Design and Construction of a Controlled Temperature Food Product Dryer Based on a Programmable Logic Controller (PLC)

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Abstract

Drying food products using traditional methods relying on sunlight takes a relatively long time, especially with unpredictable weather conditions. Essentially, artificial drying using heat-based equipment provides several advantages, including: independence from weather conditions, adjustable drying capacity, controlled temperature, no need for extensive space, controlled drying conditions, and guaranteed and uniform drying quality. Therefore, this design aims to create a food drying apparatus with PLC control. PLC is used as the controller for this drying apparatus, allowing automatic drying of certain types of food. In this design, we connect a DC motor to rotate the drying cylinder with a PLC device by creating a ladder diagram and determining the inputs and outputs in the CX-Programmer application. The design utilizes three inputs and two outputs. It is important that the I/O is readable by the PLC so that the system operates according to the programmed instructions.

Keywords: *Drying Machine, Programmable Logic Controller (PLC), Controlled Temperature.*

I. INTRODUCTION

Until now, agriculture in Indonesia has not been able to show maximum results if we can see from the welfare of farmers and the national income generated from this sector. Even though the natural resource potential is large and diverse, apart from that, the share of national income is quite large, the size of national exports , and actually the Indonesian population depends on this sector for their livelihoods, and also the role of farmers who provide food for the community.

So far, food products are sold directly and the rest is dried. One way people dry their food is by traditional drying. Drying traditional food products that rely on sunlight takes a relatively long time, especially in uncertain weather conditions. Basically, artificial drying using a heat addition tool provides several advantages, including: it does not depend on the weather, the capacity of the dryer depends on your wishes, the temperature can be controlled, it does not require a large area, and the drying conditions can be controlled and the quality of the drying results is more guaranteed and uniform.

The technology used in the previous research "Design of a Controlled Temperature Food Product Dryer (*Rotary Dryer*) has similarities to what will be made, namely the shape of the tool. However, the difference is that this tool is based on *a Programmable Logic Controller* (PLC).

II. LITERATURE REVIEW, THEORY OR HYPOTHESIS DEVELOPMENT

Drying too quickly can damage the material, because the surface of the material dries too quickly so that it cannot be compensated by the speed of water movement in the material towards the surface. Therefore, it causes hardening on the surface of the material and the water in the material can no longer evaporate because it is blocked. Besides that, drying operations at temperatures that are too high can damage the material. Setting the temperature and length of drying time is done by paying attention to the contact between the dryer and the heating device (either in the form of hot air flowing or other heating devices). However, for nutritional standard considerations, heating is recommended no more than 85° C. (Mc. Cabe. 2002)

Biologically, newly harvested grain is still active so the respiration process is still ongoing which produces CO2, water vapor and heat, biochemical processes are still running fast. If

this process is not controlled immediately, the grain will become damaged and the rice will be of low quality. If temporary storage is to be carried out, the grain must be dried to a minimum moisture content of 16% so that it is safe and there is no quality damage. Milling is carried out if the grain has been dried to a moisture content of between 13-14% so that the quality of the milled rice is better (Umar and Herawati, 1992).

Dry basis water content can be determined using equation (2.2).

$$y = \frac{Wm-Wd}{Wd} \times 100\% \qquad (1)$$

Where:

y = Dry weight water content (%)

Wm = Weight of water in the material (gr)

Wd = Absolute dry weight of material (gr)

III. RESEARCH METHODS

The procedure for making a food product dryer (PLC) is first done by making *the hardware* of the tool by following the tool design architecture, then making *the software* using the CX- *Programmer application.*

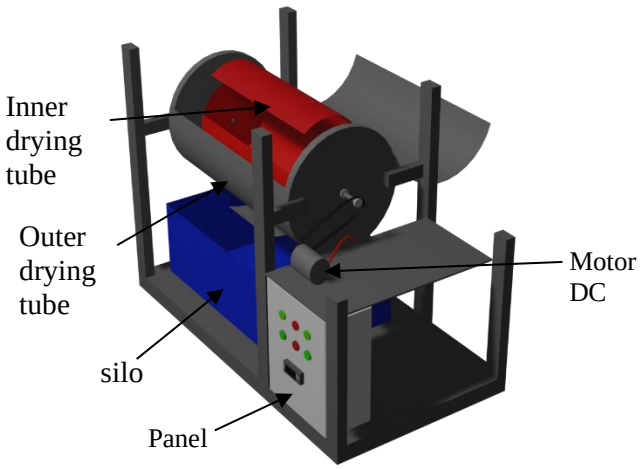

Figure 1. Tool Construction

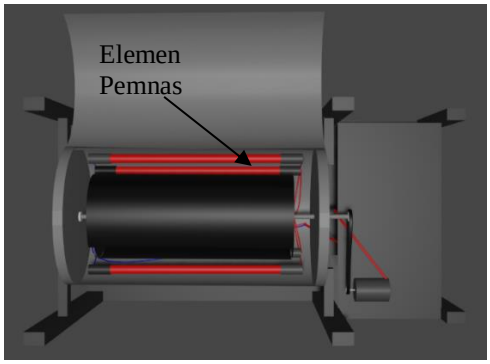

Figure 2. Top view of tool construction

In this research, a method of measuring the moisture content of food ingredients is used by drying the food ingredients until the moisture content of the food ingredients is between 13% - 16% so that there is no damage to the quality of the food ingredients. Water content is measured by weighing the food before and after drying.

IV. RESULTS AND DISCUSSION

Part of the activity carried out in this research is designing and assembling the components of the temperature controller (thermostat) module, PLC and *software testing has also been carried out* by drawing up a PLC *ladder diagram* in the CX- *Programmer application* and *hardware* by testing drying without food and with food. .

Software Testing

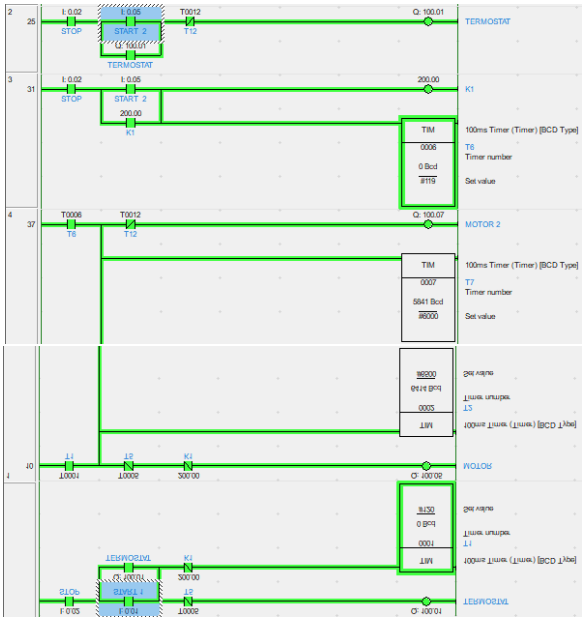

Figure 4.4 PLC Program Testing

Hardware Testing

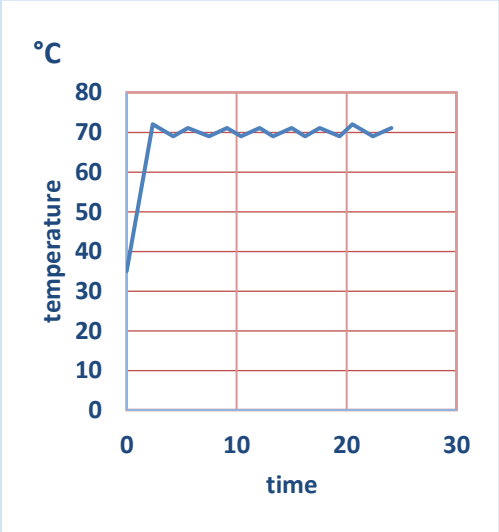

Figure 3. Graph of temperature readings on the tube

Based on Figure 3, it can be seen that the average temperature in the heating tube is 70°C, in accordance with the temperature used for drying rice and corn food.

Table 1. Test results of the rice drying process

No.	Initial Weight	Drying Time	Final weight	Water content (%)
1.	500 grams	10 minutes	480 grams	27
2.	500 grams	20 minutes	465 grams	21.5
3.	500 grams	30 minutes	440 grams	15.4
4.	500 grams	40 minutes	415 grams	8.6

Table 2. Corn drying process test results

No.	Initial Weight	Drying Time	Final weight	Water content (%)
1.	500 grams	10 minutes	490 grams	33
2.	500 grams	20 minutes	475 grams	30
3.	500 grams	30 minutes	450 grams	25
4.	500 grams	40 minutes	430 grams	21
5.	500 grams	50 minutes	415 grams	18
6.	500 grams	60 minutes	400 grams	15

V. CONCLUSION

A PLC-based food dryer has been successfully created and works at a temperature of 70°C controlled directly using a thermostat. Different drying times were obtained depending on the type of food, for rice with an initial weight of 500 grams it took 30 minutes to obtain the desired water content and the final weight obtained after drying was an average of 4 40 grams with an average water content of 15.4 %. For corn with an initial weight of 500 grams, it takes 60 minutes to obtain the desired water content and the final weight obtained after drying is an average of 400 grams with an average water content of 15 % .

THANK-YOU NOTE

We would like to express our thanks to all our friends who have helped carry out our research activities, namely the design of a PLC-based dryer, especially to PNUP which has facilitated the design of this tool so that it can be completed.

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