# Effect of Air Speed and Expansion Valve Openings on Moisture Content and Dry Air Ratio in a Modified Air Conditioning Evaporator System

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# Effect of Air Speed and Expansion Valve Openings on Moisture Content and Dry Air Ratio in a Modified Air Conditioning Evaporator System

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**Abstract.** Air conditioning system has four main components of compressor, condenser, expansion valve, and evaporator. The effect of air speed and expansion valve openings on moisture content and dry air ratio in a modified air conditioning system has been investigated. The transerved air stream with the aid of a blower enters the evaporator through three baffles. Air flow capacity of the blower can be altered to get the variation of air speed entering the evaporator. The result of this research shows that the expansion valve openings have a significant change on the ratio of water vapor and dry air.

## INTRODUCTION

Weather conditions of an area in Indonesia throughout the year vary widely. Hot and rainy weathers are common conditions in Indonesia every year. Palembang is one of cities in Indonesia. In the beginning, the city of Palembang was a fairly wide swamp area. However, at this time, the swamp land has diminished due to the considerable development. Palembang's population growth continues to increase, followed by the need for housing, shopping and office space. The real impact is the rise in atmospheric temperature and atmospheric humidity has created an uncomfortable environment as a residence, where every household, shopping area, and office use air conditioning (AC) to get the comfort of a standard room. Increasing the use of air conditioning for households, shopping and office space will increase the amount of electricity demand.

The AC system has a close relationship with the dehumidifier. A dehumidifier is a device to reduce air humidity. The dehumidifier works by pulling and sucking water in the indoor air, flowed through cooling pipes so that condensation takes place. The condensate water collected from this process is discharged through the drain or dehydration process, so the air that is sprayed into the room becomes dry and there is an increase in temperature.

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For that reason, the study of AC systems and dehumidifier continue to be done by the researchers in order to be able to save electricity usage. Energy saving and AC peak load reduction potential with humidifier usage have been researched and are capable of conserving electric energy annually [1]. Energy consumption and air-conditioning usage patterns are important data in an effort to evaluate the efficiency of energy use to standardize energy policies in China [2]. In fact, research on saving energy consumption of AC systems in offices by utilizing solar energy is promising [3]. Specific energy management of the use of air conditioners whose energy sources from fossils need to be restricted in order to reduce global warming [4]. According to [5] that the freshwater production of the studied hybrid AC system increases due to the ratio of fresh air, the temperature of the air and the outer wet ball. Meanwhile, exergetic analysis [6] and mathematical modeling [7], as well as simulation of thermodynamic systems on air heaters and refrigeration for two condensers and one evaporator [8] and a dehumidifier with a spray dryer for vitamin a extraction in tomato as a heat-sensitive material [9] have been performed to study dehumidifier performance parameters. Some of the important factors that cause decreasing humidity are the increasing temperature of dehumidifier and desiccator entry, incoming dryer concentration, and the ratio of incoming air moisture. Similarly, the effect of air velocity of dehumidifiers was also investigated by the two-phase flow modeling [10].

In addition, research has been conducted on the above energy savings, the role of refrigerant used in the split AC system is important in the determination of its performance. According to [11] who has researched 4 (four) refrigerant types, the most suitable type of refrigerant is R424A, which can be used instead of R22.

## EXPERIMENTAL APPARATUS AND PROCEDURE

A schematic diagram of the Air Conditioning testing facility with a modified evaporator is shown in Fig. 1.

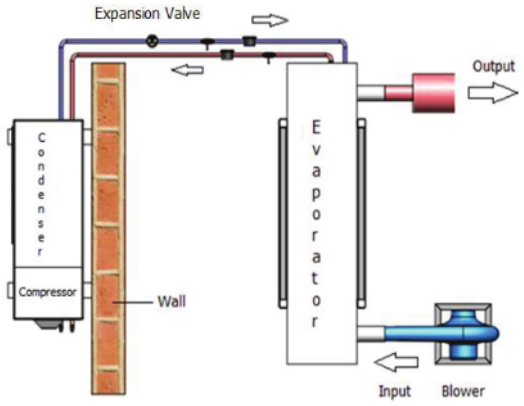


**FIGURE 1.** Experimental facility of the air conditioning system.

AC testing facilities consist of the main components of compressor, condenser, expansion valve, and evaporator. The installed expansion valve is a replacement capillary pipe to facilitate the adjustment of the refrigerant flow rate into the evaporator.

The split air-conditioning evaporator is modified to resemble fluid flow in a shell and tube equipped with 3 (three) buffles as shown in Fig. 2. The shell and tube evaporator dimensions are 900 x 223 x 195 mm and isolated assuming no outside and incoming heat This system. Blowers serve to suck the atmospheric air and flowed into the evaporator. Airflow rates and expansion valve openings are varied to obtain test data. While the measurement of temperature and pressure to each using K type thermocouple and pressure manometer.

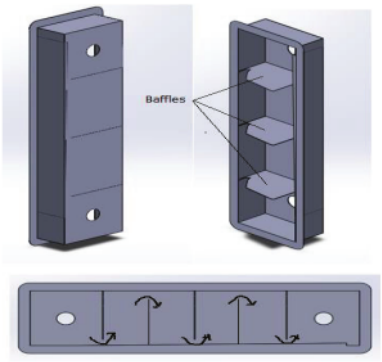


**FIGURE 2.** Baffles and airflow patterns in the evaporator.

## METHODOLOGY

The research methodology used is experimental by making test equipment in the form of a set of split AC system equipped with 2 PK power Fig. 1. Tests were performed on some weather conditions, expansion valve openings, and airflow rates entering the modified evaporator Fig. 2. The refrigerant used is R410-A.

The atmospheric air was sucked with a blower and flowed into the evaporator. Air blower velocities has been varied at 9, 10, 11, and 12 m/s. The airflow was blown through a 2-inch paralonic pipe and the expansion valve is used with variations of valve openings of ¼, 2/4, ¾, and 4/4.

Testing has been done per 15 minutes and averaged for each data, adjusted to the variation of expansion valve openings and blower airflow rate.

The following table 1 describes the data of the AC system test equipment used.

**TABLE 1.** Data from Test Equipment of Split AC System

| No | Variable Name | Value | Unit |
|---|---|---|---|
| 1 | Power | 2 | PK |
| 2 | Cooling Capacity | 5200 | Watt |
| 3 | Heating Capacity | 5300 | Watt |
| 4 | Indoor | 970x315x235 | mm |
| 5 | Outdoor | 800x590x300 | mm |

## RESULTS AND DISCUSSIONS

### Result

Several tests have been performed on this modified AC system, with variations in blower speeds of 9, 10, 11, 12 m / s, and opening of the expansion valve (OEV) at ¼, 2/4, ¾, and 4/4.

The following is the result of testing on a Split AC system with a modified evaporator.

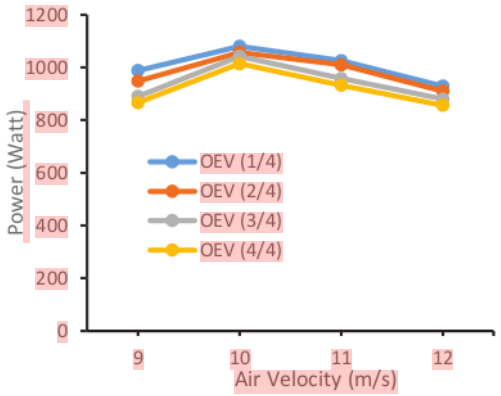


**FIGURE 3**. The effect of expansion valve opening and air velocity on power

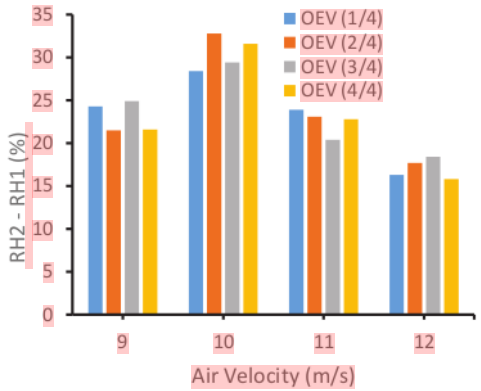


**FIGURE 4.** The effect of expansion valve opening and air velocity on relative humidity

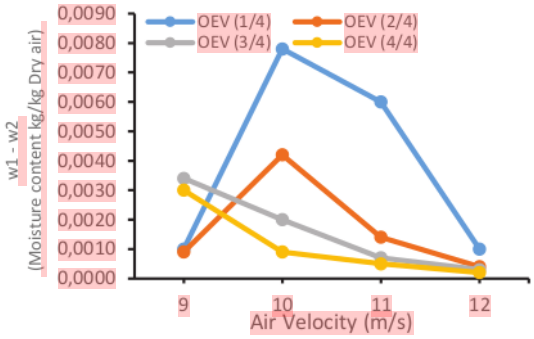


**FIGURE 5.** The effect of expansion valve opening and air velocity on moisture conten

## Discussions

The power increase occurs at air speeds of 9 and 10 m/s but decreases at 11 and 12 m/s Fig. 3. The influence of hot and rainy weather will affect the relative temperatures and humidity of the inlet and outer air of the evaporator

Fig. 4. The greatest difference in relative humidity leaving and entering the evaporator (RH2 – RH1) has occured at a blower air velocity of 10 m/s. Changes in relative humidity and temperature of the atmosphere around the test equipment greatly affect the ratio of water vapor and dry air generated Fig. 5. The greater airflow rate entering the evaporator will decrease the difference in the ratio of water vapor per dry air, except the speed of 10 m/s yields the largest ratio of water vapor ratio per air to dry.

## CONCLUSION

Based on calculations and exprimental data, the expansion valve opening and air velocity in the modified AC modified system will affect the power, relative humidity, and the ratio of water vapor per dry air.

The greater the air velocity supplied to the evaporator system and the addition of expansion valve openings leads to a decrease in power, the percentage of relative humidity entering and leaving the evaporator system, and the ratio of water vapor per dry air.

The test of this split AC system shows a tendency for increased power, percentage of relative humidity in and out of the evaporator system, and ratio of water vapor per dry air for expansion valve openings of 1/4 and 2/4, but for valve openings of ¾ and 4/4 tends to fall at a 10 m/s air speed.

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## REFERENCES

1. K. O. Aduda, Z. Wim, B. Gert, D. B. Kevin, On the use of electrical humidifiers in office buildings as a demand side resource. *Procedia Computer Science*. **32**, 723–730 (2014).
2. J. Wu *et al.*, Residential air-conditioner usage in China and efficiency standardization. *Energy*. **119**, 1036–1046 (2017).
3. A. Ilie, R. Dumitrescu, A. Girip, V. Cublesan, Study on technical and economical solutions for improving air- conditioning efficiency in building sector. *Energy Procedia*. **112**, 537–544 (2017).
4. A. E. Kabeel, M. Abdelgaied, R. Sathyamurthy, Performance improvement of a hybrid air conditioning system using the indirect evaporative cooler with internal baffles as a pre-cooling unit. *Energy Procedia*. **62**, 629–638 (2014).
5. S. A. Nada, H. F. Elattar, A. Fouda, Performance analysis of proposed hybrid air conditioning and humidification – dehumidification systems for energy saving and water production in hot and dry climatic regions. *Energy Conversion and Management*. **96**, 208–227 (2015).
6. M. Ghazikhani, I. Khazaee, S. Vahidifar, Exergy analysis of two humidification process methods in air-conditioning system. *Energy and Buildings*. **124**, 129–140 (2016).
7. M. M. Bassuoni, A simple analytical method to estimate all exit parameters of a cross-flow air dehumidifier using liquid desiccant. *Journal of advanced research*. **5**, 175–82 (2014).
8. E. A. Kosasih, R. Nanang, Combination of Electric Air Heater and Refrigeration System to Reduce Energy Consumption: Simulation of Thermodynamic System. *International Journal of Technology*. **2**, 288–295 (2016).
9. E. A. Kosasih, N. Ruhyat, in *AIP Conference Proceedings* (2017), vol. 20008, pp. 1–7.
10. B. Sreelal, R. Hariharan, The Effect of Air Velocity in Liquid Desiccant Dehumidifier Based on Two Phase Flow Model Using Computational Method. *International Journal of Emerging Engineering Research and Technology*. **2**, 142–152 (2014).
11. V. Oruç, A. G. Deveciog, B. Ug˘ur, V. I˙brahim, Experimental comparison of the energy parameters of HFCs used as alternatives to HCFC-22 in split type air conditioners. *International Journal of Refrigeration*. **63**, 125–132 (2016).

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