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Dryer-Cleaner Machine for Ricehull as Litter Material for Broiler-Breeder Production

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Abstract
Rice hull, being considered as one of the best bedding materials for broiler-breeders, is also a home for microorganisms including pathogens. The impurities present on the rice hull and the wet condition brought by several factors such as the open location, dry and wet season, enhances degradation on the quality of the material. With this, the study was conceptualized to develop a machine for rice hull drying and cleaning through removal of moisture and impurities. The machine is a continuous fed, convective-type, single-pass, horizontal dryer with cleaner. It operates on the principle of simultaneous effect of drying and sieving actions. The machine uses fined-type electric heaters as heat source. It is composed of six major assemblies; dryer-cleaner assembly, power transmission assembly, fan-heater assembly, hopper assembly, discharge chute assembly, and frame assembly.

Keywords: ricehull, broiler, decontamination

1. INTRODUCTION

Broiler breeder is one of the fastest and most progressive animal enterprises today. Broiler production shares 34.45% or that is equivalent to 64.22 million birds from the total 186.37 million birds in the 2019 total chicken distribution inventory. Most broilers were raised under contract growers or independent growers and provide the majority of chicken meat in the Philippine local market.

Broiler chickens are normally reared in poultry bedding materials called litter. Different agricultural by-products such as rice hull, rice straw, saw dusts, and some other inert materials are being used. Today, rice hull is in demand and considered as one of the best bedding materials because of a good moisture absorber quality, light weight, quick drying, abundant and cheap.

Despite of its amazing characteristics, rice hull is also a treat to broiler chickens. These materials, which is normally seen uncovered, are prone to visit and gets urinated by wild animals. And the soil which act as long-term reservoir for microbial life is suspected to be the source. Through time, the quality of rice hull starts to degrade and eventually leads to contamination. Thus, this project aimed to develop a dryer-cleaner machine for ricehull as litter material for broiler-breeder production.

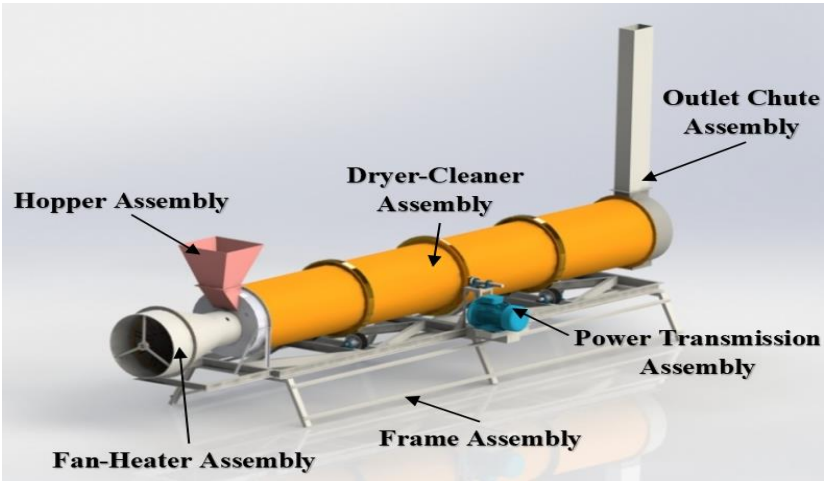
2. Methodology

Design of the machine

To date, specifically in the Philippines, there is no available machine specific for rice hull disinfection. As

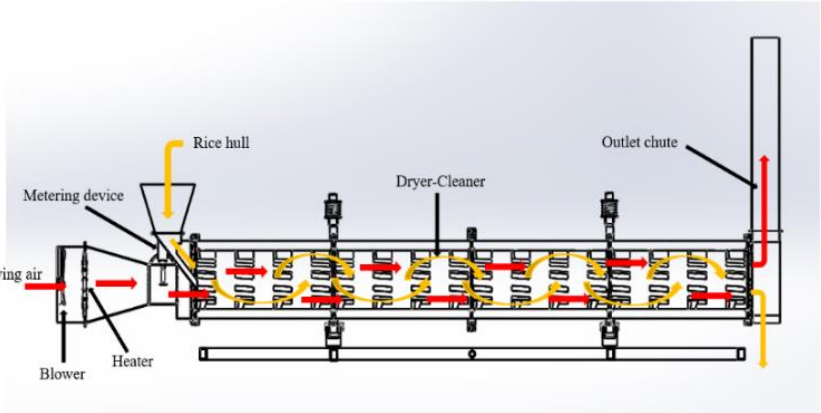
initial step, the ricehull dryer-cleaner was designed to clean and dry the ricehull before its introduction to the broiler house. The major components of the machine are dryer-cleaner assembly, power transmission assembly, fan-heater assembly, hopper assembly, outlet chute assembly and frame assembly (Figure 1).

Figure 1: Design of the ricehull dryer-cleaner machine



The technology is a continuous fed, convective type, single pass, horizontal dryer-cleaner machine. It operates on the simultaneous effect of drying and cleaning through sieving action. Material flows concurrently with the heated air being introduced in one section, as shown in the Figure 2, and exits on the opposite end of the machine.

Figure 2: Ricehull and heated air flow



Experimental treatment and statistical analysis

Complete Randomized Design (CRD) experiment was used in the study. Sources of variation were presented on ANOVA table at 5% level of significance. Comparison among means was tested using Least Significant Difference (LSD). Two factors were considered in the study, Factor A (operating speed of the dryer-cleaner machine) with three levels; 5rpm, 6rpm, and 7rpm and Factor B (temperature range of the drying air) with three levels; 80℃ to 95℃, 96℃ to 111℃, and 112℃ to 127℃. The parameters such as machine capacity, cleaning recovery and noise level will be tested under the influenced of the operating speed alone. Other parameters including power consumption and rate of moisture reduction will be tested under the influenced of both the operating speed and temperature of drying air.

3. Results and Discussion

Description of the Machine

The rice hull dryer-cleaner machine is composed of two concentric cylinders connected with sliding rim. The machine is a continuous fed, convective type, single pass, horizontal dryer with cleaner. It operates on the principle of simultaneous effect of drying and sieving actions. The machine uses electric heaters as the heat source and a blower-coupled motor is used to force the heated air inside the cylinders. Materials lifters or flights was installed on the interior surface of inner cylinder to; first, lift the materials and create a rainfall effect for more effective convective drying and second, to aid the material advance as it rotates. The machine has an overall dimension of 7955 mm x 1660 mm x 3335 mm and has six major assemblies; dryer-cleaner assembly, power transmission assembly, fan-heater assembly, hopper assembly, discharge chute assembly, and frame assembly. Machine specification is given on Table 1.

Shown in Table 2, the summary on the performance parameter of the machine as influenced by the operating speed of the cylinder. The highest machine capacity of 208.9 kg/hr was obtained at 7 rpm cylinder speed while the lowest capacity of 174.2 kg/hr was observed at 5 rpm cylinder speed. Analysis of variance revealed that the speed of cylinder has a significant effect on the machine capacity. With an increasing operating speed, there is a significant increase in the capacity of the machine. Similar case was observed in the evaluation of carrot washer by Denson (2015), where the throughput capacity increase with an increasing speed.

Additionally, the highest cleaning recovery of 82.78% was obtained at 7 rpm cylinder speed while the lowest recovery of 81.11% was observed at 5 rpm cylinder speed. The cleaning recovery was lower under 5 rpm compared to higher rpm due to the fact that at low speed, more rice hull passes through the perforation due to the slow-motion rotation thus, fewer rice hull will be recovered in the discharge chute. Analysis of variance on the cleaning recovery revealed that the speed of cylinder has no significant effect on the machine cleaning recovery.

Moreover, highest noise produced by the machine at 87.0 dB was under 7 rpm while the lowest noise of 83.9 dB was generated under 5 rpm. It means that the noise emitted by the machine significantly increases with increasing operating speed of the cylinders. Analysis of variance showed that the speed of cylinder has a significant effect on the noise level of the machine. With an increasing speed, there is also a significant increase in the noise produced by the machine. Similar case is found by Bratu et.al. (2016) in the study of correlating noise level and mechanical vibration emitted by viboracoustic sources that the higher the revolution, the noise level increases and the vibration level reduced.

Table 1: Specifications of the Machine

Assembly	Specification
Dryer-Cleaner Assembly	
Inner Cylinder	1.5m by 60cm dia. GI #18, with 2.00mm diameter perforation
Outer Cylinder	1.5m by 80cm dia. BI Plate with 3mm thick
Cylinder Flange	Cylinder Flange (BI Plate at 6mm thick)
Cylinder rim	60cm inner dia. by 90cm outer dia. With 6mm thick MS plate
Power Transmission Assembly	
Prime mover	3Hp, Three-phase electric motor
E-Motor sprocket	10Teeth sprocket

Girth gear	117Teeth bevel gear
Pinion gear	12Teeth bevel gear
Sprocket	26Teeth sprocket
Sprocket	10Teeth sprocket
Sprocket	52Teeth sprocket
Blower-Heater Assembly	
Heater	Finned type heater 1000 Watts/220V AC
Thermocouple	Temperature Sensor (Type K Thermocouple/Shielded)
Temperature Controller, Magnetic Contactor	
Blower	1/4 Hp single phase motor coupled blower
Cover	GI Sheet #18
Hopper	GI Sheet #18
Discharge	GI Sheet #18
Frame	Main frame 6.1m by 1.1m (1/4 x Channel bar)
	Supports (1/4 x 1 20' Angle Bar)

Shown in Table 2, the summary on the performance parameter of the machine as influenced by the operating speed of the cylinder. The highest machine capacity of 208.9 kg/hr was obtained at 7 rpm cylinder speed while the lowest capacity of 174.2 kg/hr was observed at 5 rpm cylinder speed. Analysis of variance revealed that the speed of cylinder has a significant effect on the machine capacity. With an increasing operating speed, there is a significant increase in the capacity of the machine. Similar case was observed in the evaluation of carrot washer by Denson [1], where the throughput capacity increase with an increasing speed.

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Table 2: Summary of Data Parameters on Machine Capacity, Cleaning Recovery and Noise Level

Speed (rpm)	**Average Machine Capacity (kg/h)***	**Average Cleaning Recovery (%)***	**Average Noise Level (dB)***
5rpm	174.2^{a}	81.11^{a}	83.9^{a}
6rpm	204.0^{b}	82.22^{a}	86.8^{b}
7rpm	208.9^{b}	82.78^{a}	86.9^{b}

*Means with the same letter are not significantly different at 5% level of significance

Table 3 presents the performance parameter of the machine under the influenced of operating speed of the cylinder and the temperature of drying air shows that the highest average power consumed by the machine with 10.16 kW-h was obtained under the treatment combination of 7 rpm and 80°C - 95°C while the lowest consumption of 9.57 kW-h was obtained under 6rpm-96°C - 111°C.

Analysis of variance on the power consumption as affected by operating speed of the cylinder and the temperature of the drying air revealed that both the operating speed of the cylinder and the temperature of the drying air had significant effects on the machine's power consumption. However, the interaction of the two factors did not gave significant effect on the power consumption of the machine and the higher the operating speed gives higher mean power consumption.

Additionally, the average highest moisture reduction rate of the machine with 0.91% per minute was obtained under treatment combination of 7 rpm and 112°C - 127°C while the lowest reduction of 0.35% per minute was obtained under 7 rpm at 80°C - 95°C. Analysis of variance on the rate of moisture reduction as affected by operating speed of the cylinder and the temperature of the drying air revealed that operating speed of the cylinder and the temperature of the drying air had significant effects on the rate of moisture rection of the machine. The interaction of the two factors however, did not gave significant effect on the rate of moisture reduction of the device. This means that the operating speed of the cylinders and the temperature of the drying air act independently to each other.

Table 3: Summary of Data Parameters on Power Consumption and Rate of Moisture Reduction

Speed (rpm)	Temperature (°C)	Average Power Consumption (kW-h)	Average Moisture Reduction Rate (% per minute)
5	80°C-95°C	9.99	0.45
5	96°C-111°C	9.79	0.50
5	112°C-127°C	9.57	0.49
6	80°C-95°C	9.87	0.64
6	96°C-111°C	9.57	0.59
6	112°C-127°C	9.78	0.85
7	80°C-95°C	10.16	0.35
7	96°C-111°C	9.95	0.61
7	112°C-127°C	9.74	0.91

4. Conclusion

Based on the results and findings of the study, the following conclusions were drawn; the rice hull dryer-cleaner machine has a dimension of 7955 mm x 1660 mm x 3335 mm; it operates on the principle of simultaneous effect of drying and sieving actions. The rice hull dryer-cleaner machine satisfactorily removes smaller impurities like dust, bran and small or broken rice hull, has a capacity of 200 kg per hour at 7 rpm, and conforms to the allowable noise level.

5. Acknowledgement

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