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DESIGN AND FABRICATION OF PADDY CLEANER MACHINE

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Abstract – *The traditional rice miller is highly expensive that is why small scale farmers cannot afford it and hence paddy cleaner machine for rice husk comes into picture. It is almost half of price of the existing rice miller available in the market and thereby it is easy to afford by the low production volume farmers or we can say small scale farmer. It can dehusk upto 95% clean paddy and only 5% of the foreign particles including sand grains, paddy straws, small stones, etc. Operation involves feeding the paddy into the hopper, crushed in between two rotating drums powered by electric motor. Finally, the clean paddy gets separated by forced air circulation of blower.*

Key Words: **rice miller, small scale farmer, dehusking, foreign matter, paddy, rotating drum.**

1. INTRODUCTION

Agriculture is very important for a country's economic stability and welfare. If a country's agricultural sector is so productive that it can yield enough to feed the country's entire population, it does not have to import food from other countries. If the country's agriculture sector is so productive that it can produce enough to feed the population as well as create a surplus which can be exported, that results in great economic gain for that particular country. If, however, a country's agricultural sector is unproductive and is unable to produce enough to meet the needs of its population, it adversely affects that country's economy since then it has to import food stuff from other countries which costs a lot. As a result the goods are sold in the local markets at higher rates which the most of its population can't afford. Thus, it leads to inflation and economic instability. Therefore, it is very important for any country to have a healthy and productive agricultural sector which can provide for its population and also boost trade with other countries.

Portable Paddy Cleaning Machine is designed to remove foreign materials and impurities such as sand particles, stones, paddy straws and foreign seeds from paddy. This machine provides farmers an alternative replacement of current conventional method should the farmers want to extract the paddy seed in small scale amount. Currently, they only use a traditional winnow technique as to obtain the seeds to be used next season or before processing paddies to become rice. The performance of this machine is very efficient where the percentage of clean paddy is observed to be at 95%. It helps farmers improvise their traditional method, reduces purchasing cost of paddy seed and utilizes the cleaning process at low cost and less maintenance.

Generally, the hand threshing and the traditional handling used in most developing countries case a larger percentage of foreign matter with the paddy. Thus, more cleaning is required. At this point a rice mill cleaner removes any remaining foreign material that could damage the milling machinery and eliminates foreign material from the milled rice.

1.1 Literature Review

There are various paddy cleaner machines now a days available in market however these machines are not versatile, occupies more space and of course highly expensive. Also, the existing machines are designed for higher capacity and hence are much expensive. Moreover, the machine can do the work as equal to twenty workers or more. After analyzing most of the papers it is noted that the shaft diameter ranges from 20 mm to 30 mm and motor capacity 0.25 HP to 1.5 HP depending upon the application. The machine can dehusked the paddy up to 2-3 ton/hour, the weight is in the range of 120- 130 kg. Some researcher employ vibratory sieve mechanism, blower or fan to get clean paddy, some of them used two or three pulley for transmitting motor power to shaft, someone applied rubber or other materials cladding over rotating drums to avoid the extra crushing force on paddy.

1.2 Types of Paddy Cleaner

A. According to Dehusking Mechanism(Drum)

Drum without Rubber Cladding

Drum with Rubber Cladding

B. According to separation mechanism

Vibratory mechanism

Blower mechanism

C. According to pulley used

Single pulley

Double pulley

D. According to capacity

1-2 tonne/hour

Upto 1 tonne/hour

2. WORKING OPERATION

The conceptual design of paddy cleaner machine is depicted into the picture. Following are the main components of paddy cleaner machine.

1. Frame
2. Electric motor
3. Drum
4. V-belt
5. Pulley
6. Hopper
7. Fan/blower

At the very first feeding the paddy into the hopper which is similar to floor mill hopper. Output from hopper comes in between two rollers by gravity and gets crushed. These two drums are adjustable. The crushing force is function of gap between rollers and is adjusted by the screw mechanism as there are various types of paddy available. One of drum gets power from electric motor. Finally, the paddy get separated from unwanted matter by the forced air circulation from blower.

3. CAD MODEL

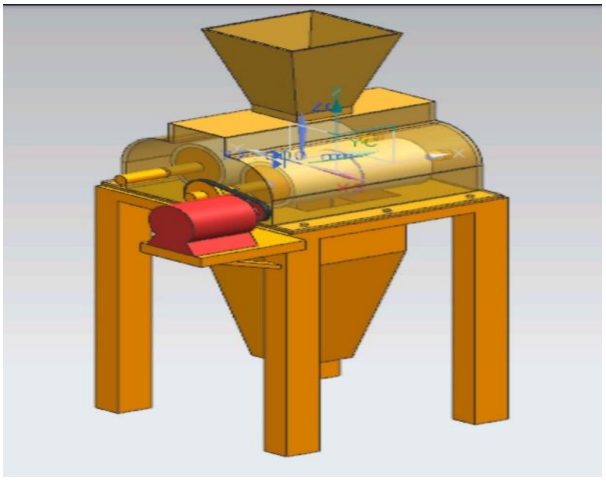

Fig. 1- Isometric view

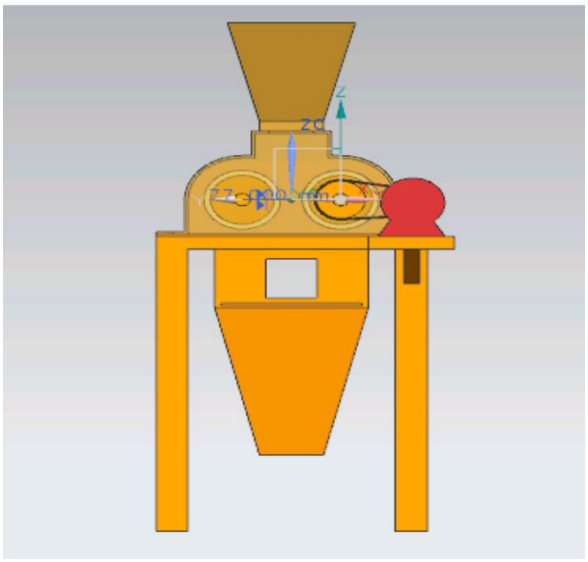

Fig. 2- Front View

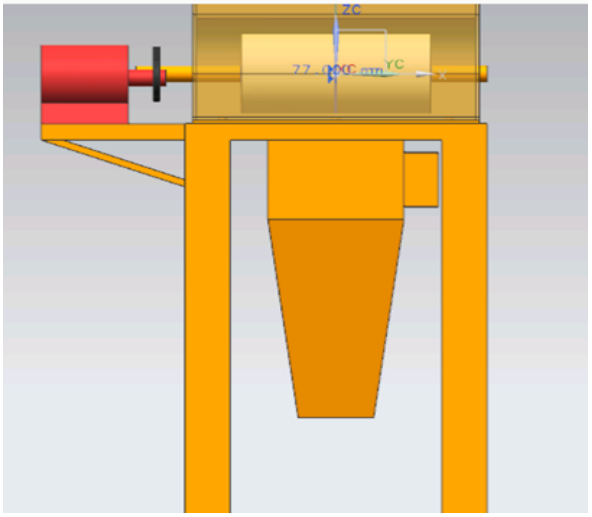

Fig. 3 – Side View

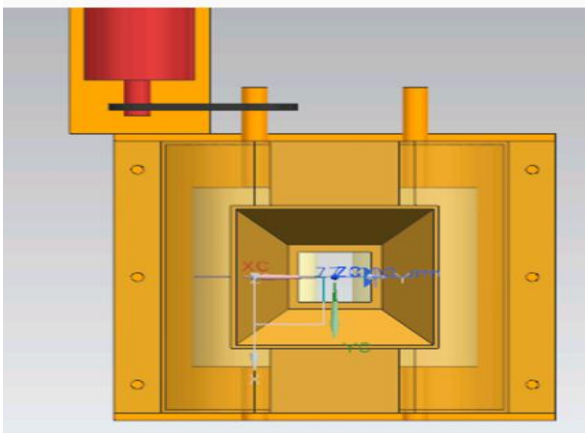

Fig. 4 - Top View

4. DESIGN CALCULATIONS

Volume of Paddy,
$V_p = l \times w \times t = 6mm \times 4mm \times 1mm = 24\ mm^3$

Drum: D_o = 150mm, D_i = 138mm, l = 100mm

Outlet from Hopper
$= 50mm \times 50mm \times 10mm = 25000mm^3$

No. of grains = 25000/24 = 1041 ≈1100

Weight of paddy, W_p = ρ_p x V_p x no. of grains
= 8.66 x 24 x 10^{-9} x 9.81 x1100
= 2.242 x 10^{-3} N

Weight of drum, W_d = ρ_{ms} x A x L x g
= 7850 x $\frac{\pi}{4}[0.15^2 - 0.138^2]$ x 0.1 x 9.81
= 20.90 N

Total weight, $W_t = W_p + W_d$
$= (2.242 \times 10^{-3}) + 20.90$
= 21 N

This load is distributed along the length of the shaft.
Let the length of shaft be 150mm
L = 0.15m
So load on shaft = $\frac{21}{0.15}$ = 140 N/m

$$F_s = \frac{wl_s}{2} = \frac{140 \times 0.15}{2} = 10.5\ N$$

Shear stress, $\tau = \frac{F_s}{A} = \frac{10.5}{\frac{\pi}{4}\times(0.15)^2} = 594.2\ N/m^2$

Bending Moment, $M_{max} = \frac{wl^2}{8} = \frac{140\times0.1^2}{8} = 1.75\ N \cdot m$

Torque, $T = W_t \times \left(\frac{D_o - D_i}{2}\right) = 21 \times \left(\frac{0.15-0.138}{2}\right) = 0.126\ N \cdot m$

Diameter of shaft,

$$d^3 = \frac{16}{\pi\tau}\sqrt{(k_b \cdot M)^2 + (k_t \cdot T)^2} = \frac{16}{\pi\times921.5}\sqrt{(1.5 \times 1.75)^2 + (1.5 \times 0.126)^2}$$

$$d = 0.02032\ m = 20.32\ m$$

So standard size of 25mm is selected.

Power,
$$P = \frac{2\pi NT}{60} = 20\ W$$
Therefore standard motor of 0.25 HP is selected

Size of the weld,
Shaft is connected to hollow drum by fillet weld
Size of weld,

$$S = \frac{2\tau}{\pi \times t_{throat} \times d^2}$$

Where,

t_{throat}= 0.77s

$$\therefore s^2 = \frac{2.82\tau}{\pi \times d^2}$$
$$S = 6\ mm$$

Separating Unit,

Assuming that the volume of dehusked paddy and impurities flowing into separating unit per second is 0.01 m cube out of which 5% are sand particles. Then,

Volume of sand,
$$V_s = \frac{5}{100} v_p = 0.0005\ m^3/s$$

Volume of paddy,
$V_p = 0.01 \times 0.95 = 0.0095\ m^3/s$

Mass of paddy,
$m_p = V_p \times \rho_p = 0.0095 \times 8.66 = 0.08227\ kg/s$

Mass of sand,
$m_s = V_s \times \rho_s = 0.0005 \times 13.1 = 0.00655\ kg/s$

Velocity of mixture,
$$v_{ps} = \sqrt{2gh}$$
Since, h = height from which mixture of paddy and impurities fall = 300mm = 0.3m
$v_{ps} = \sqrt{2 \times 9.81 \times 0.3} = 2.43\ m/s$

Force with which paddy falls,
$F_p = (\dot{m})_p \times v_p = 0.08277 \times 2.43 = 0.09992\ N$

Force with which sand falls,
$F_s = \dot{m}_s \times v_s = 0.00655 \times 2.43 = 0.01592\ N$

Force required to separate the mixture must be equal to total force of mixture,
$F_t = F_p + F_s = 0.19992 + 0.01592 = 0.259\ N$

Velocity of air required to separate the mixture,
$F = \rho_a \times A \times {v_a}^2$

$$\therefore v_a = \sqrt{\frac{4 \times F_t}{\rho_a \times \pi \times d^2}}$$

Here, d = dia of fan = 0.2m

$$v_a = \sqrt{\frac{4 \times 0.0259}{1.2 \times \pi \times 0.2^2}} = 2.621\ m/s$$

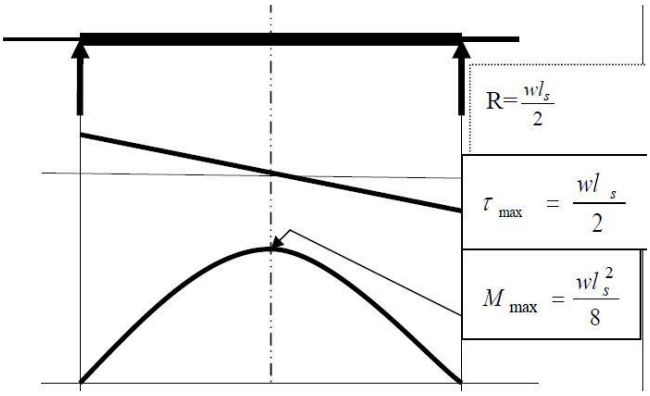

Fig. 5- Bending Moment Behaviour

4.1 Abbreviations

D_0 = Outside diameter of drum
D_i = Inside diameter of drum
l = Length of drum
d = Diameter of shaft
L = Length of paddy
W = Width of paddy
T = Thickness of paddy
ρ_p = Density of paddy
ρ_{ms} = Density of mild steel
k_b &k_t = Stress concentration factors
V_s = Volume of sand
V_p = Volume of paddy
v_s = Velocity of sand
v_p = Velocity of paddy
v_{ps} = Velocity of mixture
v_a = Velocity of air

5. CONCLUSION

By taking problems into consideration of the existing paddy cleaner, we have designed a paddy cleaner machine which is not taking lot of space i.e. compact, portable and versatile, inexpensive so that small scale farmer can afford it and capable of dehusking 95% clean paddy.

6. ACKNOWLEDGEMENT

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