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Research Article

Design and Manufacture Indirect Method Grain Bed Dryer with 10 Kg Capacity Fueled by Wasted Oil

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A B S T R A C T

Artificial grain dryers use additional heat to dry the grain, the energy source for this machine is fuel, gas, husks, and firewood. The dryer used in this study uses wasted oil with the indirect method. This grain dryer with wasted oil helps us make the environment stay clean. The purpose of this research is to design and manufacture a bed dryer type grain dryer with a capacity of 10 kg fueled by wasted oil, with the target of drying grain to a moisture content of 13-14%, dry grain is odorless, the drying cost is relatively cheap because it uses used lubricating oil. The machine is made by the selected design. Including bed dryer, plenum chamber, hot air duct, heater box, stove, oil reservoir, and oil line. The results of the design and manufacture obtained bed dryer dimensions and plenum space 120x50x100cm, a cylindrical stove with a diameter of 20cm and a height of 20cm which is connected by a channel to an oil reservoir with a maximum capacity of 30 liters. This tool succeeded in drying grain from 30% and 38% to 13% moisture. Heating uses indirect or indirect methods so that the air that heats the grain does not contain oil. The heated grain is clean and does not smell of oil.

1. INTRODUCTION

Drying grain naturally uses solar power as an energy source, where the grain is placed on a drying floor or tarpaulin. Natural drying has disadvantages, such as the drying process depending on the weather and required a large drying place [1] and uses human senses as a measuring instrument to find out grain dryness [2].

Recommended grain humidity is 13-14% [3], [4], while harvested grain in general has a water content of 21-26% [5]. Grain with high humidity will damaged the rice, the rice will be rotten, moldy, and discolored. Meanwhile, grain with a low water content will cause rice grains to break or break easily so that it will produce a lot of broken rice or groats [5].

An artificial grain dryer is a grain dryer that uses additional heat to dry the grain, an artificial grain dryer generally uses several fuels, including gas, husks, and firewood. In this study, a grain bed dryer was produced with an indirect method of 10 kg capacity fueled by wasted oil [2], [6]–[8]. The advantage of using the indirect method is that the grain does not have direct contact with smoke from the combustion of oil so the grain have their natural aroma [3], [9]–[12].

The fuel oil uses wasted oil. Due to the development of the transport and industrial sphere, increasing the use of oil. The increasing need for lubricating oil means that more and more used lubricating oil is being discarded. This will raise concerns about environmental pollution if the lubricating oil is disposed of in any place [7], [8]. Wasted oil or

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lubricating oil can also be used as an alternative fuel, one example is in the manufacture of burners where the burner can be used as a drying device in industry or can also be used as a stove for cooking. According to Hernady [2] pollutant gas that is harmful to humans, namely SO_2 (sulfur dioxide) in oil combustion, which is 4.5 μg/Nm^3, where the quality standard of SO_2 (sulfur dioxide) determined by PP RI No. 41 of 1999 is 900 μg/Nm^3, so it is quite safe [13].

Table 1. Data parameter [2]

No	Sample	Parameter	Unit	Result	Quality standard
1	Sample 1 (Wasted Oil)	SO_2 (Sulphur Dioxide)	μg /Nm3	4,5	900
2	Sampel 2 (Wasted cooking oil)	SO_2 (Sulphur Dioxide)	μg /Nm3	ND	900

ND = *Not Detected*

2. METHODOLOGY

2.1. Tool Scheme

The grain dryer machine is designed according to the scheme in Figure 1., which consists of three main parts. Such parts are the plenum chamber, heater, and oil collection point. Components to be designed and manufactured include bed dryer, hot air duct, heating box/heater, stove, fuel line, and oil reservoir.

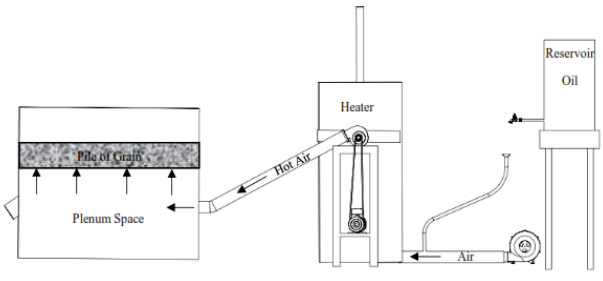

Figure 1. Grain Dryer Scheme

2.2. Design and Material Specification

Table 2. Design and Material Specification

No	Name	Dimension	Material
1	Bed Dryer	Length: 120 cm Width: 50 cm Height: 100 cm	Frame Material: Iron Elbow Wall Material: inner wall plate 0.5 mm outer wall zinc plate 0.5 mm
2	Hot Air Box	Length: 55 cm Width: 55 cm Height: 120 cm	Frame Material: Iron Elbow Wall Material: inner wall 2 mm steel plate, zinc plate outer wall 0.5 mm
3	Hot Air Duct Pipe	Length: 55 cm Diameter: 10 cm	Steel Pipe S45C
4	Combustion Chamber	Height: 20 cm Diameter: 20 cm	Pipe SG295
5	Air Duct Pipe	length: 70 cm Diameter: 5 cm	Steel Pipe
6	Blower	Blower 2 inch Rpm: 3000	
7	Oil Line Pipe	length: 100 cm Diameter: 0,8 cm	Steel Pipe
8	Blower	Blower 4 inch	
9	Blower Drive Motor	Rpm: 1420	
10	Hot Air Duct Pipe to Bed Dryer (Drying Tub)	Diameter: 10 cm Height: 125 cm	Steel Pipe
11	Used Oil Reservoir	Bucket 30 L	
12	Faucet	Ball Valve 1/8”	
13	Hole Plates	5 mm Hole Steel Plate	

2.3. Manufacturing Process

Table 3. Manufacturing Process

No	Manufacturing process
1	Material cutting process using an automatic chainsaw serves to cut steel pipes
2	Splicing process using a welding process
3	Installation of the bed dryer frame (Heating Tub) using elbow iron and hole steel plate.

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4	Installation of insulators on the bed dryer (heating tub) using glass wool where the insulator
5	Installation of the outer wall using a 0.5 mm zinc plate
6	Installation of the hot air box frame using an elbow iron
7	Installation of pipes on hot air boxes
8	Wall mounting on a hot air box using a 2 mm steel plate
9	Installation of insulators on hot air boxes using glass wool
10	Installation of the outer wall on the hot air box using zinc plates
11	Making holes in the furnace using cutting torches

3. Result and Discussion

The grain dryer machine designed is shown in Figure 2. Figure 3 shows the image captions of each components.

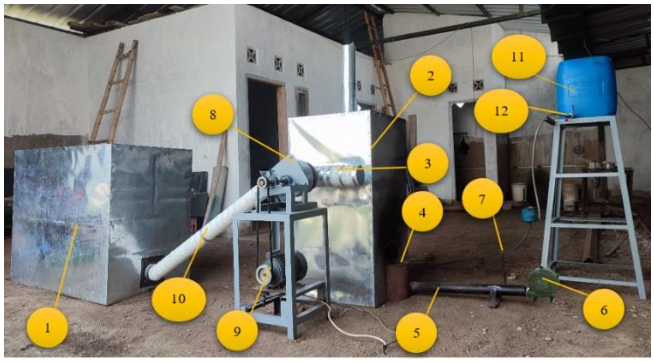


Figure 2. Grain Dryer Components

a. Bed Dryer

b. Hot air box

c. Hot air duct pipe

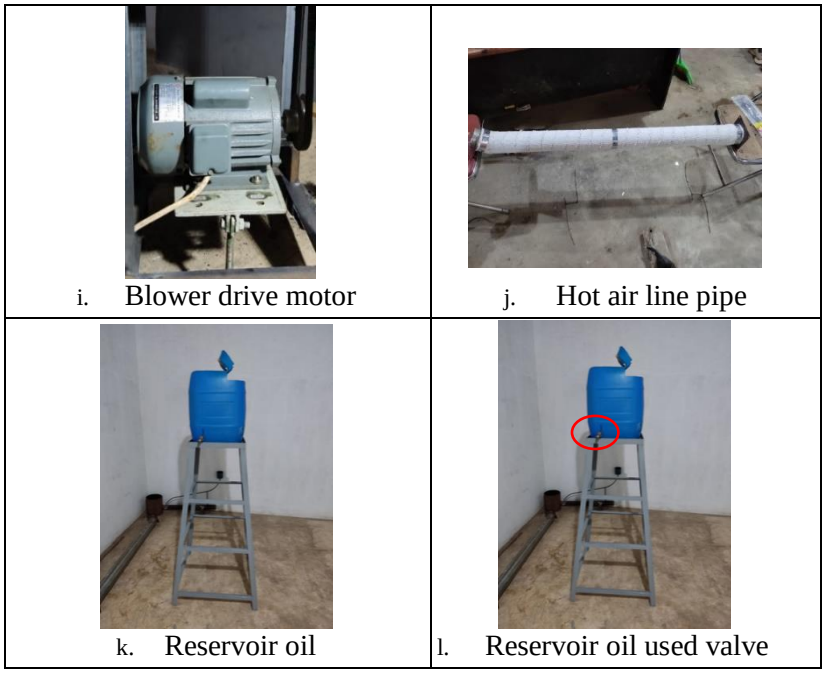
d. Combustion chamber

e. Air duct pipe

f. Blower

g. Oil line pipe

h. Heat sucking blower



i. Blower drive motor

j. Hot air line pipe

k. Reservoir oil

l. Reservoir oil used valve

Figure 3. Image captions of grain dryer machine components

The oil in the reservoir is flowed into the combustion chamber as fuel, then the fire is ignited in the combustion chamber which produces heat in the hot air box, the heat in the hot air box will be sucked in by the hot air sucking blower through the Hot Air Line Pipe to Drying Room to the bed dryer, then the rice above the bed dryer will receive the heat until the rice is reduced in water content.

From Table 4 there was a mass reduction of 0.5 kg for grain with an initial moisture content of 30% to reach a moisture content of 13%, while for grain with an initial moisture content of 38% the mass reduction reached 1 kg. From the test results can be obtained the average time to dry 10 kg of grain from a moisture content of 30% to 13% is 28 minutes and the average time to dry 10 kg of grain from a moisture content of 38% to 13% is 65 minutes. The drying temperature or air temperature in the bed dryer during the drying process is 29-35°C. Fuel used oil required 1 liter per 20 minutes. The shrinkage of grain mass is 0.05% for grain moisture content of 30% and 0.1% for grain with an initial water content of 38%.

Table 4. Test results of drying machines

	Humidity (%)		Temperature bed dryer (℃)		Time (Min)	Mass Grain (kg)	
	Start	Finish	Start	Finish		Start	Finish
1	30	13	28	67	35	10	9.5
2	30	13	74	76	20	10	9.5
3	30	13	50	71	30	10	9.5
4	38	13	28	73	70	10	9
5	38	13	67	73	60	10	9
6	38	13	50	73	65	10	9

In a comparison of the length of drying for grain, the initial moisture content of 30% can be seen in the chart from Figure 4 while the drying time for grain with the initial moisture content of 38% can be seen in the chart from Figure 5.

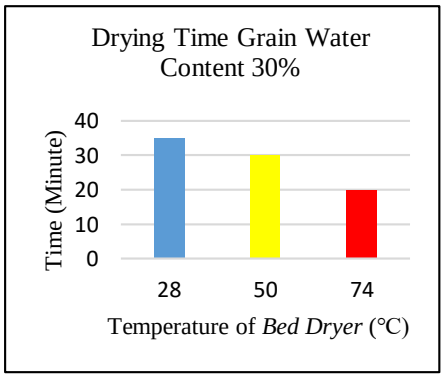


Figure 4. Graph of Drying Time of Grain Moisture Content 30%

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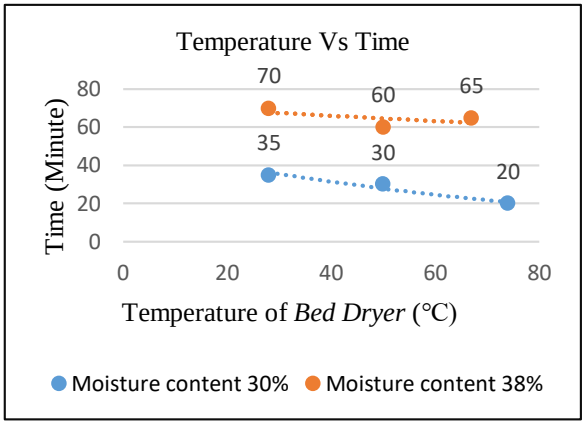

Figure 5. Grain Drying Duration Chart Moisture Content 38%

Figure 4. Shows a graph of the length of drying grain with an initial moisture content of 30% until it reaches a moisture content of 13%. The drying time of grain moisture content of 30% at the initial temperature of the bed dryer 28 °C is 35 minutes, at the initial temperature of the bed dryer 50 °C is 30 minutes and the length of drying grain the moisture content of 30% at the initial bed dryer temperature of 74 °C is 20 minutes to reach a moisture content of 13%.

Figure 5. Shows a graph of the length of drying of grain with an initial moisture content of 38% until it reaches a moisture content of 13%. The drying time of grain moisture content of 30% at the initial temperature of the bed dryer at 28 °C is 70 minutes, at the initial temperature of the bed dryer at 50 °C is 65 minutes and the drying time of the grain moisture content of 38% at the initial bed dryer temperature of 67 °C is 60 minutes to reach a moisture content of 13%.

From the old chart of drying grain above, it can be seen that the high initial temperature of the bed dryer results in a faster grain drying time to make the drying of grain sustainable or continuous, without turning off the stove first.

From the graph in Figure 6, it can be seen that drying grain with an initial moisture content of 38% takes time, which is an average of 57% longer than the initial moisture content of 30% grain. It can be said that the higher the moisture content, the longer the drying time required will be. Water content decreases as temperatures increase.

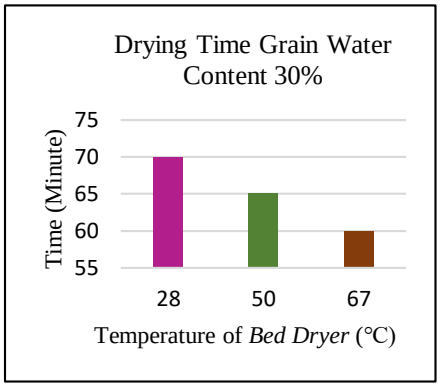

Figure 6. 30% and 38% Moisture Regression Chart

4. CONCLUSION

The design and manufacture of a bed dryer type grain dryer with a capacity of 10 kg have been successfully carried out to produce a tool with a bed dryer dimension of 120x50x100 cm, a cylindrical stove with a diameter of 20cm, and a height of 20cm which is connected by a channel to an oil reservoir with a maximum capacity of 30 liters.

This tool successfully dries grain from a moisture content of 30% and 38% to 13% with an average drying time of 28 minutes for grain with a water level of 30% and 65 minutes for grain with a moisture content of 38%, spending 1-liter of used oil every 20 minutes. The drying temperature or air temperature in the bed dryer during the drying process is 29-35°C.

Heating uses indirect or indirect methods so that the air that heats the grain does not contain oil. The grain is clean heating and does not smell of oil.

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