Electric Field Application: Grass Seed Separation Machine From Broken Milled Rice by Electric Field Technique

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Abstract: This paper has dealt with grass seed separation machine from the broken milled rice using the technique of Electric Field in increasing the quality of the broken milled rice. The principle of tasking is done by applying DC high voltage 40 kV to electrode plates for generating the electric field. The direction of electric field will be started from the lower to upper electrodes plates. When the mixture broken milled rice with the grass seed are taken pass through the electric field, electric field force will separate the grass seed from the broken milled rice. The grass seed is flew following the direction of electric field force. The broken milled rice will be passed through the other selected box. The ability of 90% separation is achieved at the mixture rate of 50g per 10kg, assort rate is 100kg/hr, low power consumption around 10W and no diffusion of the dust during operating. It do also small and compact.
Keyword: Electric field, Electric force, Field charge, grass seed, broken milled rice**.**

1. Introduction

The advantages of rice harvest using machine over man power human is time saving. The harvest by machine may get the mixture product of grass seed and broken milled rice that effects to low quality of the broken milled rice and cannot immediately transmutation. This work is to propose the grass seed separation machine from the broken milled rice by using electric field technique. The electric filed force can perform the grass seed in separation from the broken milled rice under the electric plates that be created. The principle of finite element to calculate the distribution of voltage, direction and intensity of electric field in each position is added. The good design of the electrodes can generate high electric field intensity at low power consumption. The testing is forced on the ability of separation versus assort rate with the variation of temperature, relative humidity. This test is cooperated with the local public mill. The advantage of this work is to reduce the dust pollution during separation process.

2. Theory

Particle, which has a mass and electric charge, is applied in the uniformed electric field, it can be initial moving which the velocity of the ion as this relation $v_0 = \upsilon_{0x}\hat{x} + \upsilon_{0y}\hat{y} + \upsilon_{0z}\hat{z}$ where electric field is $E = E_0\hat{z}$

The velocity and it's position can be calculated with the function of time domain (t)

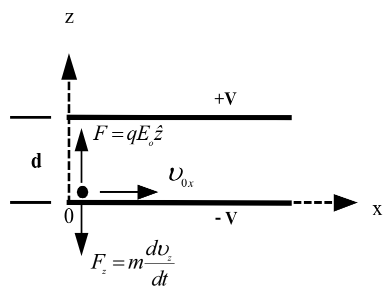

Fig.1. Movement of iron in the uniformed electric field

Force is performed with ion as shown in Eq.(1).

$$F = qE_0\hat{z} \tag{1}$$

Action force in vector $\hat{z}$ from Newton's law, is shown in Eq.(2)

$$F_z = m\frac{d\upsilon_z}{dt} \tag{2}$$

Where F : Electric force (N)
F_z : Force (N)
q : Field charge (pC)
E_0 : Electric field (V/m)
m : Mass of charge (kg)
$\frac{d\upsilon_z}{dt}$: Acceleration (m/s^2)

Eq.(1) and (2) can be result in Eq.(3)

$$\frac{d\upsilon_z}{dt} = \frac{q}{m}E_0 \tag{3}$$

Eq.(3) show the velocity in Eq.(4)

$$\upsilon_z(t) = \left(\frac{q}{m}E_0\right)t + C \tag{4}$$

Initial condition is

$$\upsilon_z(0) = \upsilon_{0z}$$

Constant C in Eq.(4) can be substituted and the velocity can result as

$$\upsilon_z(t) = \upsilon_{0z} + \frac{qE_0}{m}t \tag{5}$$

Then, the actual velocity is

$$v(t) = \hat{x}\upsilon_{0x} + \hat{y}\upsilon_{0y} + \hat{z}\left(\upsilon_{0z} + \frac{qE_0}{m}t\right) \tag{6}$$

3. Grass Seed Separation Prototype Machine by Electric Field Technique

From the above theory [1][2], the prototype can be designed and constructed. When the mixture of grass seed with the broken milled rice are taken and passed through the electric field, the electric field force will separate the grass seed from the broken milled rice and take out to the flue follow the electric field direction. The broken milled rice will be passed through the collected box as shown in Figure 2.

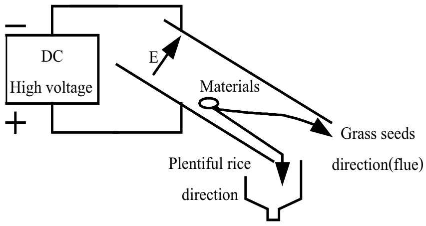

Fig.2. Configuration of grass seed separation system

3.1 Electrode Characteristic

Finite element method can be applied Eq. [3], find the resultant force that can force the grass seed in electric field. Eq.(3) can be used is in two dimensions which neglected remain ion (ρ_s=0) using MATLAB application program. The nominal electrode can be considered by symmetry principle and found that the electrode plates have the uniform electric stress at all position between electrode plates. It affect to the grass seed by moving due to constant force at all position in electric field. To avoid the excess forced on grass seed and can cause remixed between grass seed and rice, the modified plate are design as shown in Figure 3. Then the proper design of the electrode for separation must be considered to the force on the grass seed in the electric field that enough power to float the grass seed from the broken milled rice. This force must have no affect on broken milled rice from normally direction. The grass seed that already separated must not hit the upper electrode where the electrode set must have some gap. The system should have the cavity for take out the grass seed through the flue as shown in Figure 3.

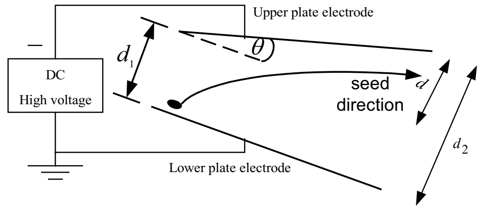

Fig. 3. Modified electrodes position of the parathion unit

When d_1 s initial gap, d_2 is final gap. d is gap for taking out the grass seed and θ is the angle of the upper electrode. Figure 3 show, the electric stress at d_1 is higher than of that d_2 because gap between d_1 electrodes are more closed. The grass seed can be floated in d_1 follow the electric field direction and the electric force will be continue decreased at d_2. Then, the grass seed is flew down be fall down and can be leave from electrode hole d.

The distribution of the voltage under electrodes can be analyzed by finite element method (FEM), It can be divided the construction of the electric field as follow 711 elements and 403 nodes for analysis shown in Figure 4.

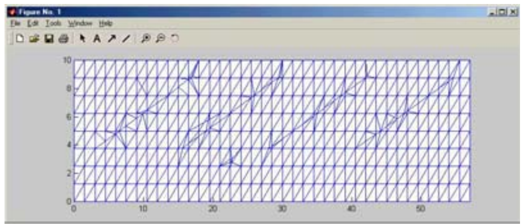

Fig.4. Discretizing the solution region into finite number of sub regions or element.

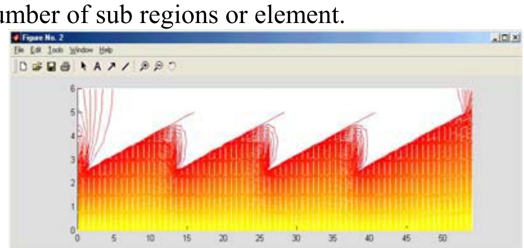

Fig.5.Potential distribution from Finite Element Method.

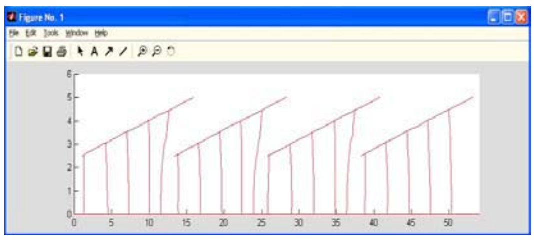

Fig.6. Electric force direction by Finite Element Method.

Figure 5 shown cross section of the system and shown potential distribution where vertical axis is the distance between the electrode plates. If can be seen in Figure 6 that the direction of E-field is curved at the edge of the upper plates. This can help the grass seed to flow out.

The finite element method can be analyzed and shown that, the electric field force that performed with the grass seed under 20^{o} of upper electrode is suitable for separating the grass seed.

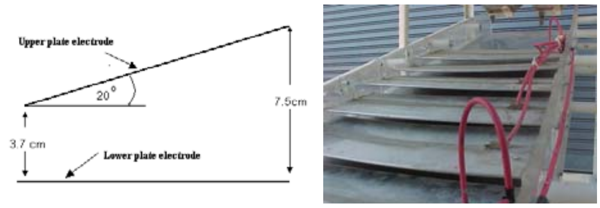

Fig.7. Electrode set.

The upper electrodes are produced from iron sheet thickness 1 mm, size 15x37 cm^2 at total 12 plates. The lower electrodes are produced from iron sheet thickness 2mm, size 40x70 cm^2 and coat with alkalis for breakdown protection between upper and lower electrodes from any accidents.

3.2 The construction of the grass seed separation machine by Electric Technique

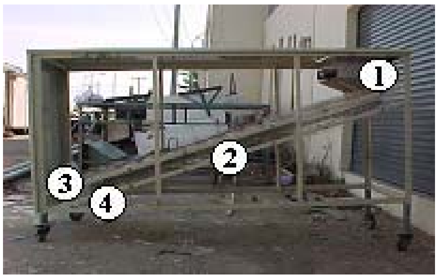

Fig. 8. Structure of prototype.

No.1: The box to be release the broken milled rice have cavity 20x38x30 cm^3. It is made of by produced from iron sheet, thickness 1 mm and the flow rate of the broken milled rice can be set.

No.2 : Each electrode sheet will be connected with one side of electric wire and another side of wire to be connects with external supply source by parallel connected circuit. Each electrode sheet on alkalis plate, size 10mm are attached and then fixed both plates on iron frame with plastic insulation. The electrodes installation should have the angle 30^{o} from flat plane because it can make the velocity of the broken milled rice to be around 0.4 m/s.

No.3 : The flue can be used to the main details of the structure are as follows takes out the grass seed. The grass seed is separated and moved through up side of the upper electrode with gravitation and fall down at the flue for throw it away. The flue is made of alkalis, thickness 5 mm and has cavity 37x10x15 cm^3

No.4 : The flue to take out the broken milled rice. The broken milled rice is separated and move with gravitation and fall down at the flue for collected rice. The flue is also made of alkalis, thickness 5 mm and has cavity 37x10x15 cm^3

This of this separation method requires high voltage for supply to the electrode set to generate the electric field. Then the construction must be closed loop system and connected with ground to be safe from voltage and electric field while operating. Figure 9 shows the completed set of the separation machine.

Fig. 9. Grass seed separation machine from broken milled rice by electric field technique.

4. Grass seed separation machine testing

The prototype of grass seed separation machine. Can be tested for it's ability at the mixture rate of grass seed 50 g per 10 kg of broken milled rice. The set experiment has done 3 times to determine the mean and it's precision.

4.1 Testing of the grass seed separation ability with flow rate through the electrode set

To study the flow rate of the broken milled rice with separation ability, the experiment can control the flow rate by adjust gap at the box to be released the broken milled rice at flow rate 50, 100, 150, 200, 250 and 300 kg/hr.

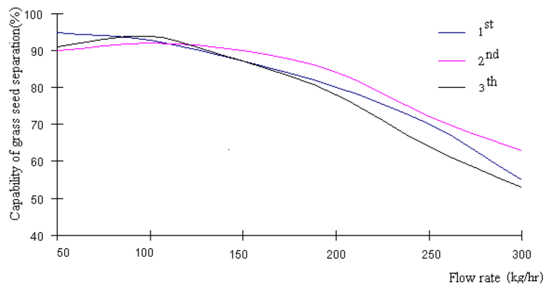

Fig. 10. Capability of grass seed separation at difference flow rate.

Figure 10 shows a slightly decrease of ability of the separation at higher flow rate. The maximum of the ability is about 92% at 100kg/hr flow rate.

4.2 Testing of the grass seed separation ability with any level of voltage

The level of voltage which apply to the electrode set with separation ability is studied.

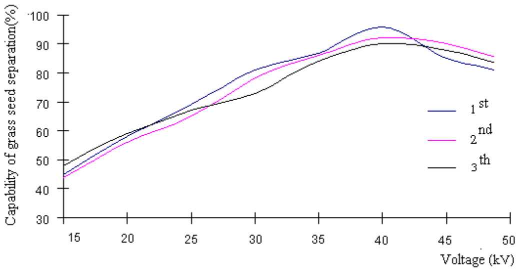

Fig.11.Capability of grass seed separation at difference voltage level.

Figure 11 shows the ability of separation is increased during the voltage between 15 kV to 40 kV. The peak of ability is about 90% at 40 kV applying. The voltage beyond 40 kV shows the decreased of separation ability.

4.3 Testing the grass seed separation ability with temperature

The temperature with separation ability is studied under the variation during 15-30 ^{o}C, changed depend on place.

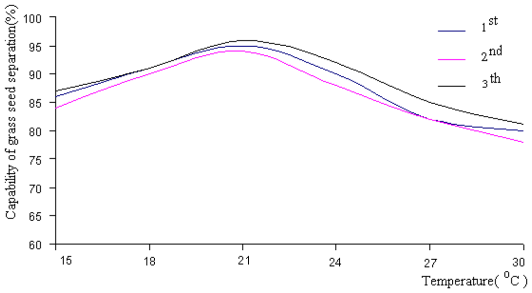

Fig.12. Capability of grain separation under changing temperature condition.

Figure 12 shows the peak about 93% at 21^{o}C

4.4 Testing for finding the relative between humidity with separation ability

The effect of relative humidity with separation ability is studied under the variation during 55-95% relative humidity because of the relative humidity while operating can be changes; depend on place, season .

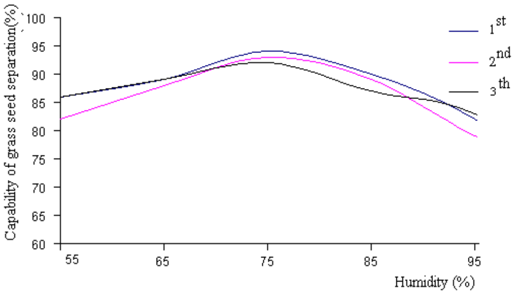

Fig.13.Effect of relative humidity on the selection ability

At this operating system, flow rate about 100 kg/hr, temperature 21 ^{o}C. The peak of separation ability is about 90% at 75% relative humidity.

Fig. 14. Location of experimental.

Fig. 15. Field testing with Khumtong Farmer group

5. Conclusion

It is found that the grass seed separation ability is 93% at temperature at 21 ^{o}C, while relative humidity around 65-85%. The proper level of voltage is 38-45 kV is suitable for providing the peak achievement in grass seed separation at the broken milled rice flow rate is 50-150kg/hr. It is observed that there is a very small diffusion of dust during the operation. The advantage of low power consumption, 10 W, is achieved. If can be interesting in term of economic during running stage.

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