

Development of Sago Drying with Environmentally Friendly Techniques

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Abstract

One of the drying machines that is commonly used by in industry is a rack-type dryer. However, the rack-type drying machine has generally fairly low efficiency. A rack-type dryer has been designed which was equipped with a hybrid mechanism, but its performance not yet known when it is controlled by an expert control system. The purpose of this research was to produce an expert control system that can be applied to a rack-type dryer with a hybrid system mechanism which can improve the performance of the dryer. The research includes the development of expert rules applied to the control system and a series of tests was carried out using 10 kg of fresh sago starch. The test results show that the drying air temperature did not show any overshoot and short settling time, drying temperature is relatively stable and there was no steady state error. The drying rate of fresh sago starch can be increased by using the hybrid system. The use of electric power with the hybrid system was lower (5.78 kWh) compared to that of non-hybrid (6.88 kWh) or a reduction of about 16% compared to the non- hybrid system. Thermal efficiency of the rack-type dryer with the expert control system was about 36%.

Introduction

The drying process is a process of reducing the water content of a particular product by drying it. It aims to stop or inhibit the development of certain microorganisms or enzymes that can cause spoilage. Thus, the dried material has a longer shelf life, reduces product volume or weight, minimizes product transportation costs, and maintains product quality.

It is just that reducing the water content of a product by means of manual drying is not effective and efficient because it requires human labor and a relatively long time. Therefore, a drying machine is needed to speed up the drying process. One of the drying machines that is commonly used by the community is a rack-type dryer.

Rack-type dryers are widely used in drying materials due to their simple and economical design. The material is spread on the shelves with an even thickness of the material so that it can dry uniformly. Drying can occur due to the flow of hot air through the rack. The key to the success of this rack-type dryer is the even distribution of airflow through the racks. The energy source of the rack-type dryer can come from solar thermal energy, electricity, or fossil fuels. Usually the water content is determined using an electronic scale to get the difference in the final and initial mass of the material [1].

The rack-type dryer has a fairly low efficiency. Several studies which show that the efficiency of the rack-type dryer is quite low can be seen from the results of the performance test of the rack-type dryer conducted by Dwi Yulita (2015) and Edi Suhendar (2017) [2, 3]. According to Jaelani, the efficiency of the dryer in drying candied papaya only reaches 12% and according to Suhendro, the efficiency is only about 10%. Therefore, the purpose of this research is the development of an expert control system on a drying machine equipped with a hybrid system mechanism.

Methods

The research was carried out for approximately 3 (three) months, namely from June to August 2021. The research location was carried out in the food processing laboratory of Hasanuddin university and Jl. Gi/3 Perintis Kemerdekaan

Research design

This drying process consists of: 1. Drying using a hybrid system method with a setting point of 60 °C. 2. Drying using a fixed time-based hybrid system. 3. Drying using a non-hybrid method. During the drying process, this system is expected to be able to regulate the amount of heat energy needed to dry fresh sago starch and maintain a stable temperature in the drying chamber by using a hybrid oven and dryer system. The use of a hybrid system will take place during the drying process.

Research procedure

The research procedure was carried out using rack-type dryer hardware, studying the control system on rack-type dryers, designing expert control system software, performing function tests and performance tests if an error or discrepancy occurred, thus it will be repaired.

Function test

In this research, the function test aims to determine whether the expert control system in the rack-type drying machine has worked according to what has been set and as expected. Function test of the drying control system, among others: 1. Gain system must be sufficiently large that the temperature of the rack-type dryer is able to exceed the setting point of 60 °C. 2 Shows a good dynamic response, namely: no overshoot, small setting time. (there is no standard rule), then in the research used <30 minutes. 3 Shows a good static response, namely: stable and steady state error of 2-5% [4].

Performance test

In this research, the performance test aims to determine the extent to which the performance of this expert system controller can be applied to dryers with fixed-time and non-hybrid hybrid systems. As for measuring the success rate, the following indicators are used: 1 The drying temperature is stable and there is no steady state error or settling time. 2 The water content of sago dried in accordance with the water content that has been set is 13% according to the SNI standard. 3 Efficiency is greater than the dryer on the market. 4 Able to save energy use.

Results and Discussion

Comparison of the dynamic response of fuzzy and expert control systems

This test was conducted to determine whether the expert control system was rather accurate or not in controlling the dryer equipped with a hybrid oven and dryer system. The results of the observations can be seen in the following figure.

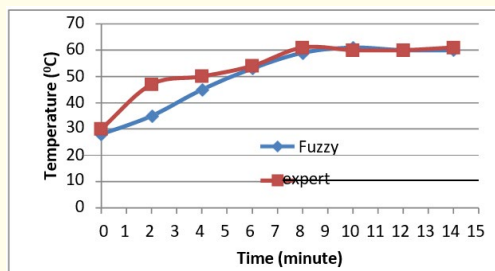


Figure 1: Dynamic response of drying air temperature with fuzzy and expert control system.

The picture above shows the dynamic response of the temperature on the dryer when it is run with the hybrid and fuzzy hybrid expert control systems. It appears that the response of the drying air temperature is almost the same, namely the time required to reach the set point (settling time) is the same, which is 10 minutes and there is no overshoot at the temperature of the drying room. According to Ogata (1979) [4], the accuracy of a controller can be seen from its dynamic response (transient response), namely there is no overshoot and small setting time. This shows that the performance of the designed expert control can match the fuzzy logic control system and can be used to control the dryer equipped with a hybrid oven system with a dryer.

Performance test

This test was carried out using fresh sago starch material to see the moisture content of the resulting material and energy use in the dryer.

Drying air temperature

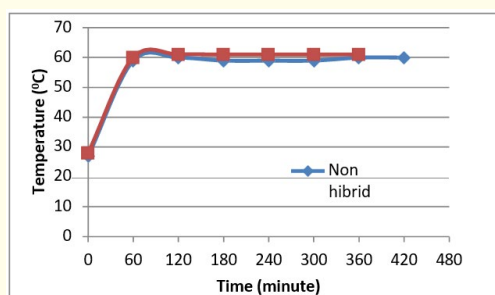


Figure 2: Temperature of the drying process with hybrid and non-hybrid methods with 1500W heater power.

Average drying rate

The results of the observation of the evaporation rate in the drying process can be seen in the following figure:

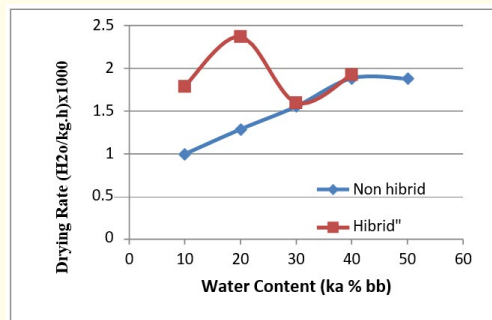


Figure 3: Average drying rate.

In the picture above, it can be seen that the drying rate in the hybrid system experienced a high evaporation rate increase in the hybrid system until it reached a moisture content of 20%, this was due to a change in the system from oven to dryer, while the rate of decrease in water content in the non- hybrid system was stable.

Average electric power consumption

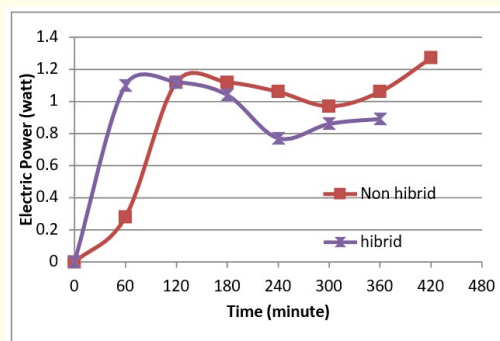
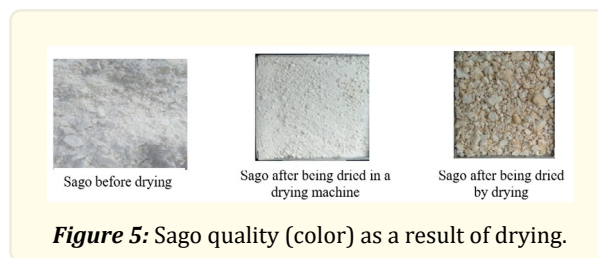


Figure 4: The use of electric power during drying.

In the picture above, it can be seen the use of electric power when the hybrid and non-hybrid systems are different. Where the use of electricity in the drying with the hybrid system decreased in the first hour while the non-hybrid drying at the end of the drying still experienced an increase in the use of electric power.

Sago quality (color) as a result of drying

The results of observations of the sago colors after drying with a dryer and the sun are as follows:



Conclusion

Based on the research that has been conducted, it is concluded that expert control rules have been successfully developed for rack-type dryers with a hybrid system mechanism and have shown quite good performance. This can be shown by a stable drying temperature, increased drying rate, can save electricity usage by 16%, and the thermal efficiency of the machine reaches 36%.

References

1. Misha S. Review on the Application of a Tray Dryer System for Agricultural Products (Malaysia: Universitas Kebangsaan Malaysia) (2013).
2. Yulita D. Analisis Energi Panas pada Proses Pengeringan Manisan Pepaya (Carica Papaya L.) Menggunakan Alat Pengering Tipe Rak (2015).
3. Suhendar E, Tamrin T and Novita DD. Test Performance of Rack-Dryer For Drying Chips Breadfruit Uses Electrical Energy J. Tek. Pertan. Lampung 6.2 (2017): 125-132.
4. Ogata and Katsuhiko. Automatic Control System 4th ed, (New Jersey: rentice Hall Swadaya) (1979).

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