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# Profile of Energy Consumption on Split Air Conditioning at Various Temperature Controls


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Abstract: Split air conditioning is the most widely used in the community for both commercial and domestic purposes. Air conditioning (AC) systems that work at room temperature conditions that are too low will cause energy consumption by the compressor to increase. This is often caused by a mistake in selecting the settings on the Split AC. For this reason, it is important to keep the system working in good comfort conditions, to prevent wasting energy use by the AC system. This study to investigate the effect of various temperature settings on split air conditioners on energy consumption and performance system. Data processing is done by using thermodynamic methods to get compressor power consumption, and coefficient of performance (COP). The expected result is to prevent wastage of electrical energy consumption. Base on the analysis result shows that the lower the room air temperature setting, the greater the energy consumption of the system. And that the lower the set temperature, the greater the energy consumption of the system. Energy consumption increases by an average of 23.3% for every 2oC decrease in temperature setting. On the other hand, the COP of the system decreases by an average of 5%.


## 1 INTRODUCTION

The thermostat in Split AC is a control component to regulate the working systems based on the desired room temperature. The thermostat works if the desired room temperature has been reached, the thermostat will automatically trigger the AC compressor to stop working. After the temperature returns to heat, the thermostat will trigger again to activate the AC compressor so that the cooling system works again. Setting the room temperature will affect how long the cooling system work, and which it will affect the power consumption of the AC system (Therese,2011). Several researchers have conducted research on digital on/off control systems and fuzzy control. The results show that the digital on/off control system and fuzzy control provide greater energy savings when compared to the thermostat control system. The main results of this study indicate that by varying the rotation of the compressor motor and selecting the right control system, it is possible to control the room temperature to obtain energy savings (Henry, 2014 dan 2016).

Another researcher investigated the effect of thermostat settings on energy consumption in a household refrigerator. And the results show that the energy consumption of household refrigerators increases with higher thermostat settings. The increase in energy consumption ranges from 17.10% to 18.65%, depending on the thermostat setting. By setting a lower thermostat, it can save energy consumption and also maintain the quality of the stored product (Edy, 2018).

Nan Wang, 2013, investigated the energy consumption of air conditioning at different temperature set points by modelling. To illustrate the accuracy of this model on energy consumption measured from the data centre is compared with the energy consumption calculated from this model with the coefficient of variation of the root mean square error between the estimated data and the measured test data is 11.5%. For air conditioners in buildings,


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the thermal control strategy to adjust the temperature set point is easy to implement and saves energy.

Marco Pritoni, 2015, researched other aspects that also determine comfort and energy savings in air conditioners other than the use of temperature control using a thermostat. The result is that temperature control determines comfort and energy savings. Besides, comfort is also influenced by; choice of clothing, use of windows, instructions for children, and general perception of thermal comfort.

Aldyanto, 2014, researched an adaptive room temperature regulation system by integrating an "indoor positioning system" based on Wi-Fi and a temperature sensor. The results show that by integrating an indoor positioning system with a temperature sensor, you can control the room temperature butter and increase energy savings. The positioning system can determine the load more accurately. Thus the indoor temperature setting can be better adjusted and can improve energy consumption savings.

Mohamed Elhelw, 2016, has conducted energy management analysis for heating, ventilation and air conditioning systems. The energy saved by using the modified bin method is higher than the CLTD/CLF/SCL method. Using the modified bin method will save energy by 45.57% and while the other methods will save energy by only 33.42%. The environmental benefits would also be realized with energy conservation benefits in the long run.

Manjula Siriwardhana, 2017, investigated the comparison of energy use between standard air conditioners and inverter type air conditioners operated in office buildings. The results show that using inverter technology can save energy up to 35% compared to use standard air conditioners.

Satish Parman, 2018, conducted an experimental study of a simple VCRS cycle and a VCRS cycle with superheating with the help of a liquid line heat exchanger. If the evaporator temperature increases before entering the compressor by 6 0C from (-2 0C to 4 0C i.e. superheating refrigerant) the COP of the cycle, and the refrigeration effect increases with the help of superheating. In general, refrigerant R-134A gives the best results for the same evaporator temperature, condenser temperature, and cooling rate compared to refrigerants R-12 and R-717 (Dharmendra, 2014).

This study will investigate the energy profile of Split air conditioners and system performance. The energy consumption profile can be used for energy conservation in increasing the efficiency of energy use.

## 2 METODOLOGY

The split type of air conditioning application has a cooling capacity of 9000 Btu / hr which is made by Panasonic electric. The sketch of the experimental equipment design and positioning of the measuring instrument is shown in Figure-1. Tests are carried out using refrigerant R32. The observed data include; refrigeration system pressure, temperature in each state, current and voltage used, and compressor power consumption.

A digital AC clamp power analyzer (LT Lutron DW-6092) use to measure the compressor power consumption system. Bourdon tube pressure gauge measures the refrigerant pressure of the out evaporator which is suitable for the refrigerant system with the 5. psi accuracy level. In this study, pressure drops in both condenser and evaporator were ignored due to the effect on the end of the result was not significant. The K-type thermocouple records the temperature in each state of the refrigerant and the air circulation of the evaporator at predetermined measurement points.

Based on (Arora, 2011 and Moran, 2004) , the desired parameter is calculated by using equations (1) to (4). Equation (1) is used to calculate the compressor power consumption. Equations (2), (3), and (4) are used to calculate Mass flow rate, cooling capacity, and system performance

$$W_k = V.I.Cos\varphi \quad (1)$$

$$m_{ref} = Wk/(h_1\text{-}h_2) \quad (2)$$

$$Q_r = m_{ref}.(h_1\text{-}h_4) \quad (3)$$

$$COP = Q_r/W_k \quad (4)$$

In all equations, enthalpy of the out evaporator, compressor, and expansion are expressed by $h_1$, $h_2$, and $h_4$ consecutively.

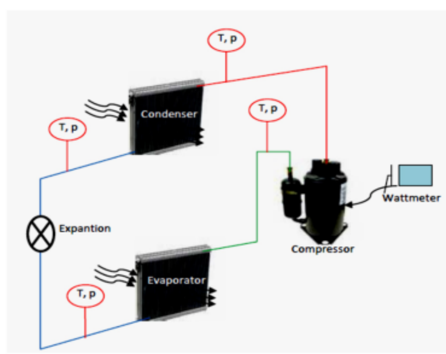


Figure 1: Experimental design and instrument tool position.

Experimental data include; energy consumption, low pressure and high-pressure system, inlet and outlet temperature of condenser and evaporator. Data processing is done by using thermodynamic methods to get compressor power consumption, and coefficient of performance (COP).

## 3 RESULTS AND DISCUSSION

The tests carried out have produced data on energy consumption at various temperature settings, as well as data on pressure and temperature in the refrigeration system. Figure.2 and figure.3 shows the results of floating system energy consumption data against time. The figure shows that at a low setting temperature, the operating period of the system is more than that at a higher setting temperature. In addition, at a lower set temperature, the system operating time is longer than the operating time at a higher setting temperature. This means that at a lower set temperature the energy consumption is greater than at a higher setting temperature. Based on the analysis, it was found that for every 2 °C increase in the setting temperature, the energy consumption of the system will decrease by an average of 23.3%.

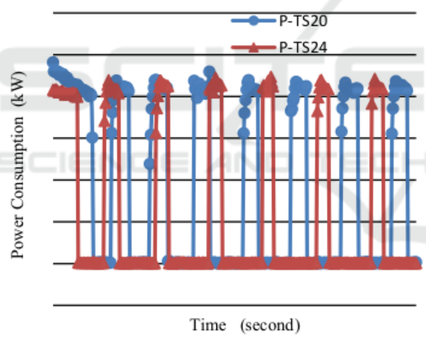


Figure 2: Graph of System Power Consumption on TS20 and TS24.

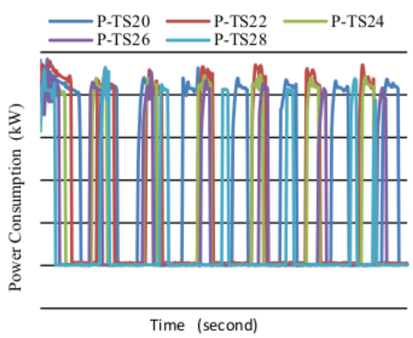


Figure 3: Graph of System Power Consumption.

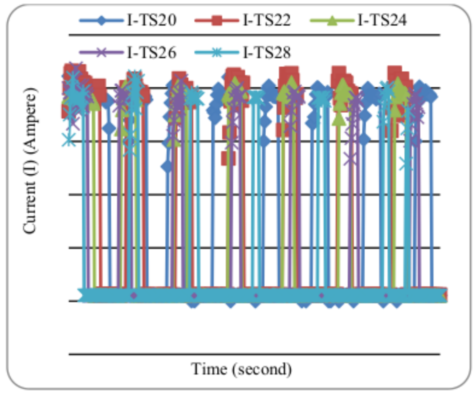


Figure 4: Graph of system Current on Various Temperature Settings.

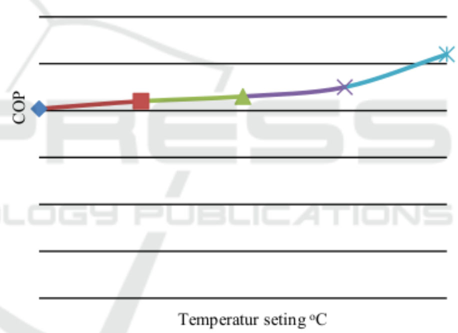


Figure 5: COP on Various Temperature Settings.

Figure 5 shows that the lower the set temperature, the system performance slightly decreases on average 5% for every 2°C decrease in the set temperature.

## 4 CONCLUSIONS

Based on this research, it can be concluded that the lower the set temperature, the greater the energy consumption of the system. Energy consumption increases by an average of 23.3% for every 2oC decrease in temperature setting. On the other hand, the COP of the system decreases by an average of 5% for every 2oC decrease in temperature setting.

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