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Research on Designing a Vibrating Screen for Manufacturing Salvia Seed Selector

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***Abstract*—** *This article has been studied to design vibrating sieves, which is used to make a split grain sorting machine, and salvia hispanica have been peeled. The characteristics of salvia seeds include light crust and increased size, so when the vibrating sieve design of this seed needs its own characteristics, it will not be like other materials. The vibrating sieve is designed by the mesh density and dimensions of the vibrating sieve, including length x width, and the velocity of the vibrating sieve is calculated by optimizing the amplitude and frequency of the vibration. The minimum productivity of the vibrating screen is designed to be 0.56 tons / hour, and it will select 100% grain during work.*

***Keywords*—** *Design vibrating sieves, optimizing vibration, Salvia Seed Selector.*

I. INTRODUCTION

Salvia seeds are a kind of grain with economic value and high Omega 3 nutrient content, which adds nutrients to the human body. Its scientific name is Salvia Hispamiola (Figure 1) and it is grown extensively in the Kimberley region, Western Australia [1].

Figure 1: Salvia salvia seeds [1]

At present, a number of enterprises are bravely test-planting and processing salvia seeds in Vietnam. A problem posed by such enterprises is the work of harvesting and processing salvia seeds. Specifically, the peeling of salvia seed coat is being done manually as our way of harvesting our wet rice 50 years ago which provides low yields, and the proportion of broken salvia seeds is also quite high, making the nutritional value in salvia seeds lost (Figure 2).

Currently, the issue on developing the supporting industries and small machines to replace expensive imported machines is a top priority factor in our country to improve the economic efficiency, step by step to be the master of mechanical technology, suitable to the trend of national modernization and industrialization. Shortening the production time as well as labor in production are the posed issues. Therefore, the research and manufacture of a salvia seed separator machine are very urgent with high practical significance.

Figure 2: Salvia seed flowers are separated manually.

In this paper, the author focuses on describing the process to research, calculate and design the vibrating screen applied in the seed separator from flowers of salvia seeds after harvest. The following are some seed selectors that use vibrating screens and researches on the common design of vibrating screens.

Figure 3 is an exen vibrating screen machine originated from Japan [2]. This machine uses a vibratory screen (directional vibrating screen), such screen is active by vibration motor. When using the machine to screen different materials, the amplitude and frequency will be adjusted differently. This vibrating screen is of good quality and can select a variety of materials but the manufacture is complex with high cost.

Figure 3: xen vibrating screen machine [2]

Figure 4 is a peanut shell separator with vibrating screen of Binh Quan manufacturing and trading company [3], its vibrating screen is a horizontal shaking one, the method of

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shaking by eccentric cam mechanism provides high efficiency with low cost in process of design, manufacture and use. Because the frequency and amplitude of a vibrating screen is changed according to mechanical details, the working process will be stable.

Figure 4: Peanut shell separator [3]

Le Xuan Hung et al. [4] described the design and manufacture of a screening machine for sorting abrasive grains by mechanical vibrating screen. The operating principle of such machine is to cause abrasive grains to have vibrating movement (up and down) and horizontal movement in order for sorting them. The weight of abrasive grains in each tray before and after being screened is weigh accurately by a scale. The research has determined an optimal set of parameters for the machine, including vibrating speed of the screen, screening amplitude and shortest screening time..

Pham Van Toan et al. [5] researched the design and manufacture of a screen machine in combination with vibration and shaking to serve organic fertilizer production lines with the purpose of correcting the existence of vibrating screens in the process of sorting the size of grinded and granulated products with the operating principle of combining vibration and vertical shaking. The design of vibrating screens working in vertical shaking mode has improved the sorting efficiency by correcting the phenomenon of creating heaps or thick layers on the vibrating screen surface.

II. Design of a Vibrating Screen Applied in the Salvia Seed Selector

A. Overall Design

Due to the characteristics of salvia seed flowers which light, swelled and spongy coat, brittle seeds that are easy to broke, absorb water, the salvia seed selector is designed with a seed separating group designed according to the principle of sliding, moving, rolling and pressing by rollers covered with rubber, turning in a reverse direction to each other. The coat separating part is a vibrating screen combined with a blower described in Figure 5, the machine is designed with a seed selecting yield of 0.56 tons/hour (based on the seed separating yield).

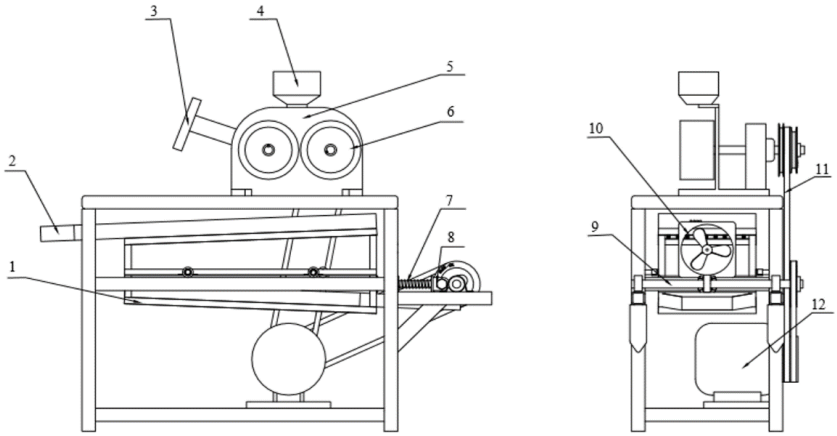

Figure 5: Structure of a salvia seed coat separator

1. Gutters;	5. Coat separating group;	9. Camshaft;
2. Vibrating sieve;	6. Roller;	10. Blower;
3. Handwheel;	7. Spring;	11. Straps;
4. Hopper;	8. Push mechanism;	12. Engine;

Within the scope of this reasearch, the authors focus on presenting the process of calculating the vibrating screen design of the salvia seed coat separator.

B. Design of the Vibrating Screen

Vibrating screen is an important detail that determines the percentage of salvia seeds selected after separating from the flowers. The vibrating screen is designed so that the seed selecting yield is greater than 0.56 tons/hour and the percentage of selected seeds is 100% after separation.

* Size of the vibrating screen

From the overall design of the machine above, the useful size of the screen is 300 × 750 (mm), the hole of selecting screens is a round one with diameter of 2 mm (the size of salvia seeds is 1.5 mm), the shortest distance among holes is calculated according to the formula (1) [6].

$$b \geq 0{,}9\sqrt{d} \quad (1)$$

of which : b - The shortest distance between two holes.

d - Size of the hole (d = 2 mm).

$b \geq 0.9\sqrt{2}$ = 1.3 (mm), Choose b = 1.5 (mm)

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The screen thickness e is calculated so that the seed is not clogged, but the screen can also be easily processed, therefore, *e* is calculated by the formula (2) [6].

$$e \le 0.625.d \quad (2)$$

Choose e = 1.0 (mm)

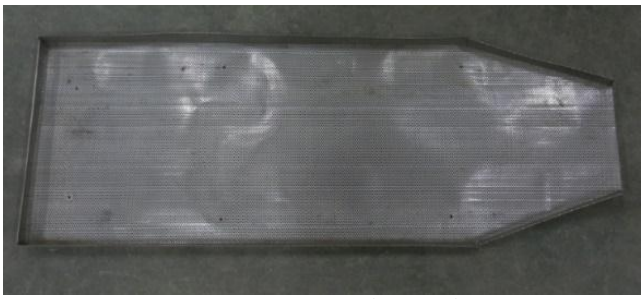

Figure 6: Vibrating screen after manufacture.

* Inclination angle of screen fram.

The inclination angle of screen frame affects the efficiency and yield of the screen, if the angle of inclination is reduced, the movement speed of seeds on the screen will be low and the efficiency of yield increase will decreas. However, if the angle of inclination is large, the efficiency of the sreen will be also not high due to the fact that the seeds slide very quickly on the screen. Therefore, in order to ensure the requirements of the machine as well as the slide of seeds on the screen surface, we choose $\alpha = 8^o$. [7], [8].

* Calculate the speed of vibrating screen.

The speed of a vibrating screen is calculated by the method of optimizing vibration frequency and amplitude. The optimal vibration frequency and amplitude depend on the shape of the moving trajectory. These three factors affect the efficient yield and the ability to trap grooves of seeds on the screen. The speed and type of movement trajectory are basic factors that affect the screen's ability to trap grooves. As the movement speed of the screen surface increases, the screen's ability to avoid trapping will be better, but the efficiency of the screen will be worse because the seeds will be thrown high, the number of times that seeds contact with the screen surface will decrease and the ability to classify will be reduced..

The movement trajectory of seeds is described by a system of equations 3 and 4 [9].

$$\begin{cases} y = v_0 t - \dfrac{gt^2}{2} - \cos\alpha \\ x = \dfrac{gt^2}{2}\sin\alpha \end{cases} \quad (3)$$

of which: α - The inclination angle of screen surface.

v_0 - The vibration speed of screen surface.

When solving the above equation, we obtain (4) [9].

$$y = v_0\sqrt{\frac{2.x}{g.\sin\alpha}} - \frac{x}{tg\alpha} \quad (4)$$

We find x_1 that for which y reaches its maximum value, by deriving the above equation and giving zero:

y'= 0

$$\Leftrightarrow v_o.\frac{2}{2.\sqrt{\dfrac{2.x_1}{g.\sin\alpha}}} - \frac{1}{tg\alpha} = 0 \quad (5)$$

Make the transformation and solve, we obtain:

$$x_1 = \frac{v_o^2.g.\sin\alpha.tg\alpha}{2}$$

When replace x = x1 into the equation and take y = *e* [9]

e = 0.016 mm (vibration amplitude)

Therefore $v_0 = \sqrt{2.g.e.\cos\alpha} = 0.56$ (m/s) (6)

* Recalculate the capacity of vibrating screen

The yield of a vibrating screen machine is proportional to the width of the screen mesh, the thickness of the material layer on the screen, the movement speed of the material along the screen mesh.

The yield of a vibrating screen machine is determined by the following formula:

$Q = b.h.v_0.\gamma.3600$, (kg/h); (7)

of which:

b – width of the screen mesh, 0.3 m;

h – the thickness of the material layer on the screen, 0.005 m;

γ – volumetric weight of the material: 20 kg/m^3;

v_0 – the movement speed along with the screen of the material: 0.56 (m/s).

=> $Q = 0.3\times0.005\times0.56\times20\times3600 = 604.8$ (kg/h)

Therefore, the vibrating screen is designed with the following parameters:

+ Size: 300×750 (mm)
+ Angle of inclination to place the screen: 8^o
+ Movement speed of the screen: 0.56 mm/s
+ Calculated yield of the screen: 0.6 tons/h

III. TEST FOR VERIFICATION

After being designed, manufactured, the screen is installed and tested to verify and evaluate the yield and the ability to screen of the equipment.

Figure 7 shows the image of a salvia seed selector which has been processed, manufactured, assembled and tested at the Mechanical Center - Hanoi University of Industry.

Test results show the ability to select seeds from flowers after separation: 100%

Figure 7: Salvia seed selector

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IV. CONCLUSION

From a number of results obtained in this research, some conclusions are drawn:

Could calculate and design the vibrating screen to apply for manufacturing a salvia seed selector.

After being manufactured, the salvia seed selector has been tested to evaluate the yield and the ability to select seeds of the screen.

After being designed, manufactured and tested, the vibrating screen has been evaluated to meet the set requirements: the calculated yield of selecting seed is 0.61 tons/hour and the ability to select seeds from flowers after separation is 100%.

The research results have high applicability to manufacture salvia seed selectors in particular and seed selectors in general.

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