International Journal of Latest Research in Engineering and Technology (IJLRET)
ISSN: 2454-5031
www.ijlret.com || Volume 03 - Issue 02 || February 2017 || PP. 14-20

DEVELOPMENT OF DOUBLE ACTING CAN CRUSHER

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Abstract: Recycling plays a very important role to save our natural resources. In recentyears the use of Aluminium, as packaging material for beverages has increased tremendously. This calls for recycling Aluminium cans in a large quantity. It has been observed that storage, and later transporting undented Aluminium cansis not economically viable as the weight to volume ratio is less. Hence the need forcrushing cans arises. An attempt has been made to develop a machine usingsimple mechanisms to feed, crush and dispose Aluminium cans without much humaneffort.

Keywords: Aluminium can, slidercrankmechanism, cancrusher

1. Introduction

The most preferred material in manufacturing of beverage cans is aluminium.Its usage has increased in our day to day life; therefore it is important to reuseit as much as possible. Recycling aluminium not only helps to keep the landfills clear butit also saves energy.Aluminium can today is the most recycledof any beverage container, nearly three-quarters of all aluminium ever made remains in use today. Using recycled material for new aluminiumbeverage cans uses 95% less energy and produces 95% less greenhouse gas emissionsthan making a can from new materials.

In most cases, the cans are collected indrop-off programs or by the local scrap dealer, and then cans are sorted, consolidated, andcrushed. The crushed cans are then baled for transportation to a recycling facility whichmelts them down and converts the old aluminium into new products. [1-8]

Most self-loading can crushers have a basket on top and a stopper that allows thecan to drop when the leaver is pulled to crush it. The can crusher was developed to reduce the amount of space occupied, and to help the environment. Today's aluminium can weighs about 13.6gwhich requires an approximate crushing force 425N.

Fig:1.1 A few types of can crushers available in the market

The beverage cans can be classified into two types,based on the type of material: type A is made of tin, Type B made of aluminium. The measured average mass of an empty aluminium beverage can was about 16 g;the diameters of top shoulder, base bottom, and the main body of can are 54 mm, 48 mm,and 65 mm.

Properties ofAluminium generally used for beverage can

Parameter	Value
Density (Kg/m3)	2770
Elastic modulus (GPa)	70-80
Yield strength (Mpa)	710
Tmelt (^{o}C)	633

Table:1 Parameters of the beverage cans of type (b) [13]

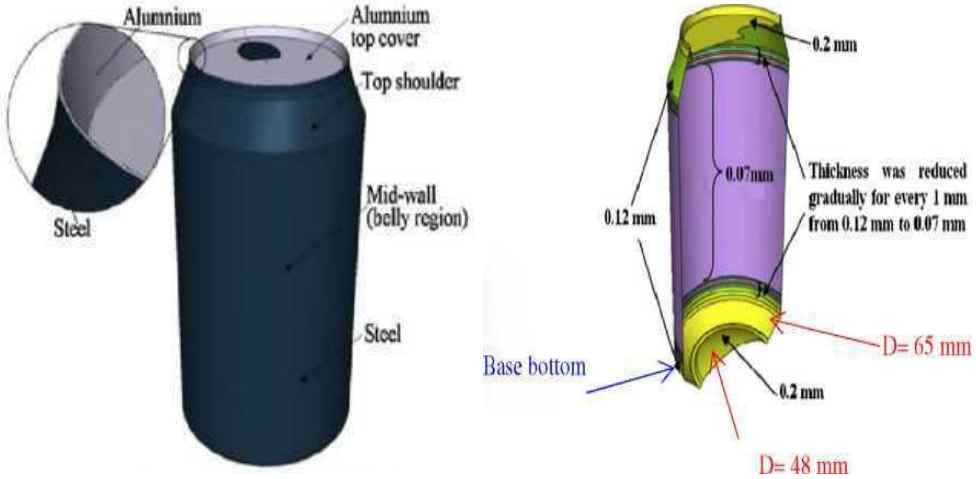

Fig:1.2 Beverage can specifications

J. Marquez et al. have found the minimum dynamic force required to crush can vertically[13].

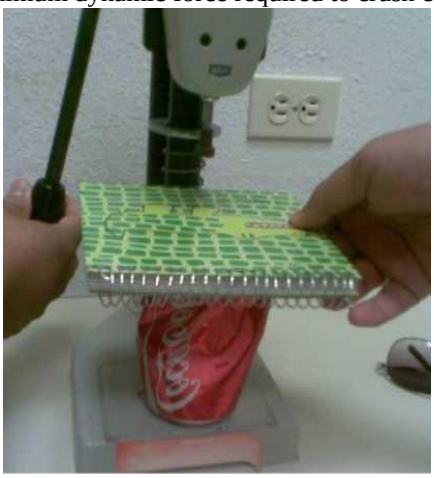

Fig:1.3Dynamometer used to crush a single can organized vertically

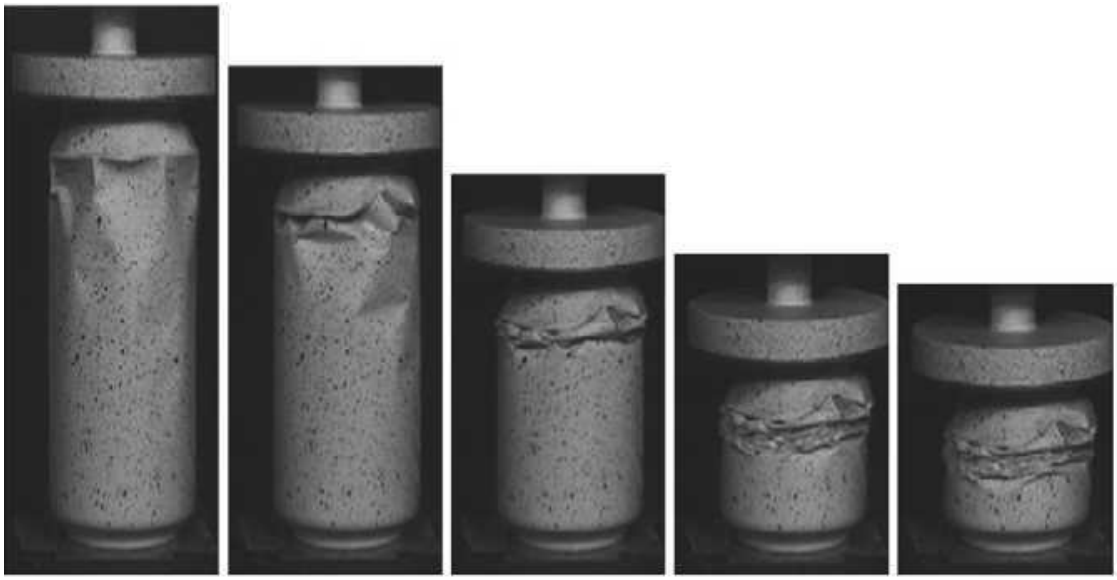

Fig:1.4 Progressive of crushing stages for a single can organized vertically

Test	Force (Kgf)
1	25
2	25
3	23
4	24
5	25
6	24
7	24
8	23
9	25
10	25
11	26
12	24
13	24
14	25
15	25
16	25
17	24
18	26
19	24
20	24

Table:2 Force needed to crush one can in a vertical position

The force to crush a can by 40% was found to be 20kgf (196N approximately).The forcerequired to crush a can increases non-linearly as percentage of compression is increased.The force required for 70% compression was found to be approximately 425N. Wehave consider 425N as the maximum force for developing our can crusher.

2. SCOPE OF PRESENT WORK

It was observed that there is a needfor the aluminium cancrusher to be lighter in weight, safe, efficient and stable. Apart from providing stability, the crusherwas required to be transported from place to place. Also, easy handling was anotherimportant criteria observed. Therefore the following were the objectives of this work:

a. It should be non-hazardous to use.
b. It should crush large number of cans in a less time.
c. It should reduce the labour involved.
d. It should be compact and should not make use of any complex mechanisms.

3. PRESENT WORK

To develop a double actingcan crusher various mechanisms were studied and the following were chosen:

3.1 Crushing mechanism

For crushing the beverage cans, the slider-crank mechanism was opted.Slider-crank mechanism is the one of the most versatile mechanisms in moderntechnology since it appears in most of the internal combustion engines includingautomobiles, trucks and small engines. The slider-crank kinematic chain consists offour bodies linked with three cylindrical joints and one sliding or prismatic joint. It isused to change circular into reciprocating motion, or reciprocating into circularmotion.A design of slider suited for our requirements was adopted. The connecting rods areon either side of ram. This allows for crushing cans in the centre of ram. A clearanceis provided for the crushed can to be collected. The mechanism had satisfied most ofthe project's objectives.

3.2SLIDER CRANK MECHANISM

Replacing one turning pair of four bar mechanism by slide pair forms a single slider crank chain.Therefore it consists of onesliding pair and three turning pairs. This type of mechanism converts rotary motion into reciprocating motion and vice versa. In a single slider crank chain, as shown in Fig. 3.2.1, the links 1 and 2, links 2 and 3, and links 3 and 4 form three turning pairs while the links 4 and 1 form a sliding pair.

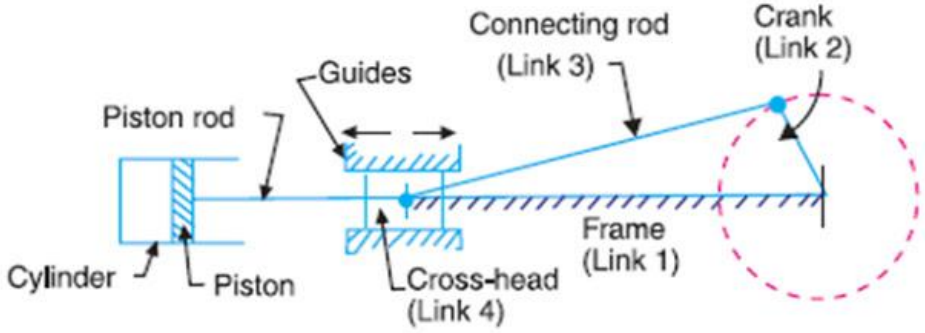

Fig: 3.2.1 Single slider crank chain

The link 1 corresponds to the frame of the engine, which is fixed. The link 2 correspondsto the crank; link 3 corresponds to the connecting rod and link 4 corresponds to crosshead.As the crank rotates, the cross-head reciprocates in the guides and thus the pistonreciprocates in the cylinder.[15]

3.3 Driving mechanisms

The driving mechanism opted was hand crank mechanism. The power will betransmitted to the main crank through chain-sprocket assembly. The other side has aplain disk of the same size as that of crank.

3.4 Feeding mechanism

The main parts of the feeding mechanism are the escapement arms which hold thecans in its place. The feeding of can is actuated by lever in the path of the ram. As theram pushes the lever, the escapement arms are pulled out and the can is dropped. Theadvantage of this feeding mechanism is that it uses the movement of the ram fordropping the can.

4. DESIGN PARAMETERS

4.1 Slider-crank mechanism

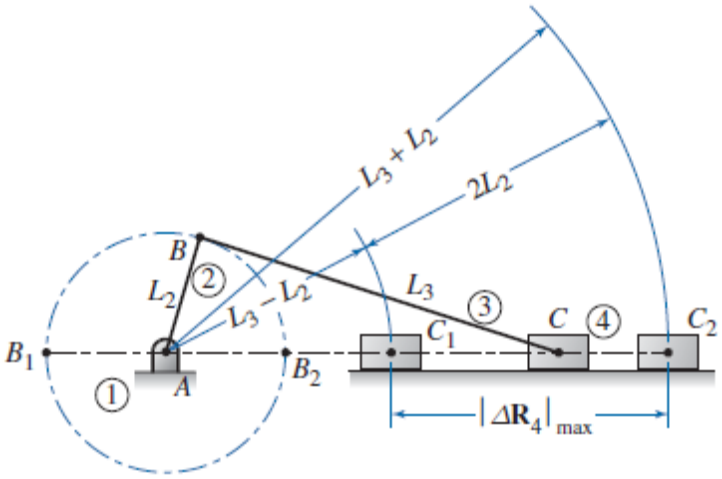

Fig:4.1.1 Inline slider-crank mechanism

L2 - length of crank
L3 - length of connecting rod
$|\Delta R4|$ max - maximum stroke length
To achieve the desired stroke $|\Delta R4|$ max
L2= $|\Delta R4|$ max/2
Taking the maximum height of a standard can as 140mm
$|\Delta R4|$ max= clearance for crushed can collection (at both ends) + maximum height of can
$|\Delta R4|$ max= (20*2)+140 =180mm
L2= $|\Delta R4|$ max/2
L2=90mm

By a general rule of thumb [14]
L3>3*L2
L3=300mm (approximately)

4.2. Chain Sprocket Design

No. of teeth on smaller sprocket Z1 = 25
No. of teeth on bigger sprocket Z2 = 72
Centre distance C =195 mm
For pitch = 9.52 mm the ANSI chain number is 35
Pitch p = 9.52 mm
1. Transmission ratio i = Z2/Z1 =72/25 =2.88
N2= 40 rpm, □ N1=N2*i=40*2.88
N1=115.2 rpm
2. Pitch diameter of sprocket: D = p/(sin(180°/Z))
D1= 9.52/(sin(180°/25)) = 75.95 mm
D2= 9.52/(sin(180°/72)) = 218.25 mm
3. Velocity of chain: V= pZ1N1/60*1000
V = (9.52*25*115.2)/(60*1000)
V = 0.456 m/s

5. Figures

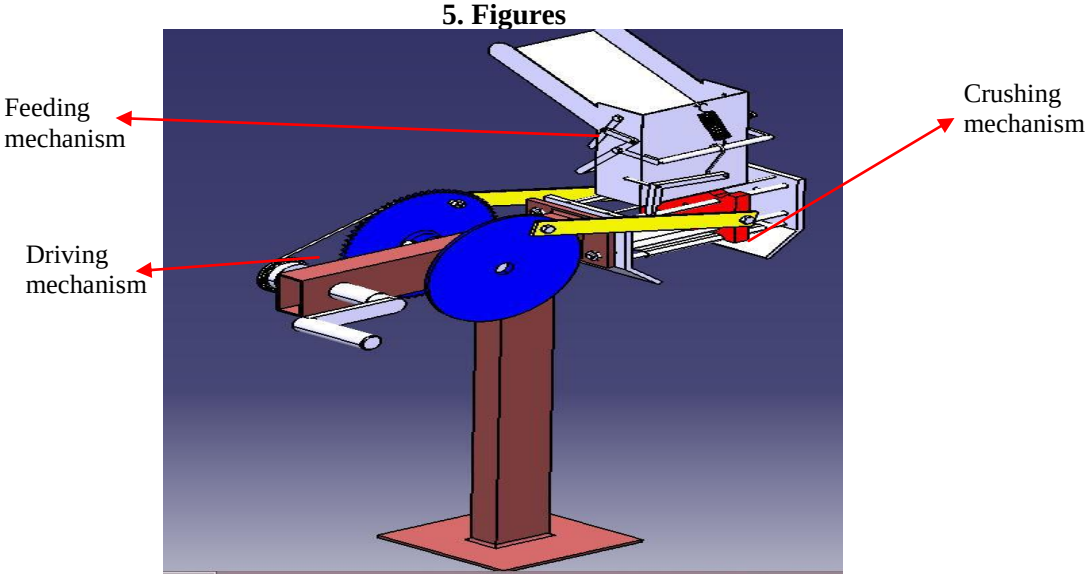

Fig:5.1Can crusher assembly (CAD model)

Fig:5.2 Assembly of crushing and driving mechanism

Fig:5.3 Linkages for feeding mechanism

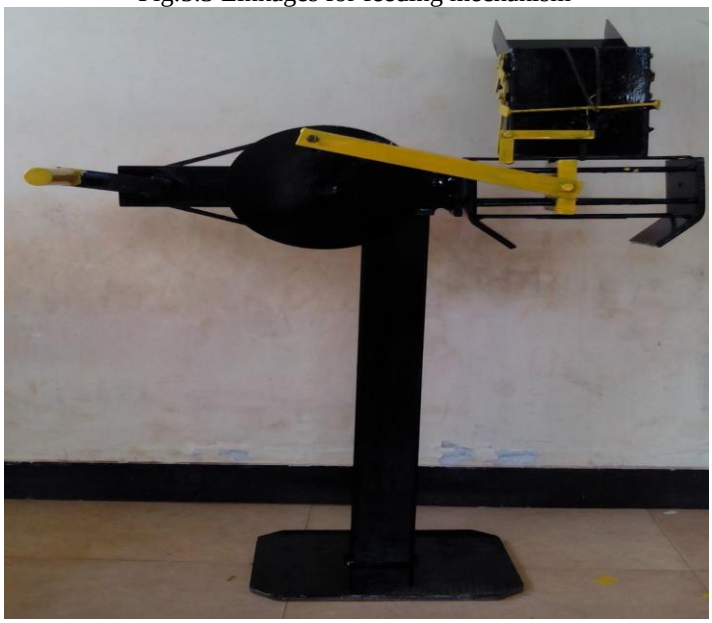

Fig:5.4 Final assembly

6. CONCLUSION

The development of a double acting can crushing equipment to crush the beverage cans wassuccessfully achieved. For this purpose, the various existing designs of crusher werestudied and efforts were made to develop a can crusher which can fulfil the requirementsof crushing of beverage cans.Some of the achieved features in the can crusher machine are given below:

a) As the ram can crush the bevreage cans during the forward and return stroke more number of beverage cans can be crushed more efficiently
b) Improved crushing mechanism: Since we are using slider crank mechanism,homogeneous crushing is obtained.
c) Minimum working cost: As it does not use any external power source to run theequipment, the running cost is negligible.
d) Portability is achieved by keeping the construction light.
e) Engineering Ergonomics has been taken into consideration while developing thecan crusher.
f) Crushing has been achieved and the working of this equipment has been found satisfactory.

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