Designing, Constructing and Performance of Sifter Machine with Double Filter for Corn Rice

Yohanes Benediktus Yokasing [1,*], Amiruddin Abdullah [1], Priska Gardeni Nahak [2], and Ricard Fa'ot [1]

[1] Department of Mechanical Engineering, State Polytechnic of Kupang, Kupang, East Nusa Tenggara, Indonesia
[2] Department of Civil Engineering, State Polytechnic of Kupang, Kupang, East Nusa Tenggara, Indonesia
Email: yohanesyokasing12@gmail.com (Y.B.Y.); amiruddinabd88@gmail.com (A.A); prigardeni2@gmail.com (P.G.N); ricardfaot24@gmail.com (R.F)
*Corresponding author

***Abstract*—"Corn rice" derives from dried corn which is grinded into grains, and the medium sized grains are sorted (corn rice grains). In Indonesia, people separate corn rice by using traditional sieve tray called "*Nyiru*" or using Sifter Machine. The Sifter Machine currently used, must be done in 2 stages of the sieving process. This requires more time and effort. For this reason, "The sifter machine with double filters for corn rice" was studied. The Study intended to answer these problems. The machine has the following specifications: 2 filters, 4 springs on each filter, and 3 channels of sifter machine, with rotation of 52.9 rpm, spring length of 100 mm, and a filter tilt angle of 10^{o}, for a capacity of 1 kg of corn grains can separate 0.402 kg of corn rice. Meanwhile, at rotation of 63.3 rpm, spring length of 80 mm, and tilt angle of 5^{o}, the sorting capacity is reduced to 0.345 kg.**

***Keywords*—milled grinded corn grains, sifter machine, corn rice, filter**

I. Introduction

The corn rice is one of the food ingredients for the Indonesian people. From year 2010 to 2016, Indonesia was the eighth largest corn producer in the world [1]. Indonesian uses corn to make corn rice. Corn rice is obtained by grinding dry corn, and the results are sorted into three groups of grains. The three groups of granules consist of the large granular group, the medium granular group, and the small granular group. The medium grain group is corn rice.

The people of East Nusa Tenggara Province, Indonesia, sorted corn rice using traditional sieve tray called "*Nyiru*" or using Sifter Machine. *Nyiru* is a tray commonly used to separate solid or dry objects. The sifter machines used by people today must be carried out in a 2-stage of sieving process. The first stage of the sieving process, separates large grain groups from medium grain groups and small grain groups. In the second sieve process stage (advanced stage), separate the medium grain group from the small grain group. For the second stage, the process begins with changing the sieve. The filter used in the second stage has a smaller cavity than the first process. This stage separates the corn rice grain group from the small grain group. This type of sieving process is ineffective and inefficient, because it requires a lot of time and energy, to separate 1 kg of grinded dry corn it takes 3–4 min [2].

This encouraged the researchers to conduct a study to find another alternative Sifter Machine. Meshram *et al.* [3] studied of Sand Sifter Machine with several sieves that can be changed according to the requirements. This sifter machine has 1 sieve frame and a sieve plate with 2 types of cavity sizes installed. The movement of the sieve follows the slope of the sieve. Nwigbo *et al.* [4] developed a sifter machine in which the filters are stacked (arranged vertically) and mounted on a shaking unit. The shaking unit intended to stir, and was driven by a transmission of two bevel gears which rotate the sieve. Nofriady *et al.* [5] developed an automatic sand sifter machine that sorted three sizes of sand. The filter plate has 2-cavity sizes and is mounted on one frame. The two ends of the filter plate are connected. The filter frame is a hollow cylinder.

The sifter machines described above are less effective and efficient for corn rice. Therefore, the study was carried out in using, "Sifter Machine with Double Filter for Corn Rice Products". This study aims to make a sifter machine that can be used to separate corn rice products, and also to determine the capacity that can be separated each kilogram of grinded corn.

Several advantages of the sifter machine are: (1) Reciprocating movement; the direction of reciprocating motion is opposite to the flow direction of the sifted material; (2) The results of the upper filter are directed to the lower filter; after touching the surface of the lower filter, the granule group is immediately sieved; (3) Grinded dry corn grains flow from the hopper, spreading to the surface of the upper sieve; (4) The filter on the sifter machine, adjusted at an angle to the horizontal axis; (5) Jerking and vibrating movements, occurring at the end and beginning of each back and forth movement of the filter.

The weakness of this sifter machine is that the width comparison between the upper and lower filters has not been studied. The comparison of the width of the upper and lower filters is related to the performance of the two filters.

Manuscript received July 18, 2023; revised July 27, 2023; accepted December 13, 2023; published July 26, 2024.

doi: 10.18178/ijmerr.13.4.448-455

The upper filter is a distributor of filter material, and the lower filter is a recipient. To overcome this deficiency, a guiding component are installed on both sides of the upper filter. The component creates additional weight for the filter. gaining weight requires additional time. Further research needs to be done so that the time required for sifting is more efficient. The ideal sieving time parameters greatly influence the sieving results [6].

II. Literature Review

Sieving is a very common method of separation, used on its own or combined with other processes [7]. Grain groups are sorted based on the size of the filter cavity s. The filter used can have one or more types of cavity sizes. If there are two types of filter cavity sizes on one sieve, then each type is placed in a separate section. There are also the same number of filters as the number of filter cavity sizes. Meshram and colleagues, in 2022, developed a multi-plate sieving machine that will help sieve sand of various grades by changing its sieve plates accordingly [3]. There is only one filter, and the filter wire plate has 2 kinds of cavity sizes. The smaller filter plate cavity size is placed in the upper 1/2 of the filter frame, and the larger cavity size is placed in the lower 1/2 frame. The lower end of the upper filter plate is connected to the upper end of the lower filter plate. The movement of the filter during sieving follows the slope of the filter. In 2017, Nwigbo and his colleagues also studied a sieve machine that consists of a set of stacked sieves, driven by two inclined bevel gears. The result shows that the machine is suitable for sieving sand grain size of the order of 0.1 to 1.0mm but cannot sieve larger particles such as gravel [4]. Handra and his colleagues in 2016 also developed an automatic sand sifter machine that produces 3 sizes of sieve products [5]. The sieve machine used has only one sieve. The filter is installed with 2 filter plates, which have different cavity sizes. The filter plate has a cavity width of 2.5 mm, cavity length of 2.5 mm, installed on the top 1/2 of the filter frame. On the other 1/2 part of the frame, the filter plate is installed, the cavity width is 3.5 mm, and the cavity length is 3.5 mm. The filter plate is installed covering the filter frame. When operating, the filter rotates in the opposite direction to the length of the filter. The Sifter Machine described above is different from the Double Filters Type Sifter Machine for Corn-Rice Products. These differences are found in the filter, direction of movement, tilt of the filter, vibrations and jerks

A. The Filter

Sifter Machine with Double Filters for Corn Rice has different filter cavity size. Two filters that have different filter cavity sizes produce three types of product sizes. The three sizes products are oversize, on-size, and undersize The position of the filters in the machine are installed symmetrically on the vertical axis. One filter is above and the other is installed just below it.

The cavity size of the top filter is larger than the cavity size of the bottom filter. The lower filter receives the granular filter results from the upper filter. So as to produce a sifted product of the desired size [8]. The filter is an important component in the separation process. Ławińska *et al.* also stated, "Selection of the right sieve for grains with certain size standards in the sieving process".

The used filter is in the shape of squares the size of the upper filter cavity is 3.5 cm long and 3.5 mm wide. The bottom filter is 1.5 mm long and 1.5 mm wide. The size of this cavity adjusts to the need for separating corn rice. Musyafak *et al.* stated "The size of corn rice is approximately 1.5 mm to 3.5 mm" [9].

The upper filter will separate grains ≥ 3.5 mm from grains measuring ≤ 3.5 mm. Granules ≥ 3.5 mm will flow through the filter surface, while granules ≤ 3.5 mm will be filtered through the filter cavity s. Furthermore, the filter in the lowest position has a cavity size of 1.5 mm, separating grain sizes ≤ 3.5 mm to ≥ 1.5 mm from grains < 1.5. Grain sizes ≤ 3.5 mm to ≥ 1.5 mm which are separated are corn rice grains.

Corn rice grains will flow on the surface of the filter, and grains measuring < 1.5 mm will be filtered through the filter cavity s. The three groups of granules that have been successfully separated are channeled to their respective channels. Large grains flow towards the upper channel, corn rice grains flow towards the middle channel, and small grains flow towards the lower channel

B. The Angle of Inclination of the Filter Surface and Grain Flow

Angles are straight lines rotated about one point [10]. The angle of inclination of the filter surface in a Sifter Machine with Double Filter is formed from a straight line parallel to the horizontal axis rotated about one point on the filter surface, and the final position of the line corresponds to the filter surface. Due to the tilt of the filter surface during the sieving process, the grains flow and move on the filter surface and are sorted by the filter cavity.

The slope of the filter affects the separation capacity of a sifter machine. The tilt angle of the filter affects the performance of the machine [5]. The smaller the tilt angle of the filter, the greater the sieve capacity [9]. Increased separation efficiency can be achieved by selecting the appropriate filter tilt angle" [10]. The greater the tilt angle used on the filter, the more it will affect the results. This shows that the size of the angle affects the performance of the machine [5].

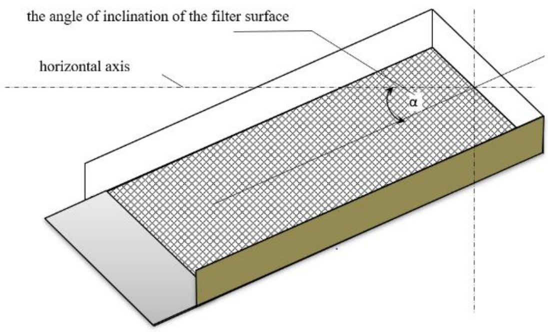

Fig. 1. The inclination angle of the filter surface on the machine.

In Sifter Machine with Double Filter, the filter is installed at an inclination angle of filter surface 5° and 10° to the horizontal axis, as shown in Fig. 1. Corn rice has the physical characteristics that can flow. Haque [11] reported that the followability is more influenced by physical characteristics. Physical properties that influence flow capability. Flowability includes particle shape and size. The shape and size of corn rice are irregular and vary in certain shapes.

C. *The Spring and Vibration*

Spring is an elastic component used to produce vibrations. Sifter Machine with Double Filters require vibration to speed up the grain separation process. Vibrations in the filter come from an unbalanced mass system due to the springs installed at each corner of the filter. Modeling an unbalanced mass excitation system on a filter by installing a spring to cause vibration. Vibrations that occur in the vertical direction. There is also reciprocating motion and tangential motion. The movement of the filter causes the grains to be push other through the filter's cavity [12]. As a result of this movement, there is an exchange of places where the grains at the bottom move to the top and vice versa.

These movements support the sorting process so that separation can take place quickly. This movement causes the sieving time to be more efficient. "The efficiency of particle size separation depends on the length of the sieve process [13]." Changes in particle position during the sieving process change the size composition of materials in various layers, which ultimately affects the overall sieving efficiency [14].

III. METHODS

This study uses the "Action Research (AR)" method, with several activities which are to build and to apply scientific theoretical concepts in accordance with sifter machines. The scope of these activities includes designing, constructing, and testing the performance of a double filter type of machine for sifting corn rice [15]. Machine design uses Autodesk Inventor Professional 2020. In general, the flowchart of the study is shown in Fig. 2. The machine was made in the State Polytechnic of Kupang, Mechanical Engineering Laboratory which has ISO 9001:2015 certificate standard.

A. *Design of Sifter Machine*

1) Concept of design

The concept of design began with conducting interviews and identifying needs of consumer for a double filter type sifter machine for corn rice. The data of interviews and identification are used as a basis and theory formulation for designing and constructing as well as considering the HOQ (House of Quality) method.

2) Product design

a) Results of design

The results of designing a double filter type of sifter machine for corn rice are shown in the Fig. 3.

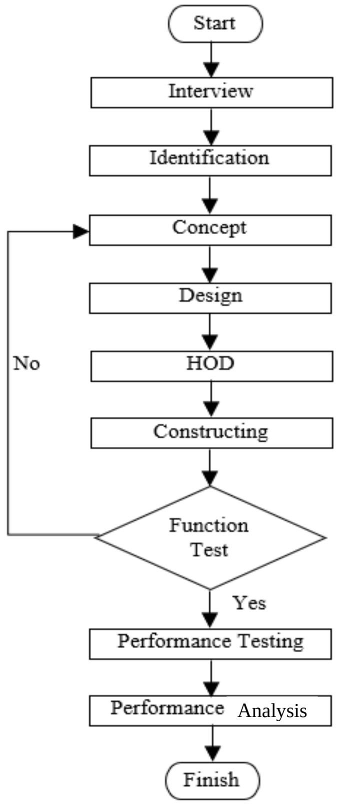

Fig. 2. Flowchart diagram of research activities.

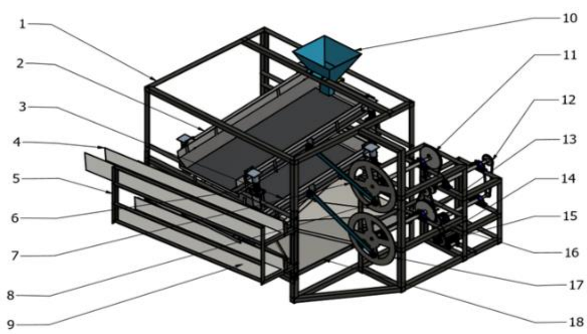

Fig. 3. Design of a sifting machine type double sieve for corn rice of products. (Note: The names of sifter machine components in Fig. 3 are shown as follows: 1: Frame; 2: Upper filter; 3. lower filter; 4. lower Channel; 5. Channel Frame; 6. Spring; 7. power shaft; 8. Pin; 9. Middle Channel; 10. Hopper; 11. Pulley; 12. Gear; 13. Gear 14. Gear; 15. Shaft; 16. Pulley; 17. Pulley; 18. lower channel).

b) Working principles of the machine

The electric plug is connected to the socket, and the dynamo shaft rotates. The rotation of the shaft is transmitted to the "power-shaft" through a transmission circuit. The "power-shaft" drives and pulls the filter repeatedly (reciprocating motion). The grinded corn is fed into the hopper; the hopper channel is opened. The corn that have been grinded are passed onto the surface of the filter, then sieved.

B. Planning of Sifter Machine Components

1) Transmission components

The transmission components of the sifter machine with double filters for corn rice are shown in Fig. 4.

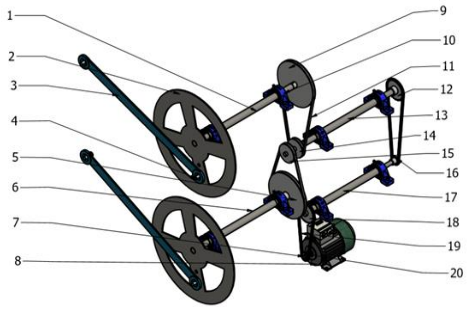

Fig. 4. Transmission circuit of components of the machine. (Note: The Transmission Components are shown as follows: 1. Shaft 5 ; 2. Transmission Plate; 3. Power shaft; 4. Pin; 5. Pulley 3; 6. Shaft 4; 7. Gear 1; 8. Dynamo; 9. Pulley 4; 10. Bearing; 11. Belt; 12. Gear 4; 13. Shaft 3; 14. Pulley 1; 15. Pulley 2; 16. Gear 3; 17. Shaft 2; 18. Gear 2; 19. Chain; 20. Shaft).

The series of transmission components as shown in Fig. 4 have functions to reduce rotation and convert rotation into reciprocating motion. The transmission disc transmits power through the power shaft to push and pull the filter. Slowing down the rotation of the transmission disc is done by designing the ratio of the number of teeth on the driven gear to the number of teeth on the driven gear and also designing the ratio of the diameter of the driving pulley to the driven pulley [16].

- The comparison of rotational speeds between the dynamo shaft (shaft 1) and shaft 2, is calculated using the Eq. (1)

$$n_2/n_1 = Z_2/Z_1 \quad (1)$$

where, n_1 is the rotational speed of the dynamo shaft (shaft 1) =1400 rpm; n_2 is the rotational speed of shaft 2; Z_1 is the number of teeth in gear wheel 1 = 14; and Z_2 is the number of teeth in gear wheel 2 = 38 $1400/n_2 = 14/38$, n_2 = 516.6 rpm

- The ratio of rotational speed between shaft 2 and shaft 3, calculated by Eq. (2)

$$n_3/n_2 = Z_4/Z_3 \quad (2)$$

where, n_3 is the rotational speed of the shaft 3; n_2 is the rotational speed of shaft 2 = 516.6 rpm; Z_3 is the number of teeth in gear wheel 3 =14; and Z_4 is the number of teeth in gear wheel 4 =38

$$526.6\ /n_3 = 38/14; \ n_3 = 190.6 \text{ rpm}$$

- The ratio of rotational speed between shaft three and shaft 4, calculated by Eq. (3)

$$n_3/n_4 = D_3/d_1 \quad (3)$$

where, n_3 is the rotational speed of shaft 3 = 190.6 rpm; n_4 is the rotational speed of shaft 4; D_3 is the Diameter of pulley 3 = 60 mm; and d_1 is the diameter of pulley 1=200 mm

$$190.6\ /n_4 = 200/60; \ n_4 = 57.75 \text{ rpm}$$

- The rotation ratio, on a of shaft 3 with shaft 5, is calculated by Eq. (4)

$$n_3/n_5 = D_4/d_2 \quad (4)$$

where, n_3 is the rotational speed of shaft 3 = 190,6 rpm; n_4 is the rotational speed of shaft 5; D_4 is the Diameter of pulley 4 = 200 mm; and d_2 is the diameter of pulley 2 = 60 mm, n_5 = 57.75 rpm

$$190.6\ /n_5 = 200/60; \ n_5 = 57.75 \text{ rpm}$$

2) The filter

The filter has a series and shape, as shown in Fig. 5. A Sifter machine with a double sieve for corn rice has two filters, namely;

(1) Upper filter, the size of the filter cavity, width b = 4 mm, and length a = 4 mm. This function of the filter is to separate granules measuring ≥ 4 mm from granules measuring ≤ 4 mm.

(2) Lower filter, it has a cavity size, width b = 1.5 mm, and length a = 1.5 mm. This filter separates granules measuring ≥ 1.5 mm from granules size ≤ 1.5 mm. Grains ≥ 1.5 mm and ≤ 4 mm are granular corn rice flowing on the surface of the filter towards the center channel. Groups of grains ≤ 1.5 mm were separated through the cavities into the bottom channel.

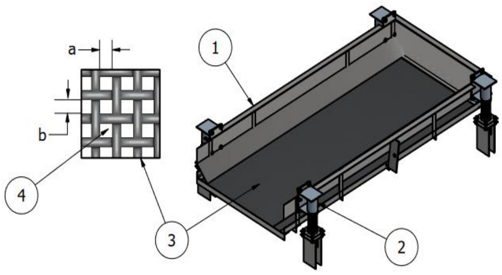

Fig. 5. Filter and filter's cavity (1). Main Frame (2). Spring and assembly (3). Filter Wire/sifter plate (4). Filter cavity.

The filter comprises a mainframe, clamp frame, and filter wire/sieve plate. The main frame is made of L-shaped carbon steel with dimensions of length 1370 mm, width 600 mm, thickness 3 mm, and gravity 22.5 N. Meanwhile, the clamp frame is also made of L-shaped carbon steel with dimensions of 1366 mm, width of 592 mm, thickness of 2 mm, and gravity of 12.8 N. The filter wire weighs only 0.4 N. The filter wire is adjusted accordingly to the surface area of the filter formed by the filter frame and weights 0.3 N. The amount of load can be calculated using the Eq. (5)

$$W = W_f + W_c + W_w \quad (5)$$

W_f is the main frame load of 22.5 N, W_c is the clamp frame load of 12.8 N, W_w is the filter wire load of 0.3 N, and F is the reciprocating motion. These loads and forces overload the spring and its assembly. The filter receives force in reciprocating motion from the torque (T) on the power rod drive shaft, which can be calculated using the Eq. (6)

$$T = (60 \times P/2 \times \pi \times n) \quad (6)$$

where, P is power of motor = ¾ hp = ¾ × 745.7 =559.2 Watt = 559.2 J/s; n is the rotational speed of shaft 3 or 4, = 57.75 rpm

$$T = (60 \times 559.2/2 \times \pi \times 57.75) = 92.5 \text{ Nm}$$

The magnitude of the force due to the torque that occurs, i.e.;

F = T/ r = 92. 5 /0. 1 = 177. 8 N

So, the load and force (W_{tot}), which loads the spring.

$$Wtot = W_f + W_c + W_w + F \quad (7)$$
$$= 22.5 + 12.8 + 0.3 + 177.8 = 213.4 \text{ N}$$

The strength of the filter is planned against the torque load. Stress occurs in the ratio of force or load to surface area [17].

$$\bar{\sigma} > \sigma \quad (8)$$
$$\sigma = F/A \quad (9)$$
$$= W_{tot}/A$$

where, W_{tot} is the load received by the filter = 213.4 N; A is the surface area of a pin = π× d × b = 3.14 × 0.012 × 0.01 = 0.00037 m

So,

$$\sigma = 213.4/(3.7 \times 10^{-4}) = 576.10^3 \text{ N/m}^2$$

For allowable shear stress ($\bar{\sigma}$). The allowable shear stress is the ratio of the allowable tensile stress to the safety factor [18]

$$\bar{\sigma} = \sigma/n_1 \quad (10)$$

where is the pin of *st* 37, the tensile stress of the pin is 370×10^6 N/m^2, and n is safety factor = 6. The occurring allowable shear stress.

$$\bar{\sigma} = 370 \times 10^6/6 = 61.6 \times 10^6 \text{ N/m}^2$$

So,

$$\bar{\sigma} \geq \sigma = 61.6 \times 10^6 \text{ N/m}^2 > 576.10^3 \text{ N/m}^2$$

The filter is stronger against loads.

3) The compression spring

The type of spring used is a helical compression spring, wire diameter (d) 0.0035 mm, outer diameter (D) 0.04 m, inner diameter 0.0033 m, number of coils (N) 10, spring length (L) 0, 1 m, spring material St 42, the spring receives a static load of 193.5 N. The construction and forces acting on the spring are shown in Fig. 6.

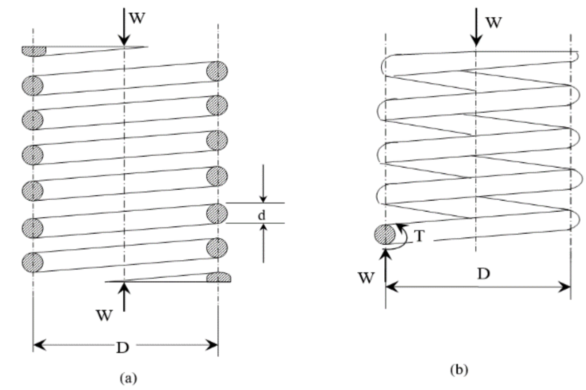

Fig. 6. Construction and forces acting on springs.

(a) Axially loaded helical spring

(b) Free body diagram showing that wire is subjected to torsional shear and a direct shear things planned for spring [19] are as follows:

(1) Average Diameter (Dm)

The average diameter of a compression spring is the sum of the average outer diameter (D) plus the inner diameter; divided by 2; it can be calculated with the Eq. (11)

$$Dm = (D + d_1) / 2 \quad (11)$$
$$= (0.04 \text{ m} + 0.033 \text{ m}) / 2$$
$$= 0.0365 \text{ m}$$

The cross-sectional area of the spring (A) is calculated using the circular the area equation Eq. (12)

$$A = \pi \times (Dm / 2)^2 A \quad (12)$$
$$= \pi \times (0.0365 \text{ m} / 2)^2 A$$
$$\approx \pi \times (0.01825 \text{ m})^2 A$$
$$\approx 0.001048 \text{ m}^2$$

(2) Spring constant

The spring constant is calculated as the ratio between the restorative force exerted by the spring and the change in its length, Eq. (13).

$$(N) : k = (E \times A) / L \quad (13)$$

Material of spring, St 42 steel, modulus of elasticity is about 200 GPa (200,000 N/mm^2 or 200,000,000 N/m^2): k = (200,000,000 N/m × 0.001048 m^2) / 0.1 m

$k \approx$ 2,096,000 N/m (or 2,096 kN/m)

(3) Spring elongation (x)

Spring elongation (x) can be calculated using Hooke's law ($F = kx$) using the magnitude of the applied load of 213.4 N; calculated by Eq. (14)

$$F = k \times x \quad (14)$$

x = 213.4 N / 2,096,000 N/m

x ≈ 0.0000925 m or 0.0925 mm

IV. RESULT AND DISCUSSION

A. Constructing of the Machine

1) Materials

The materials used include L Shaped Carbon steel sizes 40×40×4 mm, 30×30×3 mm, and 20×20×3, and solid carbon steel with diameters of 50 mm, 30 mm, 20 mm, and 10 mm; steel plate 6 mm and aluminum plate, and filter plate.

2) Tools and machines

Tools used: ruler, caliper, set square, hammer, screwdriver, wrench, etc. Machines used: welding, grinding, bending, lathe, and milling.

B. Manufacturing and Assembly of Components

Each component is made with appropriate materials, tools, and machines. The components are made according to the planned shape and dimensions and assembled, constructing a sifter machine, as shown in Fig. 7.

Fig. 7. The sifter machine with double filters for corn rice.

The materials used have the specifications are presented in Tables I and II. Component specifications are presented in table III

TABLE I. SPESIFIKASI CHEMICAL COMPOSITION

The Name of the Material	Chemical Composition of Materials				
	C (%)	Mn (%)	Si (%)	S(%)	P(%)
L Shape Carbon Steel 40×40×4 mm	0.05–2.0	1.5	0.4	0.04	0.04
Solid steel cylinder, dia 30 mm	0.02–2.1	0.3–1.5	0.4	0.04	0.04
Steel plate, thick 6 mm	0.05–2.0	0.2–2.0	0.04	0.05	-
Steel Mesh	0.05–2.0	0.25–2.0	0.04	0.05	-

TABLE II. SPECIFICATIONS OF MECHANICAL PROPERTIES

The Name of the Component	The Strength of the Material			
	TS (MPa)	Ys (MPa)	EL (%)	H (HB %)
L Shape Carbon Steel 40×40×4 mm	370–500	300	20–30	
Solid steel cylinder, dia 30 mm	400–700	250–450	20–30	
steel plate, thick 6 mm	370–520	235–390	20–40	20–40
Steel Mesh	300–1,000		< 10%	

TABLE III. SPECIFICATIONS OF COMPONENT

Name Component	Material	Type
V-belt Pulley	aluminum	S. Groove V-Belt Pulley
Gear Wheel	Cast steel	Gear wheel motorcycle
Transmission Chain	Alloy steel	Roller Chain Drive
Bearing	Cast iron	Bearing Type Pillow Block
Electric motor dynamo Ac	-	AC, ¾ hp

C. Performance Test

The performance variables were shaft rotation, spring length, and sieve tilt angle on corn grain capacity for each grinded corn kilogram. The research procedure is as follows,

a) The grinded product of corn is sifted manually to determine the corn rice capacity per kilogram.
b) Check all components to ensure the machine is ready to operate.
c) The sifter machine is operated.
d) The grinded product of corn is put into the hopper.
e) The cover plate of the hopper is opened, and the grinded product of dry corn is distributed onto the sieve surface; filtering occurs.
f) Corn rice is obtained.

D. Comparison between Variables

1) Comparison of rotation speed shaft 4 with corn rice capacity at a spring length of 100 mm, shown in Fig. 8.

The highest corn rice capacity of 0.393 kg was achieved at a sieve inclination of 5°, at a shaft rotation speed of 52.9 rpm, and the time required was 0.26 min. The lowest capacity of 0.361 kg occurred at a rotation speed of 63.3 rpm and a time required of 0.24 min. Meanwhile, at a sieve inclination of 100, the highest corn rice sieve capacity of 0.402 kg occurred at a shaft rotation speed of 52.9 rpm, and the time required was 0.22 min. The lowest capacity is 0.374 kg at a shaft rotation speed of 63.3 rpm, and the time required is 0.21 min.

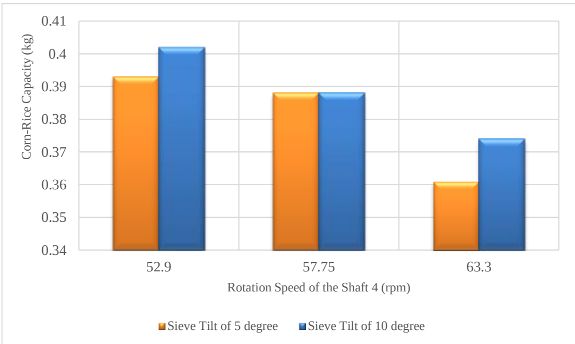

Fig. 8. Comparison of shaft rotation speed 4 with corn rice capacity at spring length 100 mm.

2) Comparison of inclination angle of filter surface with capacity of corn rice

Comparison of Shaft 4 Rotation Speed with Corn Rice Capacity at a spring length of 80 mm as shown in Fig. 9.

The highest capacity for sieve corn rice is 0.380 kg, at a sieve tilt angle of 5°, a rotation speed of 52.9 rpm, and a time required of 0.28 min. Meanwhile, the lowest sieve capacity of 0.345 kg occurred at a speed of 63.3 rpm, and the time required was 0.26 min. At a sieve angle of 10°, the highest corn rice sieve capacity of 0.390 kg occurred at a rotation of 52.9 rpm, and the absorption time was 0.25 min. Meanwhile, the lowest sieve capacity of 0.355 kg occurred at 63.3 rpm, and the absorption time was 0.24 min.

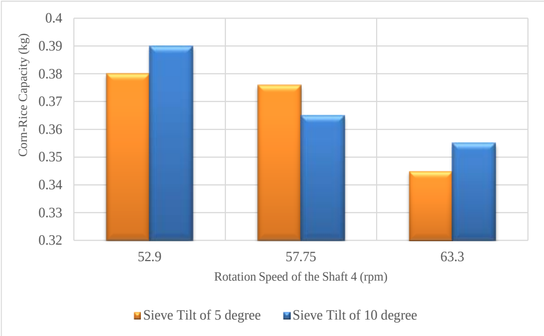

Fig. 9. Comparison of shaft rotation speed 4 with corn rice capacity at spring length 80 mm

3) Comparison of spring length with the corn rice sieving capacity

Referring to Figs. 8 and 9, the graphs show that the highest sieve capacity of corn rice, 0.402 kg, occurs at 100 mm, and the lowest, 0.355 kg, occurs at a spring length of 80 mm.

4) Comparison of Inclination Angle of Filter Surface with the Capacity of the Corn-Rice Sieve

The highest corn rice capacity of 0.402 kg occurred at a sieve surface tilt angle of 10° the lowest capacity of 0.345 kg occurred at a surface tilt angle of 5°. The machine's efficiency for corn rice products is higher than the sieve machines used by the common people so far. This can be measured from the time required to sort corn rice for 1 kg of grinded corn grains, which is only 0.25–0.27 min, while the sieve machine used by the community takes 3–4 min.

V. Conclusion

Based on the results presented on the previous discussion, we conclude some main points as follows:

Firstly, the Sifter Machine with Double Filters for Corn Rice has specifications of 2 filters, four springs on each corner of the filter. The sieve moves relative to one another, three channels distribute the sieve results, driven by a ¾ hp dynamo, construction frame of carbon steel. The separation capacity for corn rice is 0.380 kg from the total of corn rice, which is 0.483 or 78.67% for each kg of milled dry corn granules.

Secondly, shaft rotation speed, at 52.9 rpm (shaft 4), the rice and corn separation capacity reached 0.402 kg, and the lowest capacity of 0.345 kg occurred at a shaft rotation speed of 63.3 rpm.

Thirdly, spring length: The highest capacity for corn rice from separation was 0.402 kg at a spring length of 100 mm, and the lowest was 0.355 kg at a spring length of 80 mm.

Fourthly, angle, sieve surface tilt position: Corn rice's highest separation yield capacity was 0.402 kg at angle 10°, and the lowest was 0.345 kg at angle 5°.

Finally, it is stated that the results of the innovation "Sifter Machine with Double Filter for Corn Rice" make it easier and faster to produce corn rice and can be developed in various sizes according to needs.

Conflict of Interest

The authors declare that they have no conflict of interest.

Author Contributions

Yohanes Benediktus Yokasing, Amiruddin Abdullah, Ricard Fa'ot conducted the research, simulation and experimental work. Priska Gardeni Nahak supervised the research. All authors contributed in writing, reviewing; all authors had approved the final version.

Funding

This research was funded by the DIPA funds of the State Polytechnic of Kupang following the injunction of the Director of State Polytechnic of Kupang, Number 84/ Year/2021

Acknowledgment

The authors thank the Office of Research and Community Service at the State Polytechnic of Kupang and the Mechanical Engineering Department of the State Polytechnic of Kupang.

References

[1] S. A. Amran *et al.*, "Quick way to self-sufficiency in corn," *Journal of Chemical Information and Modeling*, S. Hasil, Yulianto and I. N. Widiarta Eds. IAARD Press, pp. 7–16, 2018. (in Indonesian)

[2] F. Richart, "Performance comparison of rotation speed, tilt angle, and sieve area to the capacity product of sieve on a sifting machine type double filter," Undergraduate thesis, State Polytechnic of Kupang, 2022

[3] H. Meshram, N. Bawankar, Y. Nikhar, D. Khan, L. Petkar, M. K. A. Aziz, U. Khan, and M. Shakebuddin, "Design and fabrication of multi-sieve sand sieving machine," *International Journal for Research in Applied Science and Engineering Technology*, vol. 10, no. 5, pp. 1606–1613, 2022. https://doi.org /10.22214/ijraset.2022.42606

[4] M. N. Nwigbo, J. N. Beredam, G. Dan-Orawari, A. S. Ayodele, and H. Itekena. (2017). Fabrication and performance evaluation of a mechanical sieve shaker. *International Journal of Engineering and Modern Technology*. [Online]. 3(2), pp. 7–13. Available: www.iiardpub.org

[5] N. Handra, A. David, and J. Randa, (2016), "Automatic sand sieving machine with three sieves," *Jurnal Teknik Mesin Insititut Teknologi Padang*. [Online]. 6(1). pp 19–23. Available: https://jtm.itp.ac.id/index.php/ jtm/article/view/451

[6] RETSCH GmbH Haan, "Sieve analysis taking a close look at quality," Part of Verde Scientif, RETSCH GmbH, pp. 5–7, 2015.

[7] J. Drzymala, *Foundations of Mineral Processing*, Wroclaw University of Technology Publishing House, Wroclaw(in Polish), 2009.

[8] W. Foust, *Principles of Unitary Operations*, NY: John Wiley and Sons, 1990.

[9] M. Musyafak and R. Amir, "Optimization of the step speed of the corn crusher machine for corn rice with a size of 2–4 mm," *Journal of Applied Mechanics*, vol. 1, no. 1, pp. 19–26, 2020. https://doi.org/10.32722/jmt.v1i1.3327

[10] Y. B. Yohanes, A. Abdullah, and S. Tamelab, "The two-channel sieve machine is equipped with a guide for corn rice," *Scientific Journal of Mechanical Engineering*, vol. 16, no. 2, 112, 2022. https://doi.org/10.24853/sintek. 16.2.112-122

[11] M. Haque, *Variation of Flow Property of Different Set of Formulas of Excipients Against Variable Ratio of Different Diluents*, Bangladesh: East West University, 2010.

[12] I. N. Mc Cabe and J. P. M. Syvitcki, *Principles and Methods of Particle Size Analysis*, New York, Cambridge University Press, pp. 13–21, 1991.

[13] J. Li, C. Webb, S. S. Pandiella, and G. M. Campbell, "Discrete particle motion on sieves-A numerical study using the DEM simulation," *Powder Technology*, vol. 133, no. 1–3, 2003. https://doi.org/10.1016/S0032-5910(03)00092-5

[14] R. T. Fowler and S. C. Lim, "The influence of various factors on the effectiveness of separating finely divided solids by vibrating screens", vol. 10 No. 3 pp. 163–173, 1959

[15] S. K. Yogesh, *Fundamental Research Methodology and Statistics*, New Delhi, New Age International (P) Limited, New Delhi, 2006, pp. 261–270.

[16] K. S. Sularso, *Fundamentals of Machine Element Design and Selection*, Pradnya Paramita, pp. 215–216, 1997.

[17] D. Halliday, R. Resnick, and J. Walker, *Fundamentals of Physics*, 5th Edition, John Wiley & Sons, Inc, New York, Chichester, Brisbane, Toronto, Singapore, 1997, pp. 83–84.

[18] M. L. Robert, *Machine Elements in Mechanical Design, Design of Integrated Machine Elements*, Book 1, 1st ed vol. 09, Yogyakarta, Andi Yogyakarta, 2009, pp. 78–79.

[19] D. Dahmir, *Machine Elements*, 1st Printing, Jakarta, Citra Harta Prima, 2012, pp. 95–98.