# The Performance of Dryer Box Using Desiccant to Improve Drying Rate

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**Abstract.** Humidity in drying process is a factor that affects how fast the drying process occurs. The thing used to lower the humidity level is desiccant which used to reduce the moisture content in process of drying. The aim of this study is to design a dryer box and the addition of desiccant to determine the performance of the dryer box by determining SMER and SEC during the drying process. The method used in study is directly carried out by utilizing solar energy directly to generate electricity from solar photovoltaics. The results shows that the utilization of desiccant improved the performance of dryer box. The main conclusion of this study convinced that the humidity is a factor to improve drying rate and desiccant was the material used.

**Keywords:** Humidity; desiccant; dryer box; SMER; SEC

## 1 Introduction

The increase of global energy requires the user of energy to skimp the use of energy. It's not enough to save the energy usage only, the increase of energy efficiency must also be done to overcome the existing problems [1]. In drying machine, there are many method used to increase the efficiency of the machine. It looks like convection of hot-air dryers that recirculate hot-air to drying environment area and dry somethings from sucking fresh air [2]. Reducing the water content in the drying process can be done by knowing the influence of the air temperature, air humidity and air speed which can affect the temperature of drying. The higher the air velocity, drying temperature will increase. It was caused by the rate of mass loss, and it required time to decrease moisture content [3]. When the conditions of drying are constant, the drying speed and drying layer temperature must remain constant. But during this circumtance, the rate of drying is only constant in the equilibrium state, not during the entire time. Indeed, except for coefficient of heat transfer, the rate of transfer of heat is determined by the dynamics of the air temperature with respect to the particles. During recession, the moisture rate movement decreases and controls the rate of drying [4].

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Dehumidification dryer is a feasible method to produce air with low values of humidity and determine the factors of dehumidification performance [5]. Based on to the type of dryer, air drying systems can be liquid-based cooling systems and solid dryer-based cooling systems. Recently, efforts of many tremendous researchers have been made to develop desiccant dehumidification [6]. Air drying can be done using a desiccant, where dry air is air that contains little water vapor. The presence of vapor of water in the air must be minimized to reduce the water vapor content in the air. An alternative that can be used is the process of reducing water vapor using the adsorption method. The type of desiccant used for the adsorption process must be adjusted to the nature and condition of the substance being adsorbed, this is done because some types of adsorbents have specific properties and only absorb certain substances [7]. Reduction of relative humidity can be done by using an adsorbent dehumidifer by passing air through a desiccant, then the desiccant will absorb the contained of vapor of water in the air, so the contained of vapor of water in the air will decrease [8].

The aims of this reseach are to design a dryer box by adding desiccant to determine the performance of the dryer box by determining SMER and SEC during the drying process. The parameter to determine the objective such as formulation and equation (1-6).

Moisture content (MC) can be expressed in drying clothes as the equation (1) [9][10][11]. Where mt is wet weight, and md is weight after drying.

$$MC = \frac{m_t - m_d}{m_d} \quad (1)$$

The dehumidification performance can be expressed by [12];

$$\Delta\omega = \omega_{in} - \omega_{out} \quad (2)$$

Where $\Delta\omega$ represents the temporary capacity of dehumidification, $\omega_{in}$ is the the inlet air humidity and $\omega_{out}$ is the the output air humidity and the equation to calculate the dehumidification efficiency ($\eta_d$) is as follows;

$$\eta_d = \frac{\Delta\omega}{\omega_{in}} \times 100\% \quad (3)$$

Where $\Delta\omega$ is the dehumidification capacity.

Some strategies to determine performance of machine, especially in dryers. Michael [13] believes that the main factors that determine the performance of electricity and dryers are solar radiation and photovoltaic modules. Morfi [14] wrote an equation to determine the drying rate as follows:

$$\dot{m}_d = \frac{m_w - m_d}{t} \quad (4)$$

Where $\dot{m}_d$ is the drying speed (kg/hour), t is the drying process time, $m_w$ and $m_d$ are wet clothes and dry clothes (kg), respectively. Furthermore, Amiebenomo [15] stated that the process of drying is influenced by the humidity and the temperature of box dryer. The performance index of the drying box is the specific dehumidification rate (SMER). SMER is known as the number of water that evaporated from clothing when using electrical energy in one hour, or in other words the energy required to evaporate 1 kg of water in units of

kg/kWh[14]. SMER can be assumed as the utilization between the electricity and the moisture consumed. The unit is kWh/kg. It is known as the equation [16]:

$$SMER = \frac{\dot{m}_d}{W_{in}} \tag{5}$$

It indicates the energy consumption required to remove each kilogram of water from the clothes as load of drying. This can be represented as an equation [17]:

$$SEC = \frac{1}{SMER} \tag{6}$$

## 2 Method

In this study, there are three parts of component used to design box dryer, i.e., box dryer itself, heater fan, and dessicant. The temperatures, mass of clothes, and humidity are measured by using temperature data logger, weights, and humidity RH meter, respectively. The performance that measured in this research as shown in Table 1.

**Table 1.** Measurement Parameters

| No. | Variabel | Indikator | Instruments |
|---|---|---|---|
| 1 | Temperatur lingkungan | Temperature | *Ambient apparatus* |
| 2 | Temperature of box dryer | Temperature | Agilent dan Termokopel |
| 3 | Mass of clothes | Mass | Hanging weight scale |
| 4 | Air humidity | Humidity | Voltmeter |

Before starting the experimental, the box has been set-up in work temperature 45°C-50°C. The experimental setup shown in **Figure 1.**

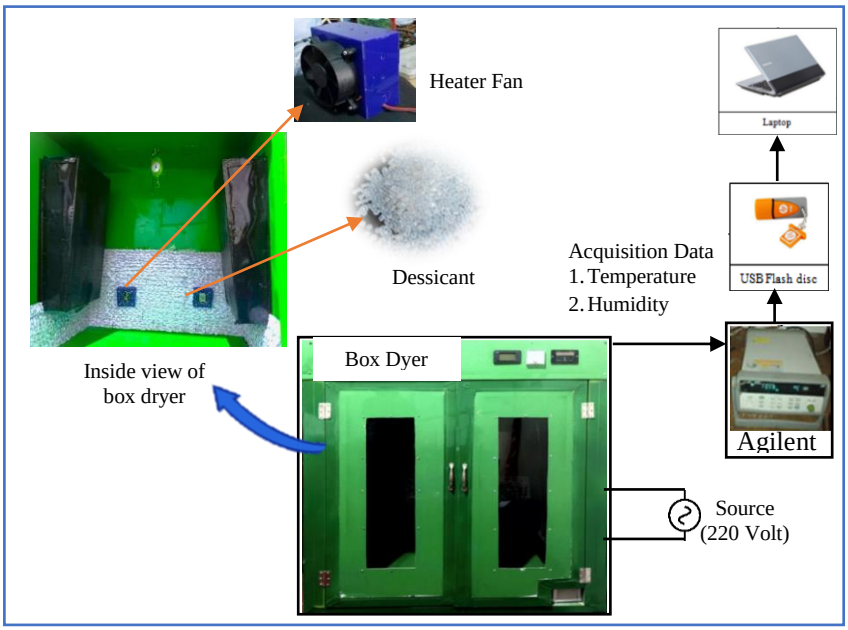


**Fig. 1.** Experimental setup.

## 3 Result and Discussion

After accumulating experience in this study, data were collected and calculated as shown in Table 2.

**Table 2.** Calculation Data.

| | |
|---|---|
| Clothes Type | Polyester |
| $m_d$ (kg) | 0.18 |
| $m_w$ (kg) | 0.22 |
| $\dot{m}_d$ (kg/hr) | 0.00125 |
| SMER (kg/kWh) | 0.003788 |
| SEC (kWh/kg) | 264 |

The time duration of drying load are shown in **Figure 2.** The experiment was completed in 32 minutes. It was better not to use desiccant to reach 45 minutes and increase higher than 40. 62%, like increasing the total volume of adsorbed water vapor to 22% [18]. The drying speed was 0.00125 kg/h. The process of drying took slowly until the temperature of the dry clothes is reached. Since the volume of water in the raw material is smaller than the volume of dry matter, the content of moisture is significantly reduced [19].

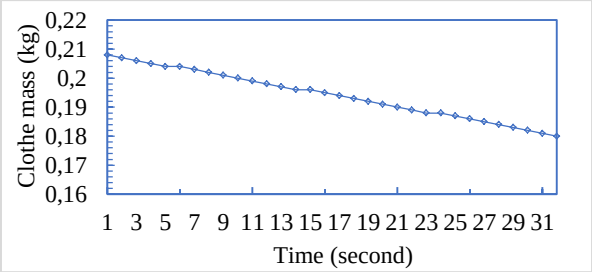


**Fig. 2.** Time of drying rate.

In the discussion, only the duration of air drying at constant speed from a fan heater was presented. The temperature, the humidity, the efficiency drying, the rate drying, the SMER and SEC are the parameters observed in terms of energy consumption in the drying chamber. The performance of the drying drum was analyzed using SMER.

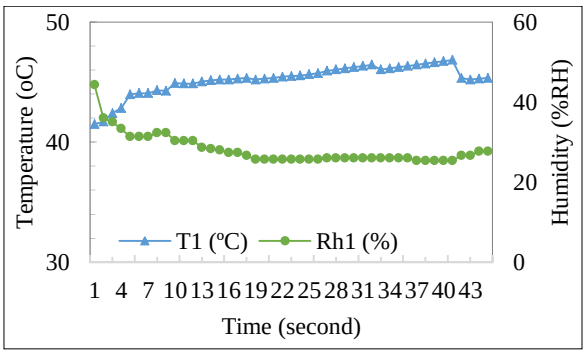


**Fig. 3.** Characteristic of temperature and humidity.

This can be seen from the energy efficiency used to remove moisture from dry clothes. Instead, SEC was obtained to determine the product of energy consumption. Apart from that, the SMER and SEC values were 0.003788 kg/kWh and 264 kWh/kg, respectively. The air temperature average in the box dryer room was 44.16ºC with air humidity 31.37%. The higher SMER value will reduce the consumption of energy required for the drying process. The air temperature will increase as the drying time increases. During this time, the humidity in the air gradually decreases until it becomes relatively dry. This is what helps clothes dry faster as it provides a higher drying rate.

## 4 Conclusion

The drying process uses desiccant within 32 minutes after drying to dry 0.22 kg of clothes. How quickly clothes dry depends on the number of moisture in the clothes and the time of drying. Higher drying speed with lower consumption of energy will result in high SMER and low SEC. Higher air temperatures during drying indicate higher heat transfer rates. A decrease in humidity of air indicates the difference of water vapor concentration during the drying process. The concentration of steam can cause moisture to escape from clothes.

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