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Multifunctional Agricultural Crop Dryer Machine

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Abstract:

This study describes a Multifunctional Agricultural Crops Dryer Machine equipped with motors and sensing elements as a tool used for the controller. The study conducted is designed based on the temperature-process controller. This controller is used to control the temperature by setting the Set Value and the Proportional-Integral-Derivative function of the process. To achieve the desired value to dry the grains, the Process Value must be equal to the Set Value. The Process Value must reach the set value. The process value is coming from the sensing element, which is the thermocouple. The machine will reduce the labour and efforts involved in the manual drying specifically sun drying, increase its demand, enhance production, and make operational processes more convenient. The study also shows a much safer and efficient dryer machine because of the innovated design that provides better drying process. The machine is cost-effective.

***Keywords* — Proportional Integral Derivative, Multifunctional Dryer Machine, Temperature-Process Controller, Thermocouple, Crop dryer**

I. INTRODUCTION

The rapid development of technology nowadays provides huge impact in the industry. In agricultural setting, different machines used to increase the production and provide high quality food crops. In a machine, one of the instruments used is a dryer. Dryers are insulated to reduce heat losses, and they circulate hot air to save energy [1]. Drying is a process of removing relatively small amounts of water, or other liquid from a solid material in order to reduce the content of residual liquid to an acceptable value [2]. Sun drying was usually a single pass operation, which did not allow the grain to go through a tempering phase to relieve internal stresses. As a result, small fissures were formed [3]. Sun drying in the Philippines has become notorious among its peers in post-harvest forums for its "highway dryers". The Filipino observes with humor that they have the longest rice dryer in the world. There are reports that to be able to get the farmers off the roads with their paddy, the government through NAPHIRE has been subsidizing the construction of multipurpose pavements principally for sun drying in every village. It was found that majority of the farmers in the Philippines that uses the method of sun drying in drying of crops, consume space the same as the size of a basketball court which is very much spacious than to use a machine. Unfortunately, sun drying of crops is unreliable. The sun may not be available when it is most needed; if it rains for a week during harvest time the grain is likely to germinate, yellowed or rotten; when there is sun shine in the morning and the grain is spread out, a sudden rain storm can cause fissured grain; if the sun is hot, the workers prolong mixing the grain and the result again will be fissured grain. A miller interviewed in Laguna, Philippines, said that despite the greater expense of drying rice in their heated air dryers (estimated cost 5 times more), they could not afford to sun-dry anymore because of the damage to grain quality is more expensive for them. In the Philippines, the simple flatbed batch dryer was designed and introduced in the 1970's. The Filipino farmers did not accept the technology. The basic complaint was the higher cost of the flat bed drying compared to sun drying.

The main purpose of drying farm products is to reduce its water level from the harvest level to the safe storage level in order to extend its shelf life. Once the products have been dried, its rate of deterioration due to perspiration, insect infestation, microbial activities and biochemical reactions should diminish leading to maintenance of the quality of the stored product. The evaluation of the drying process requires knowledge of a number of parameters of drying techniques, such as the characteristics of the material, optimum drying temperature, the coefficient of conductivity and transfer, and the characteristics of shrinkage. In most cases these parameters cannot be evaluated using analytical method hence the use of experimental procedure is much preferred.

II. METHOD

A. Process

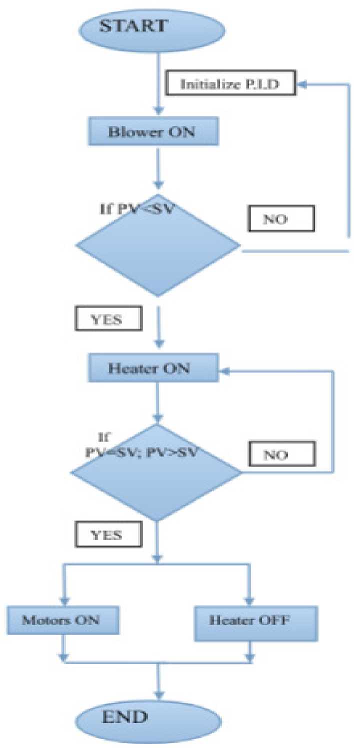

Fig. 1 Process Flow of the System

Shown in Figure 1 is the process flow of the system, which is controlled by the temperature-process controller. Hence, the process inside the machine is that from the hopper, the grains will pass to the 3-layer screen, heating process, blower and out through the System Temperature Controller.

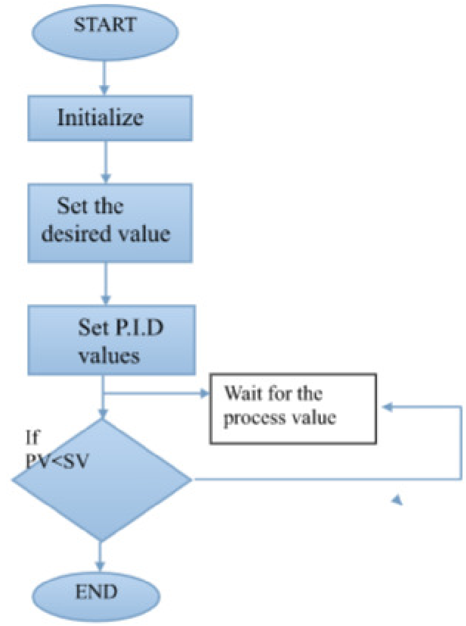

Fig. 2 PID Tuning Process

Since a temperature-process controller controls the system, Figure 2 shows the PID tuning process of the temperature-process controller. When the operator turns the controller on, the first thing that will happen is the initialization of the values. After that, the operator will set the desired value and the PID values. If Process value (PV) is less than the desired value (SV) the controller will still wait and the heater is still on. When the process and the set values are equal the heater turns off.

B. Design and Development

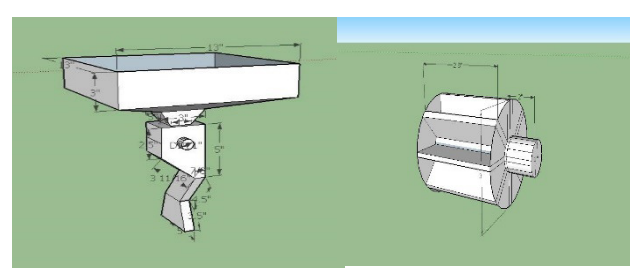

Fig. 3 Hopper with Propeller

Shown in Figure 3 is a roller that is connected to the hopper and the roller is connected to the propeller that is controlled by a wiper motor. The propeller is located inside the hopper. It helps to control the amount of grains entering in the machine.

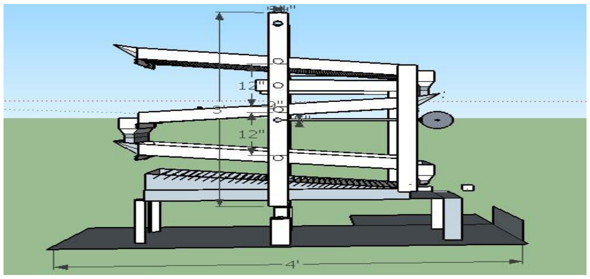

Fig. 4 Screen

The screens of the machine are shown in Figure 4 that are connected to a solid metal with a small shaft and bearings. The bearing helps the screen to move smoothly. There is also a vibrator that is connected to the screen, which helps the screen to be shaken slowly in order for the grains to move down from one screen to another.

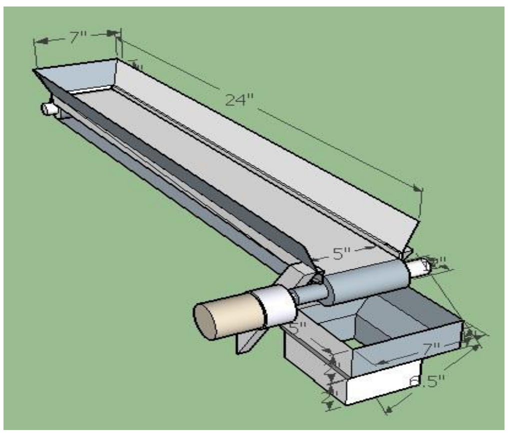

Fig. 5 Conveyor

Shown in Figure 5 is the conveyor of the machine that is controlled by a DC motor. This acts as the passage of the finished product to go out from the machine. There is also a hopper attached below the conveyor that will control the amount of grains going out from the machine and will also make sure that there will be no waste of finished product that goes out.

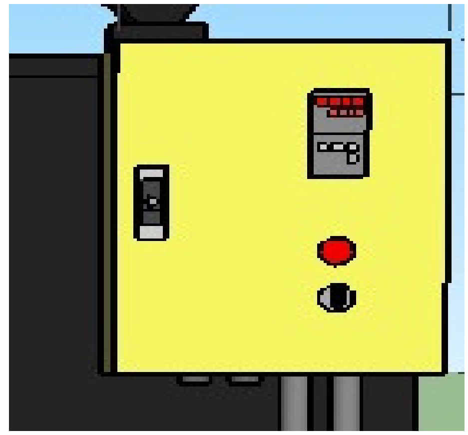

Fig. 6 The Control Panel

Shown in Figure 6 is the control panel system that contains the electrical wirings of the system. Shown outside the panel is the temperature-process controller, heat indicator lamp, and one-position metal-headed switch are also shown above. While inside the panel, there is a contactor with overload contact, 3 relays, breaker and a timer. The connection of the AC motor is connected to the contactor. The relays are for the heater, fan, and the DC supply, which is the wiper motors.

III. RESULTS AND DISCUSSIONS

A. *Design and Development*

Shown below is the Figure 7, which is the isometric view of the finished prototype. Testing the machine comprises the speed of the motor, sensor functionality, the mobility of the system, accuracy of the program, structure durability and its reliability. The motor is used to control the vibrator of the screen. In testing, it was found out that the motor's speed is too fast for such a dryer machine. Therefore, to achieve the desired rpm for the motor using of pulleys are done. The process flow was followed correctly and thus, problems in the sensor were found. Sensors must be calibrated well so that the machine would work more efficient. There are minor changes done in the program and in the Temperature-Process Controller just to have a precise output. The mechanical parts of the machine must be weld properly in order to have best structure durability.

Experiments were conducted to determine if the Automated Dryer is more effective and efficient than the sun drying method in drying of crops.

Fig.7 Isometric view of the Machine

Shown in Table 1 are the results of the trial 1. There are 2000g of grains were prepared. In each method it must have an equal amount of grain (1000g each). Seen on the table is the time, temperature during the test the initial weight of the grain before dried (Ww), the final weight after dried (Wd) and the loss of moisture content of the grain in using the of both method. Therefore, based on the data the machine drying method dries the grain in a shorter period of time compare to the sun drying method. Thus, machine-drying method has greater loss of moisture content in the grain compare to the other method.

TABLE I
The First Trial

Ways	Time	Temperature	Ww	Wd	Mn
Sun drying	35mins	31˚C	1000g	948g	5.20%
Machine drying	6mins and 32 secs	58˚C	1000g	946g	5.40%

Trial 2 is also done in order to verify the first result in the first trial. The same process as in the first trial is done and the same initial weight of grain was used. Based on the gathered data, still the machine drying method dries grain in a shorter period of time and has a greater loss of moisture content in the grain.

TABLE II
The Second Trial

Ways	Time	Temperature	Ww	Wd	Mn
Sun drying	10mins	31˚C	1000g	987g	1.30%
Machine drying	6mins and 32 secs	58˚C	1000g	946g	5.40%

IV. CONCLUSION

The study conducted on the development of multifunctional agricultural grains dryer machine was fulfilled especially in terms of its mobility and functionality. The result of the evaluation in terms of its functionality exemplifies that the researchers have reached the objectives specified.

While sun drying depends on the weather, the heat in the machine drying method can be manipulated which tends to dry grains faster than the sun drying method. Based on the testing, evaluation and all the trials done the machine drying method is more efficient and effective than sun drying in terms of drying grains. With this low cost yet efficient drying machine, it helps the farmers here in the Philippines to do less human labour and to do faster production compare to the production than in using the sun drying method. Overall, the machine is very reliable in terms of its quality and performance.

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