

**DESIGN AND CONSTRUCTION OF SINGLE SHAFT SHREDDER MACHINE****William Harris<sup>1</sup>, Zoe Adams<sup>1</sup>, Daniel Taylor<sup>2</sup>, Lucas Robinson<sup>3</sup>, and Olivia Carter<sup>\*3</sup>**<sup>1</sup> School of Biomedical Sciences, University of Queensland, Australia<sup>2</sup> Department of Computer Science, University of Cambridge, UK<sup>3</sup> Department of Environmental Science, University of Melbourne, Australia**ABSTRACT**

Today the disposal of waste is the biggest cause of our pollution that creates harmful gasses which directly affects the environment and human body. These waste mostly includes plastic, rubber, papers, coke can etc. Most waste materials, now-a-days are non-biodegradable or it takes decades to degrade; this leads to an increase in the amount of wastes in dump sites. The continuous process of production and use of products from rubber, plastic, papers and the intensified construction lead to a serious accumulation of waste, imbalance, and danger for the environment. In all industrial societies, the need appears for reducing the household and techno genic waste and their reintegration in the production process.

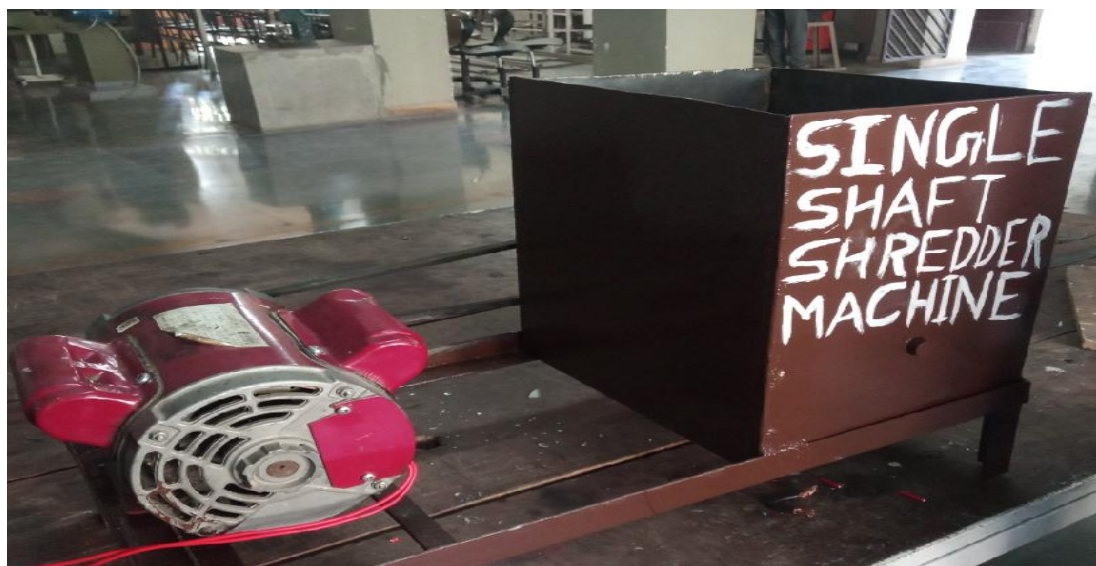
This shredder machine crushes used bottles and cans and helps in waste management and disposal. This machine is designed using locally available raw materials which make it cheap and easy to maintain and repair.

**KEYWORDS:** recycling; waste; plastic; shredder machine.

**1. INTRODUCTION**

A shredder is a machine or equipment used for shredding. Shredding systems are used to reduce the size of a given material while most online dictionaries define the shredder as "a device used for shredding documents as a security measure to prevent identity theft," shredders can be of many types based on the material being processed.

There are shredders designed to support material reduction across a range of recycling applications, including plastic recycling, e-waste recycling, scrap metal, tire recycling, agriculture waste and wood recycling. The shredding process produces raw material to be re-introduced into manufacturing, as well as finished products such as landscape mulch. Various terminologies are used to describe size reduction equipment, including grinders, chippers, granulators and hammer mills. Overall, their main function is to reduce the size of a given material.

**2. DESIGN OF COMPONENT****Speed of the belt on driven pulley**

To determine the speed of belt on driven Pulley V

$$V_2 = (\pi \times d_2 \times N_2) / 60 \quad (1)$$

Where  $d_2$  = diameter of driven pulley,  $N_2$  = speed of driven pulley.

$$d_2 = 71\text{mm} = 7.1\text{ cm} = 0.071\text{ m}, N_2 = 1100\text{ rpm}$$

$$V_2 = (\pi \times 0.071 \times 1100) / 60, V_2 = 4.0893 \text{ m/s}$$

$$\text{Tension in tight side of driver belt } T_1, \quad T_1 = T - T_c \quad (2)$$

$$T = \sigma a \quad (3), \quad T_c = mv^2 \quad (4)$$

Where  $T$  = tension in tight side of the belt,  $T$  = maximum tension in tight side of belt,  $T_c$  = centrifugal tension,  $m$  = mass of belt per meter length,  $V$  = velocity of belt,  $a$  = cross section area of belt.

$$a = 8.477 \times 10^{-3} \text{ m}^2 = 84.77 \text{ mm}^2, m = 103 \text{ gm/meter} = 0.103 \text{ kg/m.}$$

if  $\sigma = 1 \text{ Mpa}$ , then-

$$T = 1 \times 84.77 = 84.77 \text{ N}, T_c = mv^2 = 0.103 \times (4.0893)^2 = 1.72 \text{ N}, T_1 = T - T_c = 84.77 - 1.77 = 83 \text{ N.}$$

#### Tension in the slack side of drive belt

Using  $L_n(T_1/T_2) = \mu \times \theta$  (5), where  $T_2$  = tension in slack side,  $\theta$  = angle of contact in radians,  $\mu$  = coefficient of friction between the rubber belt and the cast iron pulley,

If  $\mu = 0.3$  then-

$$L_n(T_1/T_2) = \mu \times \theta, L_n(83/T_2) = 0.3 \times \pi, T_2 = 32.341 \text{ N}$$

#### Power transmitted by the belt

$$P = (T_1 - T_2) \times V \quad (6), P = (83 - 32.341) \times 4.0893 = 207.159 \text{ W}$$

#### The twisting moment or torque on the shaft (M).

$$M = (T_1 - T_2) \times R_2 \quad (7), M = (83 - 32.94) \times 0.0335 = 1.677 \text{ Nm} = 1.677 \times 10^3 \text{ Nmm.}$$

#### The bending moment on the shaft ( $M_n$ ).

$$M_n = F \times L \quad (8), \text{ where } F = \text{load on shaft, } L = \text{perpendicular length,}$$

$$F = T_1 + T_2 \quad (9), F = 83 + 32.341 = 115.341. M_n = F \times L = 115.341 \times 0.0335 = 3.864 \text{ Nm} = 3.864 \times 10^3 \text{ Nmm.}$$

#### The equivalent twisting moment ( $M_e$ ).

$$M_e = \sqrt{[(K_m \times M_n)^2 + (K_t \times M)^2]} \quad (10), \text{ where } K_m = \text{combined shock and fatigue factor of bending, } K_t = \text{combined shock and fatigue factor for twisting.}$$

Let  $K_m = 1.5$ ,  $K_t = 1.5$ .

$$M_e = \sqrt{[(1.5 \times 3.864 \times 10^3)^2 + (1.5 \times 1.677 \times 10^3)^2]} = 6345.867 \text{ Nmm}$$

#### The diameter of the driven shaft

$$M_e = d^3 \times \tau \times \pi / 16, \text{ where } \tau = \text{allowable shear stress on the shaft, } d = \text{diameter of shaft.}$$

$$\tau = \tau_u / \text{fos}, \text{ where } \tau_u = \text{ultimate shear stress on the shaft, fos} = \text{factor of safety.}$$

The material used for shaft is carbon steel of grade 45C8, which has  $\tau_u = 700 \text{ Mpa}$ , and  $\text{fos} = 5$

$$\tau = 700 / 5 = 140 \text{ Mpa}$$

$$M_e = d^3 \times \tau \times \pi / 16, d^3 = (M_e \times 16) / (\pi \times \tau) = (6345.867 \times 16) / (140 \times \pi), d = 6.1344 = 16 \text{ mm}$$

### 3. CONCLUSION

Shredder machine was successfully run in the Workshop Department of Mechanical Engineering United college of engineering, Naini, Prayagraj, India and the following conclusion can be summed up:

- i. It was able to perform the desired cutting.
- ii. It was economic in cost.
- iii. It provided the desired Material cutting Rate.
- iv. Blades can be cleaned easily.
- v. Highly skilled operators are not required

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