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Analysis of Maizena Drying System Using Temperature Control Based Fuzzy Logic Method

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Abstract Corn is one of the rice subtitution food that has good potential. Corn can be processed to be a maizena, and it can be used to make type of food that has been made from maizena, viz. Brownies cake, egg roll, and other cookies. Generally, maizena obtained by drying process carried out 2-3 days under the sun. However, drying process not possible during the rainy season. This drying process can be done using an automatic drying tool. This study was to analyze the design result and manufacture of maizena drying system with temperature control based fuzzylogic method. The result show that temperature of drying system with set point 40^0C - 60^0C work in suitable condition. The level of water content in 15% (BSN) and temperatureat 50^0C included in good drying process. Time required to reach the set point of temperature in 50^0C is 7.05 minutes. Drying time for 500 gr samples with temperature 50^0C and power capacity 127.6 watt was 1 hour. Based on the result, drying process using temperature control based fuzzy logic method can improve energy efficiency than the conventional method of drying using a direct sunlight source with a temperature that cannot be directly controlled by human being causing the quality of drying result of flour is erratic.

INTRODUCTION

Increased human population has an impact on the level of food demand[1,2]. Population growth also requires increased food resilience[3]. Several technologies have been developed in the industry to improve the quality of food products. Industrial science and technology of electronics such as control systems has now grown rapidly. The control system has been applied in the area of engineer and science to facilitate human performance activities[4]. To increasing food production need several tools that used to help community needed. The application of control systems to industrial equipment is a way of optimizing industrial productivity. One of the control system that is on corn dryer.

Corn is a type of food with an increasing number of requests[5]. Corn productivity in Indonesia reaches 21 million tons / year. The potential of corn productivity is an opportunity in the carbohydrate-based agriculture industry. One of the products of corn processed is cornstarch. Maize powder is obtained by drying process. The process of drying and processing has been widely applied in food production, but the scientific approach in this process has not been widely implemented[6]. Currently the process of draining the community is still conventional under direct sunlight. However, the application of this drying technique increases the risk of decreasing the quality of flour due to the unstable environmental conditions.

Temperature and humidity are important factors that impact on the process of drying foodstuffs[7]. Temperature control and humidity in the drying process affect the quality of cornstarch. The design, development, and implementation of control systems require appropriate methods to facilitate human performance[8]. Representation of temperature and humidity conditions requires appropriate methods in the control process. Temperature and humidity are two variables that when combined in a control system require decomposition for effectiveness in

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control. In addition, coupling problems also cause system instability when measuring results. Temperature and humidity values include interval presets and unclear interval limit. Fuzzy logic was developed to overcome the control issues related to the vagueness of the limits of a variable for effectiveness in control[9]. Fuzzy theory is a generalization of the classical theory introduced by Lotfi A. Zadeh in 1965. The Fuzzy method represents a less obvious condition that allows linguistic variables to be of input and produces an output variable in the form of a set with a membership value of 0 to 1[10]. The implementation of fuzzy control has been widely applied in a variety of control issues, since fuzzy control is capable of completing a nonlinear system that allows interaction of multiple inputs to obtain output values[11]. Fuzzy controls have high computing performance to minimize power consumption and low cost[12]. The use of fuzzy controls makes it easy to merge analog converter to digital, and performance improvements are easily done by changing rules or adding new features to the system[13]. The aim of this research is to apply fuzzy control system to cornstarch drying system to increase efficiency of power usage.

STUDY MATERIAL

In this research, variables that are used to conduct an assessment of the research object is cornstarch. There are three research variables which are weight and moisture starch content, temperature and drying chamber. The variable weight and moisture content of cornstarch are expressed based on wet weight or dry weight. The temperature variable was measured using SHT11 sensor with ºC temperature unit. And the humidity variable is measured using SHT11 sensor with unit hygrometer.

METHOD

The control system in this flour dryer has a systematic working system. The block diagram of this control system is shown in Fig. 1.

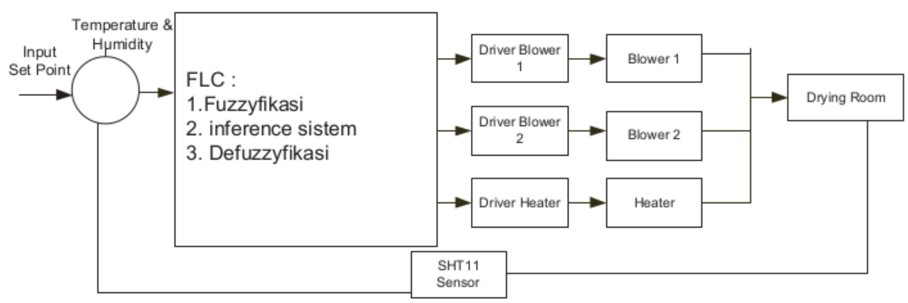


FIGURE 1. System Block Diagram

The automation system in this flour dryer uses the input values of temperature and humidity. The temperature and humidity values are the outputs of the SHT11 sensor. Temperature and humidity are multivariable nonlinear systems that need to be controlled in the drying process[14]. Control system in this automation system using close loop with fuzzy mamdani method. The temperature and humidity sensor SHT11 measures the rate of heat and humidity of the drying chamber by sending data to the arduino and adjusting the temperature and humidity assigned to the program. The output of the arduino control sends an input signal in the form of a PWM signal to regulate the heater heating and control the blower performance. The voltage control of the heater is processed by the controlled microcontroller of the fuzzy logic controller (FLC) algorithm. The fuzzy logic based control system provides a useful solution for controlling systems with nonlinear and less obvious characteristics[15]. The driver blower and driver heater circuit is shown in Figs. 2 and 3.

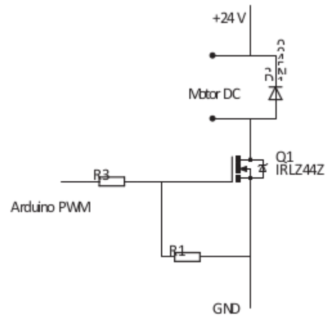


FIGURE 2. Driver Blower Circuit

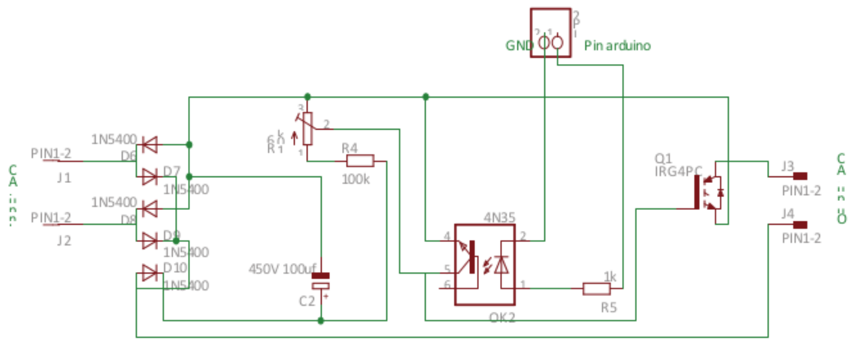


FIGURE 3. Driver Heater Circuit

The analytical methodology using FLC consists of three stages, namely the input fuzzyfication stage, the definition of the block rule, and the defuzzyfication to obtain the output[16]. The fuzzy logic algorithm is adapted from method used by Singhala et al.[17].

Data processing using FLC is done by determining the variable and range of value each variable. The fuzzyfication stage involves changing the input value of temperature and humidity into a fuzzy set. The rule block stages include creating rules and generating values for each rule and analyzed for each result of different rules. The deflection stage involves converting the fuzzy value into a discrete form to produce a command output that is the actual value of the PWM signal for heater and blower control. Variables and range of value in this automation system are shown in Table 1.

TABLE 1. Variables and Range of Value Input and Output

Function	Variable Name	Range of Value	Rate Level	Fuzzy Level	Index
Input	Temperature	[0-100]	0 – 40	Cool	D
			20 – 80	Medium Hot	AP
			60-100	Hot	P
	Humadity	[0-100]	0 – 40	No Moist	TL
			20 – 80	Medium Moist	AL
			60-100	Very Humid	SL
Output	Heater	[0-250]	0 – 127	Hot	PN
			50 – 200	Warm	H
			127 – 255	Die	M
	Blower input	[0-250]	0 – 127	Very Slowly 1	SP1
			50 – 200	Slow 1	P1
			127 – 255	Fast 1	K1
	Blower output	[0-250]	0 – 127	Very Slowly 2	SP2
			50 – 200	Slow 2	P2
			127 – 255	Fast 2	K2

Each input and output variable has a membership function type with different value constraints. This value corresponds to the constraints of each fuzzy level in the criteria. Membership function is used to obtain the degree of membership value of each variable. The next stage is the formation of a rule base that is used to perform further calculations. Rule base on this automation system is shown in Table 2.

TABLE 2. Fuzzy Rule Base

No	IF	Temperature	AND	Humidity	THEN	Heater	AND	Blower 1	Blower 2
1.		D		TL		P		K1	SP2
2.		D		AL		P		K1	P2
3.		D		SL		P		K1	K2
4.		AP		TL		H		P1	SP2
5.		AP		AL		H		P1	P2
6.		AP		SL		H		P1	K2
7.		P		TL		M		SP1	SP2
8.		P		AL		M		SP1	P2
9.		P		SL		M		SP1	K2

The fuzzy set derived from the compositions of fuzzy rules is the input process while the resulting output is a number in the fuzzy set domain and defuzzyfication using Centroid method.

After obtaining the results of the assessment using this flour dryer automation system, then calculated the error rate of the tool using Eq. 1.

$$E(t) = y_{sp}(t) - y\,(t) \tag{1}$$

Dimana:

e (t) = *error*

y (t) = temperature *setpoint*

y_{sp} (t) = temperature measurement

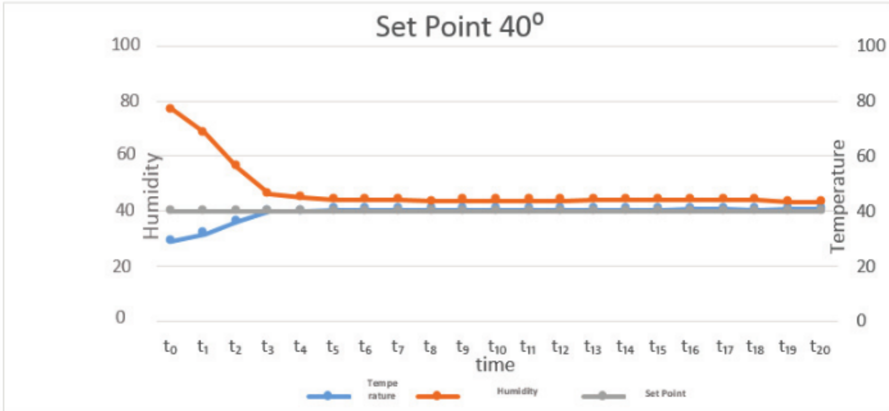
In addition to the error rate test that was also carried out on pre and post-drying cornmeal at a temperature of 40.50 ° C. The moisture content of the cornstarch is calculated using the Eqs. 2 and 3.

$$Wet\ water\ content = \frac{gross\ weight - dry\ weight}{gross\ weight} x100\% \tag{2}$$

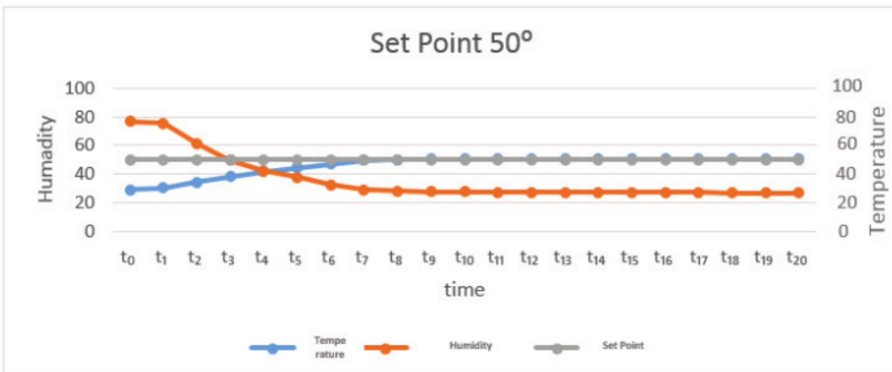
$$Dry\ water\ content = \frac{gross\ weight - dry\ weight}{dry\ weight} x100\% \tag{3}$$

RESULT AND DISCUSSION

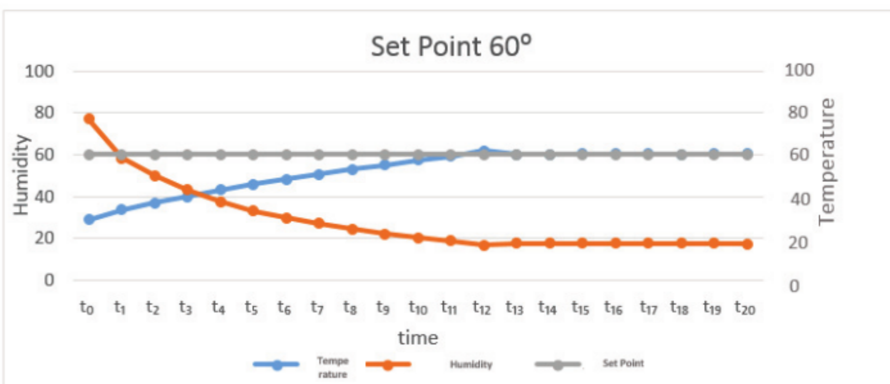
The drying system for moisture with temperature and humidity control using this fuzzy control system has been tested at a particular set point. Automation testing is done at room temperature of dryer with set point 40, 50, 60 ° C. The result of the temperature and humidity measurement test is shown in Fig. 4. Result of temperature and humidity measurement test in set point 40°C is shown in Fig. 4(a), result of temperature and humidity measurement test in set point 50°C is shown in Fig. 4(b), and result of temperature and humidity measurement test in set point 60°C is shown in Fig. 4(c).



(a) The Result of Temperature and Humidity Measurement Test in Set Point 40°C



(b) The Result of Temperature and Humidity Measurement Test in Set Point 50°C



(c) The Result of Temperature and Humidity Measurement Test in Set Point 60°C

FIGURE 4. Result of Temperature and Humidity Measurement Test Set Point 40°C in Figure (a), Set Point 50°C in Figure (b), and Set Point 60°C in Figure (c)

The starting temperature of the drying chamber for the temperature set point test of 40ºC is 29.01ºC and the time required to reach the 40ºC set point is 3 minutes. Start stable at set point 40º also at minute 3. The starting temperature of the dryer room for 50ºC set point test is 29,01ºC and the time needed to reach set 50ºC is minute 7.03. Start stable set point 50º at minute 8. The starting temperature of the dryer room for 60ºC set point test is 29,01ºC and the time required to reach set 60ºC is 11.19 minutes. Start stable set point state 60º at minute 13.

To find out the error rate in the automation system of this flour drier, then compare with other tools that have been validated. The resulting error rate is shown in Fig. 5.

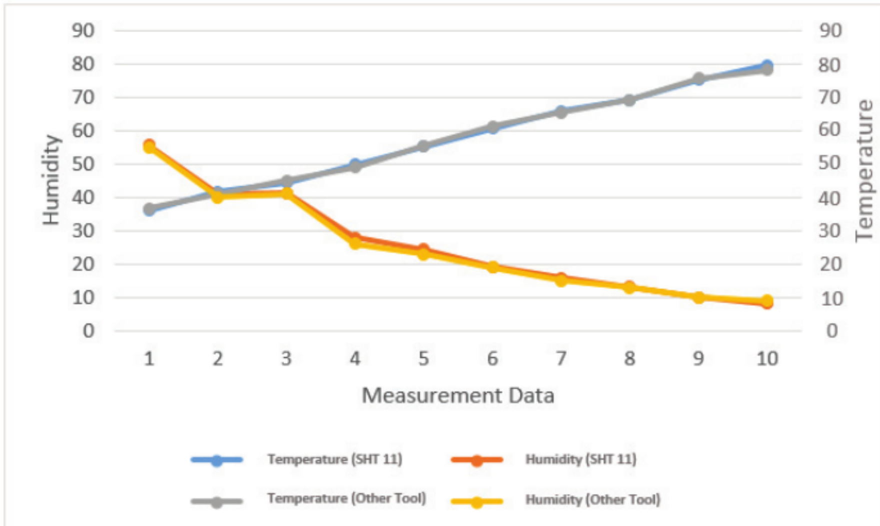


FIGURE 5. The Resulting Error Rate

Based on the graphic image of the test sample it can be seen that the error rate of the drying machine automation system has an error rate of 1.8.

Control process using fuzzy logic begins with the calculation of fuzzyfication of temperature and humidity values, the next step is inference using the implication function of max-min / min-max method, and final stage is deffuzyfication process using centroid method. From the rule viewer image shows that in the first test for the set point 40^0 and after entering the temperature of 40.07^0 with humidity 45.02, output result equal to 125 on heater, 125 on blower1 and 125 on blower2. In the second test for set point 50^0 and after entering temperature 50,05 ^{0} with humidity 28.23, output result equal to 125 output on heater, 125 on blower1 and 92,6 on blower2. In the third test for set point 60^0 and after entering temperature of 61.80^0 with humidity 16.90, output result equal to 129 on heater, 121 on blower1 and 46.2 on blower 2. Based on the results of the output value on the heater in the form of PWM signal is influenced by the size of the input temperature. The smaller the temperature value then the output value of the heater will increase to accelerate the heating in the dryer room to achieve the desired set point. The output value will decrease when the temperature will approach the set point and the heater output value will be stable if the set point value has been reached. The output value in blower 1 is influenced by the temperature input value, the higher the temperature in the dryer room the blower 1 speed will rise. This serves to flatten the drying result on the flour. The output value of the blower 2 is influenced by the humidity input value, the higher the humidity in the dryer room the blower 2 speed will rise. This serves to flatten the drying result on the flour.

Based on the graph in Fig. 4 (a) - 4 (c) the temperature measurements of the chamber at the 40ºC, 50ºC, and 60ºC set points are no different to achieve at the set point. Response to reach set point 40 is very fast that is at minute 3, while at set point 50 reach at minute 7, and at set point 60 reach at minute 11. One of the causes of that is the amount of drying room so to reach larger set points take longer. Testing has been done with fuzzy logic control has a good performance because it is able to achieve and maintain the temperature on the reference specified. Controls produce dry flour according to Indonesian national standard (SNI).

After calculation of statistic with t test on measurement of error rate of SHT sensor 11 (temperature and humidity sensor), hence obtained value of t arithmetic for table of temperature measurement is 0.3. As for the measurement of humidity is 1.8. The value of t arithmetic in the temperature and humidity measurement table is smaller than the value of t table is ± 2.262 on degrees of freedom (n-1) = 9 and the significance level of 0.05. It can be concluded that there is no significant difference in measurement results between the measurement results using SHT 11 sensors and comparison tools.

CONCLUSION

The study of automation systems of flour dryers using fuzzy logic control was successfully applied to the drying process of maize flour. Based on the test data, a good drying process is with a water content level of 15% (BSN) at 50°C. The time required to reach the set point temperature of 50°C is 7.05 minutes. Drying time with temperature 50°C for sample 500 gr is 1 hour with power capacity 127.6 Watt. Based on the test results, the drying process using temperature control fuzzy method can improve energy efficiency.

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REFERENCES

1. T. N. Prakash, "Land Suitability Analysis for Agricultural Crops: A Fussy Multicriteria Decission Making Approach," Master Thesis, International Institute for Geo-Information Scoence and Earth Observation Enschede, 2003.
2. B. Feizizadeh and T. Blaschke, *Land Suitability Analysis for Tabriz County, Iran: A Multi-Criteria Evaluation Approach Using GIS* (Routledge, London, 2012), pp. 1-23.
3. B. Rwubaste, P. I. Akubor and E. Mugabo, *Effect of Drying Methods on Functional and Pasting Properties of Orange Fruit (Citrus sinensis, L.) Peel Flour and Wheat Flour* (IOSR, Qatar, 2014), pp. 52-56.
4. V. K. Dukkipati, *Analysis and Design of Contol System Using Matlab* (New Age Internasional, USA, 2006), pp. 1-251.
5. K.S.S. Dewa, *Corn Self-Sufficiency in Indonesia: The Past 30 Years and Future Prospects* (Litbang, Jakarta, 2002), pp. 76-83.
6. P. Catalano, F. Fucci, F. Giametta, and G. La Fianza, *Agric. Eng. Int.* **10**, 1-10(2008).
7. J. Z. Chen, W. M. Tai and H. Y. Ge, *Fuzzy Control of Honeysuckle Drying by Microwave* (CMSAM, China, 2016), pp. 1-5.
8. K. D. Tarun and Y. Das, *American J. Eng. Res.* **2**(11), 86-97(2013).
9. A. N. Isizoh, S. O. Okide, A. E. Anazia and C. D. Ogu, *Int. J. Adv. Res. Artificial Intell.* **1**(3), 27-31(2012).
10. L.A. Zadeh, *Inf. Contr.* **8**(3), 228-353(1965).
11. W. Batayneh, O. Al-Araidah and K. Bataineh, *Int. J. Eng. Sci. Tech.* **2**(7), 65-72(2010).
12. M. Olejár, V. Cviklovič, D. Hrubý and L. Tóth, *Res. Agr. Eng.* **60**, S31-S36(2014).
13. S. F. Ardabili, A. Mahmoudi, T. M. Gundoshmian and H. Behfar, *Agric. Sci. Dev.* **5**(1), 1-5(2016).
14. W. Cai, S. Zhu, H. He, Z. Ye and F. Zhu, *Int. Conf. Comp. Comp. Tech. Agricult.* **368**, 79-89(2012).
15. S. E. Otean and M. Dulau, *Proced. Tech.* **19**, 569-575(2015).
16. L. Kumar, T. S. Rawat, M. Pandey and U. Kumar, *Int. J. Eng. Tech. Manage. App. Sci.* **3**(4), 183-187(2015).
17. P. Singhala, D. N. Shah and B. Patel, *Int. J. Inst. Control Sys.* **4**(1), 1-10(2014).

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