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Design and Construction of a Household Paddy Dryer with a Microcontroller

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ABSTRACT

This article had the aim of demonstrating the design and construction of a household paddy dryer using an Arduino UNO microcontroller that had the dimensions of 80 cm wide, 120 cm long, and 150 cm high. The 200-liter site for collecting paddy was controlled by the microcontroller and humidity sensor at two positions. The dryer had the paddles installed using an electrical motor. For the model, using 150 kg of paddy and the threshold moisture being at 30%, the test consisted of two conditions: 1) the motor operated every 20 minutes and the duration of the testing was three hours per each time, and 2) the motor ran every 20 minutes and the threshold moisture was set at 14%. When comparing the results by drying the rice on a general grain drying floor, the results showed that the original model of paddy drying using condition one could reduce the moisture by 22.6% and after drying on the floor, it could be reduced by 25%. Condition two could reduce the moisture by 14% after 11 hours. As a result, the model using condition one could reduce the moisture by 24.67%, which provided better efficiency than drying naturally on the floor.

Keywords: *Paddy dryer, Household Level, Microcontroller*

.1 Introduction

Rice is an agricultural economic crop that has generated valuable revenue for Thailand for a long time and is the main consumption of the people. Thai rice has the characteristics of good taste and fragrance, which is best for eating or cooking. Rice has been grown around the country, and there are several species. Nowadays, the price of glutinous rice is higher, so people tend to grow these strains of rice, but the quantity of products depends on the quantity of the production in accordance with the demand, supply, and the marketing mechanism. However, the main problem of farmers is the paddy contains high moisture, as they have mostly turned to using rice combine harvesters instead of manual labor, as it is cheaper, faster, provides a better capacity, but results in higher moisture than using labor. The farmers, therefore, must dry the paddy under the sun. If they cannot dry it, the rice will contain high moisture and the price would be low. If the rice is harvested at the appropriate duration, the kernels would contain approximately 20-25% of moisture. When the paddy is piled, the quality would be degraded; for example, it would be rotten, spoiled, yellow, have

a low-quality color, degraded kernels and grow faster. In consequence, this requires reducing the moisture to 14% for two-three months storage, but if longer than three months, the moisture should be reduced to 12%. The reduction of moisture is various; for example, sun-dry and using a drying method [1]. In general, a large rice mill would reduce the moisture by drying the rice under the sun, as it is a source of heat. This method is simple and cost-saving. On the other hand, the disadvantage is it requires a lot of manual labor and large space, as well as the quality of the rice cannot be controlled and it causes a loss in the weight and quality. Therefore, the rice mill has turned to using a kernel dryer to dry the paddy [2] resulting in higher costs. However, in the household, people still dry the paddy on the floor or in an open space. For the drying, researchers have presented electromagnetic waves infrared radiation [3-8], which is able to decrease the moisture quickly; still, this technique is expensive in terms of cost and building. This infrared radiation technique used to dry the paddy [9-11] has been offered and popularly designed and built for the industrial level due to its higher production cost. Some researchers have also introduced a heat pump dryer using temperatures of 45oC, 50oC, and 55oC, respectively, which is able to decrease the moisture in the rice [12]; in addition, the production price is not as expensive as the infrared radiation technique.
Consequently, this research would like to design and build a household paddy dryer, which would provide a low production cost and could be controlled by a microcontroller to be an original model for real usage. Moreover, this would aim to reduce the moisture to remain at 12-14%, as well as reduce the required space, time, and the cost. Farmers could build it from the community's materials, and it would reduce the waiting time to prevent the paddy from animals. This dryer could benefit the farmers and the community by increasing the value of their agricultural products and income. The results of this research would be information for developing the drying with a higher capacity in the future.

.2 Building and Testing a Household Paddy Dryer with a Microcontroller

The design and construction of the household paddy dryer with a microcontroller could be divided into three components: 1) the structure of the tank's stand, 2) the paddy storage tank, and 3) the Arduino UNO microcontroller (refer to Figure 1). For the first component, the structure of the tank's stand would have the dimensions of 80 cm wide, 120 cm long, and 150 cm high. The structure would contain four pillars for supporting the horizontal tank, which would be secured by steel bars on the two sides. One pair of the steel bars would have the roller installed, which would be installed on the head and the bottom of the tank, fixed with pulleys, to transfer the power from the one AC motor to roll the bars (refer to Figure 1).

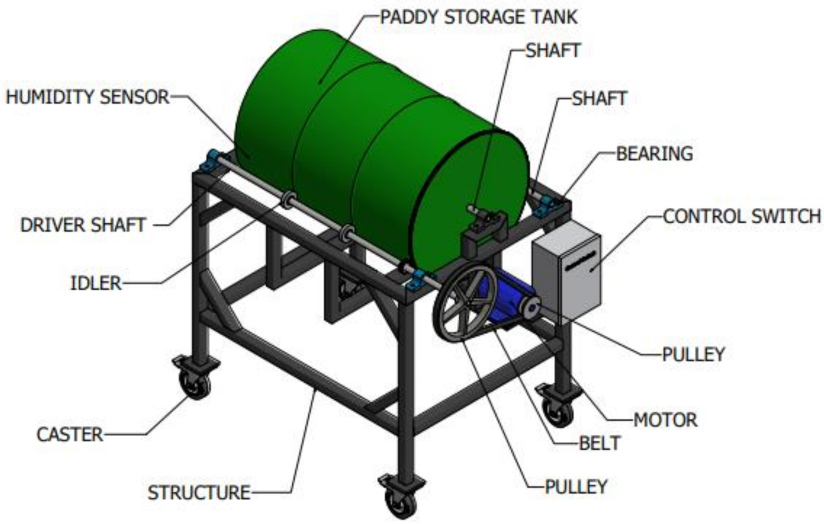

Figure 1: Design and construction of the household paddy dryer with a microcontroller.

For the second component, the paddy storage tank would have a capacity of 200 litters. Inside the rim of the tanks, paddles would be installed, and there would be a hole at each end of the tank to insert the sensor inside. For the third component, the automatic control would be composed of the Arduino UNO microcontroller (refer to Figure 2). This would connect to the two humidity sensors and control the electric motor. The result of the moisture would then be displayed on an LCD screen. The original model can be seen in Figure 3.

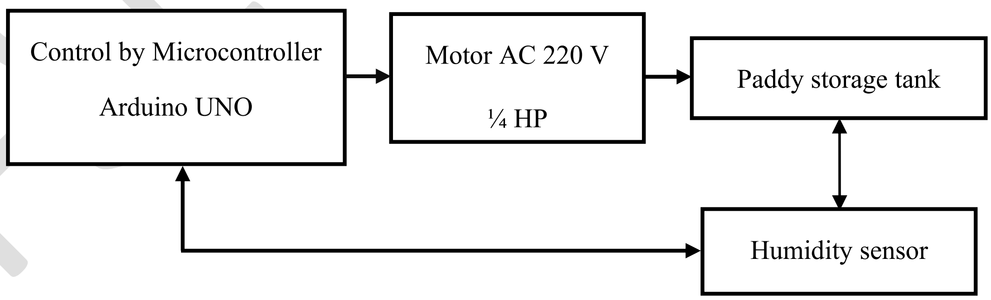

Figure 2: Automatic control by a microcontroller.

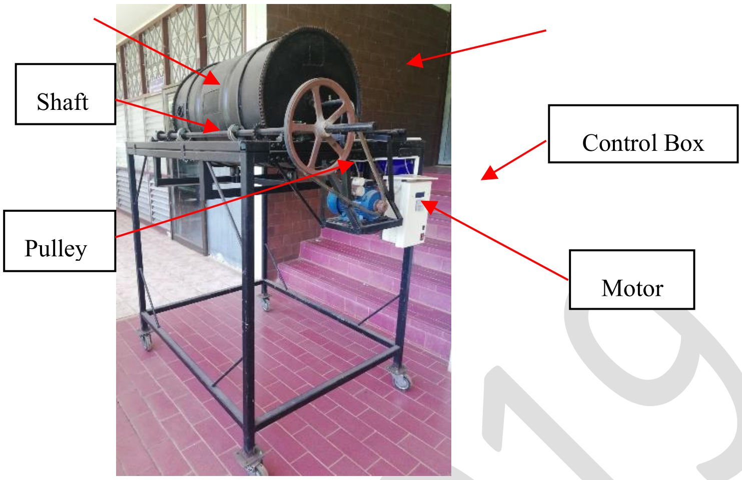

Figure 3: The household paddy dryer with a microcontroller.

The test of the original model's efficiency indicated the weight of the paddy to be 150 kg and the threshold of the moisture to be 30 %. The experiments were operated under two conditions.

1. Condition one: The motor was operated every 20 minutes, and the test took three hours.
2. Condition two: The motor was run every 20 minutes, but the threshold of the moisture was set at 14 %, and the motor stopped working.

In the comparison of the performance test between the aforementioned dryer and sun-drying, the moisture was measured five times to find the mean of the conditions.

.3 Results and Discussion

From the results of the experiments of a household paddy dryer with a microcontroller, it was shown that under conditions one and two, the original model could operate. The results of the five tests were in accordance with the conditions (refer to Table 1).

For condition one: the motor was operated every 20 minutes and the test took three hours. As seen in Table 2, the performance result showed that the moisture of the paddy inside the tank started at 30%. Then, after three hours, the moisture was reduced to 22.6% using a temperature of 33-46^{o}C while the sun-dried paddy had a threshold of moisture at 30%. After three hours, the moisture was reduced to 25%, and the outside temperature was 37-40 ^{o}C. Therefore, the change of moisture at 24.67% was better than using a sun-drying method at 17%.

Table 1: Results of the performance of a household paddy dryer with a microcontroller.

Test	1st Time	2nd Time	3rd Time	4th Time	5th Time	Result
Condition	✓	✓	✓	✓	✓	Matched

1						
Condition 2	✓	✓	✓	✓	✓	Matched

Table 2: Results of the household paddy dryer with a microcontroller according to condition one.

Time (Minute)	Household Paddy Dryer with a Microcontroller		Sun-drying	
	Moisture (%)	**Temperature (°C)**	**Moisture (%)**	**Temperature (°C)**
0	30	33	30	38
20	30	36	30	38
40	29.8	37	30	39
60	27.7	38	29.5	37
80	27.0	39	28.6	40
100	26.5	41	28.1	40
120	25.3	41	27.4	40
140	24.6	43	26.9	39
160	23.2	45	25.5	40
180	22.6	46	25.0	40

For the result of the performance of a household paddy dryer with a microcontroller according to condition two, the motor was run every 20 minutes. The temperature inside the paddy storage tank was 30.2°C, and after 11 hours, the humidity was reduced to 14%, which was the set level when the motor stopped working. With regards to the performance test in accordance with condition two, the original model could reduce the moisture to 14.0%, and the change of moisture to 55.33%, which was better than using a sun-drying method (refer to Table 3).

Table 3: Results of the household paddy dryer with a microcontroller according to condition two.

Time (Hrs.)	Moisture (%)	Temperature (°C)	Motor Status
07.00	30	30.2	Working
08.00	28.2	31.3	Working
09.00	25.7	32.0	Working
10.00	23.1	37.4	Working
11.00	21.2	40.2	Working
12.00	20.5	47.5	Working

13.00	18.0	51.1	Working
14.00	16.4	49.0	Working
15.00	15.5	41.4	Working
16.00	14.8	39.2	Working
17.00	14.4	38.4	Working
18.00	14.0	32.5	Stop

.4 Conclusion

Based on the research of a household paddy dryer with a microcontroller, it was found that when testing the performance of the dryer for five times in accordance with condition one, the motor was operated every 20 minutes and the test took three hours. The moisture of the paddy inside the tank started at 30%, and after three hours, the moisture was reduced to 22.6% using a temperature of 33-46°C. On the other hand, the paddy from the sun-drying method had a threshold of moisture at 30%, and after three hours, the moisture was reduced to 25% and the outside temperature was 37-40°C. According to condition two: the motor was run every 20 minutes, but the threshold of the moisture was set to%14 , and the motor stopped working. It was also found that the temperature inside the paddy storage tank before the test was 30.2 °C, and after 11 hours, the humidity was reduced to 14%, which was the set level when the motor stopped working. When comparing the moisture of the paddy after using the paddy dryer and sun-drying method, the dryer was capable of decreasing the moisture by 7.4% while the general method reduced the moisture by 5%. Therefore, the paddle dryer could reduce the moisture more than the sun-drying method by 2.4%. When comparing conditions one and two, the reduction of moisture was 24.67% and 55.33%, respectively, which provided better results than using the sun-drying method.

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References

[1] Rice Research and Rice Department. Rice Knowledge. (2010). Retrieved on 4th September 2019 from http://www.ricethailand.go.th/Rkb/postharvest/index.php-file=content.php&id=3.htm [In Thai]

[2] Preethong, S. (2016). THE STUDY OF FACTORS AFFECTING PADDY DRYING PROCESS USINGTHE DESIGN OF EXPERIMENT. Dissertation, Master of Engineering. Burapha University. [In Thai]

[3] J. Laohavanich and S. Wongpichet, "Thin-layer drying model for gas-fired infrared drying of paddy.Songklanakarin," J. Sci. Technol, vol. 30, no. 3, pp. 343-348, May-Jun. 2008.

[4] D. Zare, H. Naderi and M. Ranjbaran, "Energy and quality attributes wide hot-air/infrared drying of paddy," Drying Technology, vol. 33, pp. 570–582, Feb. 2015.

[5] G.P. Sharma, R.C. Verma and P. Pathare, "Mathematical modeling of infrared radiation thin-layer drying of onion slices," Journal of Food Engineering, vol. 71, no. 3, pp. 282–286, Dec. 2005.

[6] A.R. Celma, F. López-Rodríguez and F. Cuadros, "Experimental modeling of infrared drying of industrial grape by products," Food and Bioproducts Processing, vol. 87, no. 4, pp. 247–253, Dec. 2009.

[7] H.U. Hebbar, K.H. Vishwanathan and M.N. Ramesh, "Development of combined infrared and hot air dryer for vegetables," Journal of Food Engineering, vol. 65, no. 4, pp. 557-563, Dec. 2004.

[8] U. Teeboonma and S. Jongjam, "Ginger Drying Using Infrared-Vacuum Technique," Burapha Sci. J., vol. 15, no. 2, pp. 76-86, 2010.

[9] J. Laohavanich and S. Wongpichet, "Drying characteristics and milling quality aspects of paddy dried gas-fired infrared," Journal of Food Process Engineering, vol. 32, no. 3, pp. 442–461, Jun. 2009.

[10] I. Das, S.K. Das and S. Bal, "Drying kinetics of high moisture paddy undergoing vibration-assisted infrared (IR) drying," Journal of Food Engineering, vol. 95, no. 1, pp. 166–171, Nov. 2009.

[11] Saelim, N, Treeamnuk, T, and Treeamnuk, K. Development of a Continuous Flow Paddy Dryer with Infrared Radial Radiation Technique. RMUTP Research Journal, Vol. 12. No. 2 July-December 2018, pp. 37-46. [In Thai].

[12] Pituprompan, K, Poomsa-ad, N, Wiset, L. Drying of Paddy Seed Using Heat Pump Dryer. Journal of Science and Technology Mahasarakham University, Vol 32 No 5: September - October, 2013, pp. 622-625. [In Thai].

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