



DESIGNING TEXTILE WASTE SHREDDER MACHINE FOR CONTINUOUS PRODUCT

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ABSTRACT

The textile and textile products industry is one of the mainstay commodities of the manufacturing industry as well as a driving force for national economic development. Like any production process, the textile manufacturing process also produces waste or residual substances called textile waste. Likewise the impact of the activities of garment, tailor, fashion, apparel and convection, one of which is patchwork waste. If the patchwork waste is not handled properly, it will result in waste generation which will have an impact on pollution in the environment. Lack of tools that can treat textile waste, resulting in less optimal handling of textile waste. This research is trying to make a design of a cloth shredding machine that is used to crush the remains of large rags into small pieces of cloth. Thus the packaging of fabric waste is easier and more efficient, besides that it can also be used as raw material for other products so that it can reduce fabric waste that pollutes the environment. In developing the model and design of a textile waste shredding machine, this shredding machine will cut the patchwork which can be sized according to your wishes. It is hoped that the results of this research will contribute to the development, advancement and appropriate technology. The design of this textile fabric waste shredder will provide a practical solution and zero-waste process in a textile and garment industry.

Key Words: design, efficient, patchwork waste, technology, zero-waste

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1. INTRODUCTION

The textile and textile products industry is one of the mainstay commodities of the manufacturing industry as well as a driving force for national economic development. As is known, the trend in the export value of the industrial sector is prioritized to be developed because it has a strategic role in the national economy, namely as a contributor to foreign exchange, absorbing a large number of workers, and as an industry that is relied on to meet the needs of national clothing (Ministry of Industry, 2013). As the production process in general, the textile manufacturing process also produces waste or residual substance called textile waste. Likewise, the impact of the garment, tailor, fashion and convection activities produces waste, one of which is patchwork waste. If the patchwork waste is not handled properly, it will result in the accumulation of garbage which will have an impact on pollution in the environment (Ayo, Olukunle, & Adelabu, 2017). While the character of waste textile products that are into the growth of germs, it is difficult to be degraded and difficult to reunite with the natural environment, when burned will pollute the air, it could damage the organisms in the soil in a certain period of time, can clog drains and cause floods (Santoso, Muttaqin, & Widiyanti, 2017).

However, the textile fabric waste can be developed as a commodity that has prospective economic value if it is managed through an appropriate processing process. The lack of tools that can treat textile waste has resulted in less optimal handling of textile waste. Therefore, to overcome this, an innovation is needed that can help overcome and utilize the textile fabric waste. One of the efforts is to

utilize technology to manage textile waste which can reduce environmental pollution.

Therefore, this research tries to make a design of a cloth shredding machine that is used to chop or crush large pieces of rag into small pieces of cloth. Thus the packaging of fabric waste is younger and more efficient. In addition, it can automatically help overcome the problem of existing fabric waste so that it can be used as raw material for other products so that it can reduce fabric waste that pollutes the environment.

Several studies have been carried out in designing a waste crusher or shredder to minimize waste from environmental pollution. Rajagukguk (2013) has analyzed the design of a plastic crusher machine which produces a machine design with a capacity of 30 kg / hour 6 times. Restu (2013) engineered an automatic waste sorting and crusher machine with a simple control system on an internal scale at Batam State Polytechnic. Sutono (2014) designed a waste shredding system with a case study on automatic washing machine modifications. Khoider et.al (2018) conducted research on the challenges surrounding the production and disposal of automotive crusher residues. In so many studies, this can be used as a reference or reference to be developed even better. One of them is to develop a shredding machine that can be used to chop more than one type of product, for example, it can chop fabric as well as chop other materials such as Styrofoam, foam and others. So that the chopped fabric can be used as raw material for other products as needed.

It is hoped that the results of this research will contribute to the development, progress and

welfare of the Indonesian nation. Contribution in the form of creating an environment that is cleaner than fabric waste because fabric waste from textile companies can be recycled into raw materials for other products.

2. RESEARCH METHODOLOGY

This research is an applied research (Applied Research). The method used to achieve these results is design and testing or direct experimentation in the field. The product produced from this research is a fabric waste shredding machine design to help reduce environmental pollution caused by fabric waste from garment production or convection in Surakarta in particular.

The methods used include descriptive and evaluative methods. Descriptive method is used to collect conditions that exist in the field. The evaluative method is used to evaluate the feasibility of a textile fabric waste chopping machine model. Through product evaluation and the trial process, it is hoped that input on the advantages and disadvantages of the textile waste shredding machine using the developed design model can be obtained.

The procedure and data collection activities are carried out in the following order:

- a. Literature study related to shredding machines, both cloth, plastic and paper shredding.
- b. Conducting in-depth interviews with patchwork waste processing industry, where the raw material for shredding the waste cloth is the main raw material for the product.
- c. Conducting surveys and interviews with the industry regarding the potential for

patchwork waste generation so that this shredder solution is needed.

- d. Designing the drive system and fabric shredding method.
- e. Testing tool

3. DISCUSSION

To design the drive system, fabric tear strength test data are required. This tear strength test uses the trapezoidal method. In the feed direction and fabric warp on 20 fabric samples. The results of the tear strength test using the elemendoft tearing tester fx 3570 in the feed direction obtained a value of 4.77 kgf and in the warp direction a value of 4.45 kgf was obtained.

The fabric shredding method adopts the process of cutting cloth, namely the cloth that is chopped through two blades that form a certain angle (fixed blade and motion knife) which due to the rotating motion of the moving knife in accordance with the motion of the shaft, will cause the cloth passing through the two blades to be cut. The number of mobile knives is three, which are put together in one metal disk, while the number of knives remains two which are attached to the middle of the chopping machine. The cutting knife design is as follows:

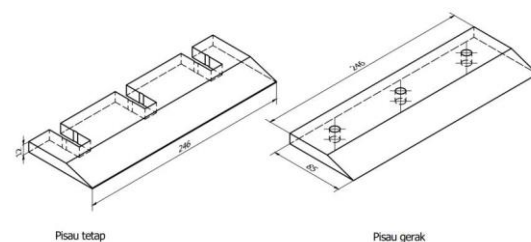


Figure 1 Fixed and mobile knife designs

The shredder part is attached to a rectangular plate body, connected to a solid shaft,

consisting of two disc-shaped plates that function as a holder for holding a mobile knife. The knife holder is connected to a disc-shaped plate using a welded joint. There are three knife holders attached to the plate with a distance of 120o for the corners of the dish. The disc design as a support for the cutting knife is as follows:

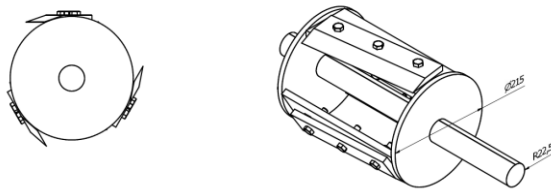


Figure 2 Cutting Knife Support Plate

Detailed cutting knife system planning data can be seen in the following table:

Table 1 Cutting Knife Planning Data

Material	S30C Carbon Steel
Diameter	215 mm r : 107,5
Knife Length	246 mm
Knife Width	2 mm
Number of Fixed Knives	2 buah
Number of Driving Knives	3 buah
Cross-sectional Area of One Knife	2 mm x 246 mm =492mm ²
Total Cross-sectional Area (A)	492 mm ² x 5 = 2460 mm ² = 24,6 cm ²
Shear Stress Value of Fabric	4,77 Kgf/cm
Knife rotation (n)	150 rpm

After designing the cutting knife, the next step is to design the shaft, peg, bearing wood, pulley and rope. Each design stage is discussed below:

a. Force of Cutting Knife (F_{knife}) :

$$\begin{aligned}
 F &= A \times F_s \\
 &24,6 \text{ cm}^2 \times 4,77 \\
 &117,342 \text{ Kgf} \\
 &1149,952 \text{ N} = 1150 \text{ N}
 \end{aligned}$$

After obtaining the cutting force, the torque value on the knife can be found using the following equation:

$$\begin{aligned}
 T &= F \times r \\
 &1150 \text{ N} \times 0.1075 \text{ m} \\
 &= 123.625 \text{ Nm}
 \end{aligned}$$

b. Power requirements planning

Determining the power requirements of a knife to cut fabric can be calculated by the following equation:

$$\begin{aligned}
 P &= H \times (2\pi \cdot n) / 60 \\
 P &= 123.625 \text{ Nm} \times (2 \times 3.14 \times 150) / 60 \\
 P &= 770.6 \text{ Watt} = 0.77 \text{ KW}
 \end{aligned}$$

From the above calculations, a single phase electric motor with a power capacity of 1 KW was selected.

c. Shaft and Peg Planning

Power and rotation transmitted are $P = 0.77$ KW and $n = 150$ rpm.

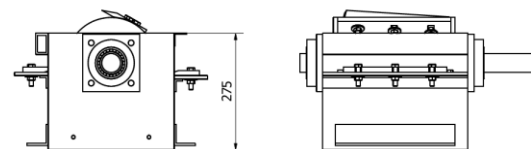


Figure 3 Chopping Machine Plate Body

The chopping part of the machine is attached to a rectangular plate body. Connected to a solid shaft, consisting of two disk-shaped plates that function as a place to hold a mobile knife holder. The mobile knife attached to the

knife holder can be positioned to the right or to the left.

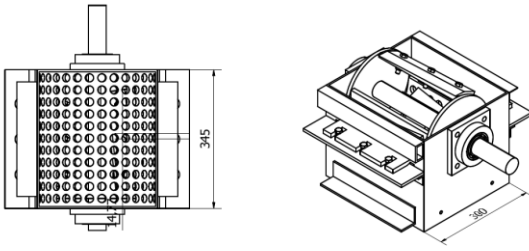


Figure 4 Middle of the Shredding Machine

At the bottom of the Shredder, a semicircular perforated plate with a hole diameter of 20 mm is installed. The function of this semicircular perforated plate is to filter the chopped parts of the fabric.

d. Selection of correction factors

The correction factor (f_c) chosen is 1.0 because the maximum power required is normal power (Sularso & Suga, 1987)

e. Power Plan

The value of the power plan can be calculated using the equation

$$\begin{aligned} P_d &= F_c \times P \\ &= 1.0 \times 0.77 \text{ KW} \\ &= 0.77 \text{ KW} \end{aligned}$$

f. The Moment of Twist the Plan

The moment of twist that may occur can be calculated by the equation

$$\begin{aligned} T &= 9.74 \times 10^5 \frac{P_d}{N_1} \\ &= 9.74 \times 10^5 \frac{0.77}{150} \\ &= 12602.99 \text{ Kg.mm} \end{aligned}$$

g. Correction Factor for Twist Moments

The twist correction factor K_t is taken from a value of 1.0 to 1.5 because when operating the shaft experiences a little shock or impact loads. The bending factor (C_b) is taken from a value of 1.2 to 2.3 because bending loads will occur when the shaft operates or rotates (Nur & Suyuti, 2017).

h. Shaft diameter

The shaft diameter (d_s) is obtained using the formula:

$$\begin{aligned} d_s &= \left[\left[\frac{5.1}{6.15} 1 \times 1.5 \times 12602.99 \right] \right]^{\frac{1}{3}} \\ d_s &= 45 \text{ mm} \end{aligned}$$

i. Upper frame

The top funnel serves as the entry hole for textile fabric waste. The position of the hole is made at an inclination of 10° so that the textile fabric waste that is inserted into the hole does not fall directly into the hole.

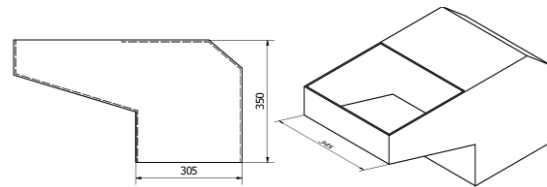


Figure 5 Upper Frame

j. Under frame

The lower part is made as a place to fall the chopped results. The position of the plate is made at a slope of 35° - 40° so that the chopped textile waste can immediately fall and enter the shelter.

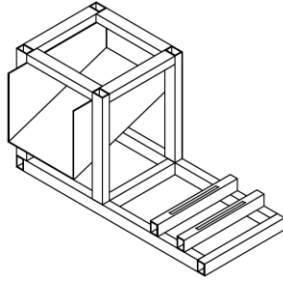


Figure 6 Lower Frame

After the parts are made, they are assembled into a compact and easy-to-use shredder. The first stage is the installation of the engine shredder on the frame. On the outer side of the shredder, a large pulley is installed as a power continuation component. After that attach the top funnel. Installation of the upper funnel using a hinge connection, so that this top funnel can be opened and closed easily, which aims to make it easier for users to clean the inside. Furthermore, the installation of an electric motor with a capacity of 1 HP is connected to the pulley and rope to the shredder shaft. The function of this pulley and rope is to reduce the rotation speed of the electric motor.

The set of tools from all parts can be seen in the figure below.

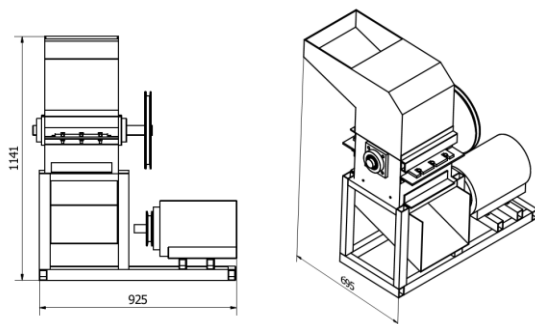


Figure 7 Outline Plan of Shredder Machine

The working principle of this machine design is quite simple; the shredded movement is

obtained from the rotation produced by an electric motor. The electric motor rotation is forwarded to the pulley and rope to achieve the desired speed reduction. The method of counting uses the principle of "cutting".

The work process begins with the entry of textile fabric waste through the top of the tool funnel then goes through the breaking stage by the shredder into small pieces. These pieces of cloth go down to the perforated plate with a certain size leading to the reservoir. The shredded fabric produced by this shredding machine can be used as a substitute for Dacron synthetic cotton for doll stuffing, motorcycle seat stuffing and sofa cushions stuffing.

4. CONCLUSION

The result of the design of the textile waste shredding machine that is made has advantages, the first is in terms of size, the size of this machine design is small so it does not take up space and is easily distributed by small business units such as convection or continuous goods production business units. Second, using a small electric motor (1HP) so that it can cut production costs and is easy to use and maintain. Third, we can determine the size of the desired count. So that the chopped fabric can be used as raw material for other products as needed. These five engine designs are simple machines, making it easy to repair and replace spare parts. As for the design of the automatic control system on this chopping machine, it can be developed in further writing.

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