Design and Analysis of Mechanical Based Can Crusher

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Abstract

The can crusher is used to reduce the volume of can by applying force along with vertical and horizontal direction. The traditional can crusher uses two separate motors for rotating two vehicle tyres, some of them used to run the driven tyre with the help of friction between the two tyre which leads excessive wastage of power. To eliminate this problem, we have designed a can crusher which is operating on a single motor and two type of belt drives which help to rotate in opposite sense to each other. This analysis and design is beneficial for easy disposal with respect to environment and consumes less power than the traditional system which is helpful to improve the productivity.

Keywords: Can crusher, Cross Belt drive, Straight Belt drive, Speed ratio

1. Introduction

The disposal of the metal waste seems to be a tedious task due to enormous consumption. There also lies an issue in transporting the metal wastes to the recycling plants which needs lot of human effort, time and money. The waste material needs to be made into a uniform shape for easy and effective transportation. This paper aims to design simple mechanical crusher which helps for easy waste management. The crusher is used to crush sheet metal wastes, paint cans, cool drink cans, and machining scraps. The uniform size and shape of the materials can be obtained by providing a bin on which the material is to be crushed. The crusher is designed to operate by both mechanical and electrical means. This crusher is designed to minimize the effort to operate both mechanical and electrical types of operation. This work involves design and fabrication of mechanical Crusher, keeping in mind the human ergonomic aspect and making the machine up to market standards. The existing crushers are heavy ones and these crushers are excessively used for crushing materials at big industries and manufacturing plants for crushing cars, stones, metal components, etc., Moreover, these crushers are hydraulically and pneumatically operated. The operating costs of these crushers are very high as it requires continuous power, proper maintenance and skilled labor for operation. [1].

The study insists the requirement for environment accountability for the engineers. The various design methodologies have been discussed to construct the can crusher which would be helpful in waste management emphasizing the need for recycling the wastes particularly the metal can wastes [2].

A wear model studied for the cone crushers which are used to crush the rocks minerals which are in the form of ores in mines to measure geometry and several effects. Due to complex construction and real time shortcomings, efficiency of the machine reduced drastically. The various drawbacks have been studied and the measurements have been done to predict the efficiency [3].

A paper studied jaw crusher performance in the granite query. Investigation was conducted to study the performance and drawbacks were spotted out [4,5].

2. Design of System

Careful design approach has to be adopted. The total design work has been split up in to two parts.

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1] System design

2] Mechanical design

1. System Design

System design mainly concerns the various physical constraint and ergonomics, space requirements, arrangement of various components on main frame at system, man plus machine interaction number of controls, working environment of machine, chances of failure. safety measure , maintenance, scope of improvement and total weight of machine.

2. Mechanical Design

The mechanical design has direct norms with the system design. Hence the foremost job is to be controlled the physical parameter so that distinctions obtained after mechanical design can be well fitted into that.

2.1. Design of straight belt drive

[P] = P * SF ------ Eq.1

= 0.746 * 1

= 746 watt = 0.746 watts

Selecting Cross section

tan(20) = (W-w)/2T ------ Eq.2

= (13-w)/16

w = 7.167 mm

Taking 12" pulley on driven side and 2.5" pulley on driver side to increase the speed ratio

Hence, i=5

Center to center distance

C_{approx}/ D = 0.98 ------ Eq.3

C_{approx} = 274.32 mm

Approx length of belt

L_{approx} = 2C+π/2 (D+d)+(D-d)^2/4c ------ Eq.4

= 2* 289.58 + π/2 * 381 + 45.11

= 548.16 + 598.47 + 45.11

=1191.91 mm

Hence, **Selecting A46 belt**.

2.2. Design of Cross Belt Drive

Step 1-

Design Power:

[P]=P *S.F ------ Eq.5

= 0.5HP = 373 Watts

Selecting Standard belt c/s symbol based on load capacity.

Selecting cross section A … (PSG 7.58)

tan(20) = (W-w)/2T ------ Eq.6

= (13-w)/16

w = 7.1676

Area of cross section

A = 1/2 [W+w]T ------ Eq.7

= 0.5 * (7.167 + 13)*8

A = 80.68 mm2

Step 3: Driving and driven pulley diameter :

For selected cross section

d>=75 mm

Taking standard driving pulley

d=3" …..(PSG 7.54)

Driven pulley diameter

D= d*i*η ------ Eq.8

Assuming 2% slip and i=1 as both tyres have same rpm

Ƞ = 0.98

D = 75* 1 * 0.98 = 73.5 mm = 75 mm

Center distance between 2 pulley :

= Radius of tyre 1 + Radius of tyre 2 + 150 ------ Eq.9

= 437.25+150 = 587mm

Approx length of belt

L_{approx} = 2C+π/2 (D+d)+((D+d)^2)/4c ------ Eq.10

= 2 * 550 + 152.4 + 10.955= 1100 + 152 = 1312.4 mm

Hence **selecting A51 belt**.

3. Working Methodology

The long base frame caused the heavy frame to tilt with small amount of vibration, or miss-alignment. So the motor was places opposite to original mounting and thus the width of the frame increased, giving more ground stability (Fig.1).

Fig.1 Heavy Duty Can crusher

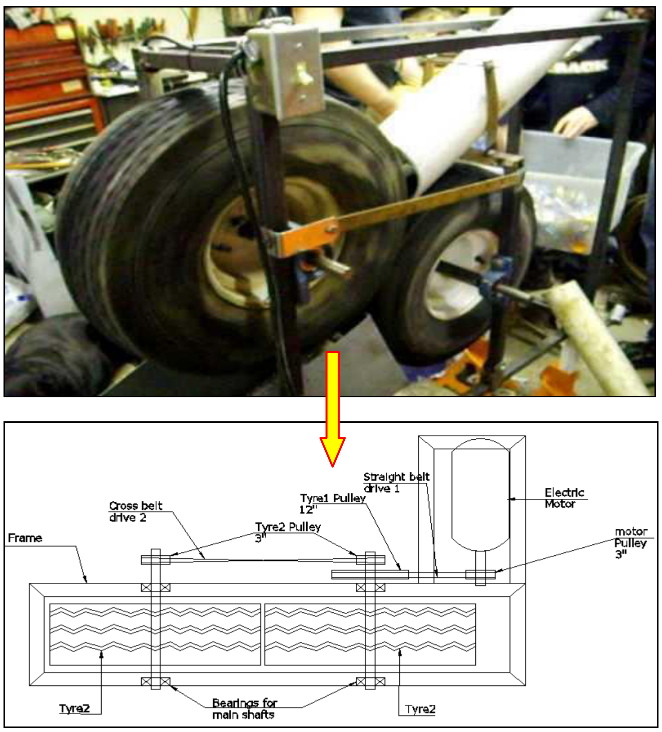

Fig.2 Simplified layout of Can crusher

In designing and fabricating the tin can crusher, a process planning had to be charted out (Fig.2).This acts as a guideline to be followed so that, the final model meets the requirement and time could be managed. The designing phase is briefly classified as the Frame, Contacting and crushing part (Tyres), bearings, power source, and the Ergonomics of the design for Human Comfort. After suitable selection of material, fabrication of prototype, the force and torque calculations are done to set the exact distance between the tyres and ideal height is adjusted for the hopper arrangement. The motor is turned on. The driver tyre starts to rotate because of the straight belt drive. As the driven tyre is connected to the driver tyre, it starts rotating with speed reduction. When the two tyres start to rotate, the cans are added from the hopper. These cans thus fall into the space between the tyres and get crushed. Arrangement is done for collecting the crushed cans.

4. Results and discussion

The cans crushed occupy lesser space than the uncrushed cans. The cans are crushed upto 75% of their volume. The can crushed volume is adjusted by the self aligning bearing. If the bearing is set closer, the tyres are brought closer thus reducing the gap between the two tyres, hence the cans are crushed to a greater extent and vice versa.

5. Conclusions

The above design procedure has been adopted for the fabrication of fully mechanical can crusher machine which make the product durable for the long time as well as make it efficient to understand the concept of design. With the help of design, possible to fabricate an automatic can crusher machine to simply reduce the volume of cans as well as to reduce the human fatigue.

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