning. The heat pipe heat exchanger is used to cool the incoming fresh air in air conditioning applications. Islam et al. [8] experimentally and numerically studied the effect of evaporatively-cooled condenser of air-conditioning systems.

This study focuses on investigating the performance of the vapor compression cycle with the addition of coil cooling in the condenser. The effect of the cooling coil will be investigated. The objective of this study, to reduce the pressure and temperature of the condenser so that getting lower power consumption and increasing the performance (COP). The result is expected to inform that waste condensate water is still proper to be used on air conditioning.

2. Method and materials

The split air conditioning has a cooling capacity of 9000 Btu/hr. coil condensate is made and placed backside of the hot coil condenser and equipped with level control. Condensate water was collected before used then streamed to cooled-coil condenser as shown in Figure 1.

The power consumption of the compressor was measured using instruments a digital AC clamp power meter. Test data is recorded every single minute for approximately 1 hour operational system with three-session, firstly in the day, secondly in evening, and last at night.

Equation (1)-(4) were parameters used to calculate the performance of vapor compression cycle. The voltage and current of the compressor, the fan and the pump were measured by instrument. Total power consumption can be obtained by using eq. (1). Mass flow rate can be obtained by eq. (2). Cooling capacity and COP can be obtained by using eq. (3) and eq. (4), respectively. In all equations, Subscripts (1), (2), (3), and (4) stand for exit conditions from the evaporator, compressor, condenser and capillary tube respectively.

$$W_c = \frac{\dot{m} \times h_3 - h_2}{Q} \quad (1)$$

$$\dot{m} = \frac{Q}{RE} \quad (2)$$

$$Q_e = \dot{m} \cdot (h_1 - h_3) \quad (3)$$

$$COP = \frac{Q_e}{W_c} \quad (4)$$

In all equations are each used to express the evaporator, compressor, condenser, and capillary tube output conditions.

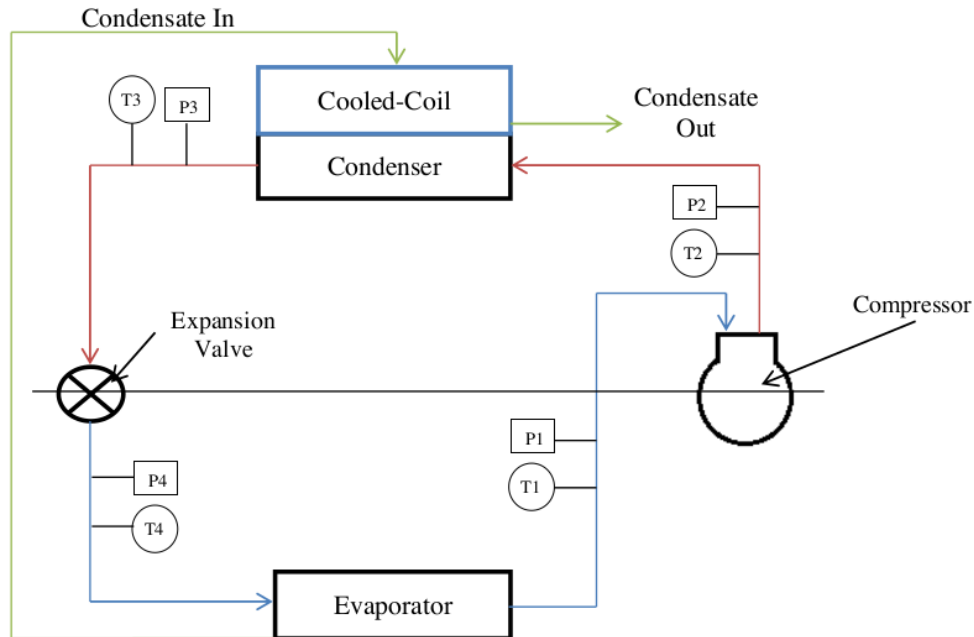


Figure 1. Experimental design and instrument tool position

As a figure 2 where the atmospheric air flows across the cold coil and then, the cold air will flow across the heat coil in the condenser. Air by across cold pipe will decrease the temperature and pressure of hot coil condenser, so the compressor will work lighter compare by usual.

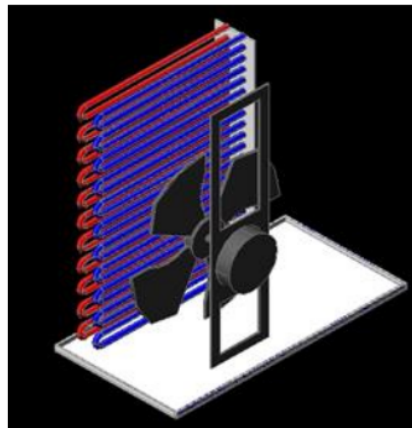


Figure 2. Hot coil condenser (red) and cold coil (blue) at condenser

3. Results and Discussion

The global warming problem, the heat transfer from the condensing unit to the atmospheric air needs higher energy consumption. Therefore, reduce air temperature entering the condensing unit has been introduced as one of the techniques to reduce the energy consumption of the air conditioning system. Where the atmospheric air flows across the cold coil and then, the cold air will flow across the

heat coil in the condenser. Air by across cold pipe will decrease the temperature of condenser lower than air with ambient temperature.

The test procedure is carried out intermittently between using condensate water and without using condensate water. In the first experiment, the test is done without condensate water, then continued by using condensate water. Measure all the parameters like the pressure, temperature, and power consumption with clamp (A/C) meter at each point set. There are three repetitions is required during the test.

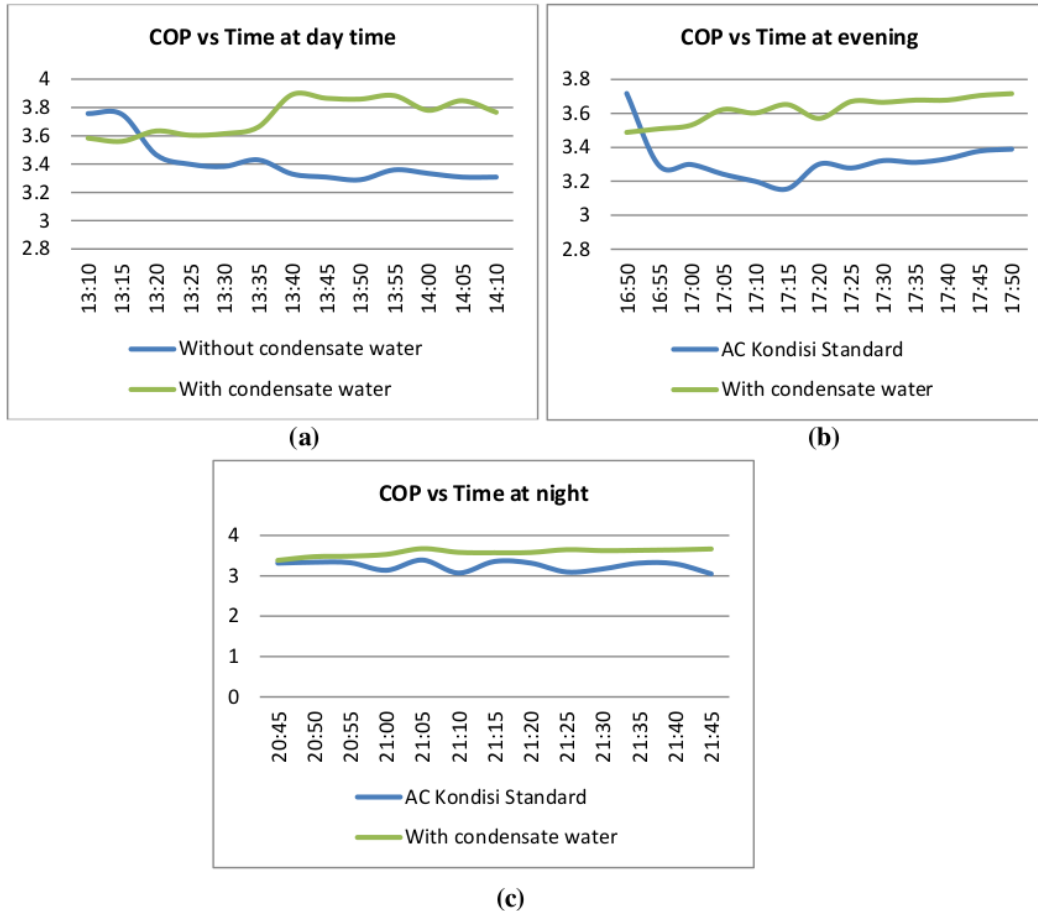


Figure 3. Performance during the operating period (a). Time vs Performance at the daytime; (b) Time vs Performance at the evening; (c) Time vs Performance at the night

As shown in figure 3, the effect of using condensate water for condenser can improve the performance of the vapor compression cycle. The average performance at the daytime during cold coil with condensate water usage increased by 8.5 %, the average performance in the evening during cold coil with condensate water usage increased by 8.1 %, the average performance at the night during cold coil with condensate water usage increased by 9.3 %. Other than, the ambient temperature has an effect on performance. As figure 3 the variance of the condition in the daytime, evening, and at the night. Temperature average at the night was 29 °C.

Based on the experimental results, the parameters such as performance (COP), cooling capacity, mass flow rate, and power required of the system were calculated. Table 1 shows the results of two procedure. The effect of using evaporative water cooling is increased. Power reduce improvement increase 6.4 %.

Table 1. Experiment result of two system

Data	AC without condensate water	AC with condensate water
COP	3,43	3,70
Massa flow rate (kg/s)	0,0117	0,0120
Cooling capacity (kJ/s)	2,382	2,397
Power (Wattt)	708,202	663,333

The better the cooling process of the condenser making the coefficient performance more it increases, the higher heat absorption has an impact at the lower temperature of the condenser, and lower temperature on the evaporator making the cooling capacity increases, thus the compressor work becomes more light.

4. Conclusion

The improvement on living standard of the human makes inefficient energy consumption, like use of air conditioners. The effect of air conditioning demand makes high energy consumption. Base on this study, addition cool pipe with utilizing condensate water from the air conditioning system. Experimental tests showed that power consumption and performance of air condenser improved significantly with cold pipe condensate water and compared to the air-cooled condenser and the improvements are increased as ambient temperature decreases. Power consumption can be decreased up to 6.4 % and total performance can be improved around 7.3% of the system.

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