

PNEUMATIC CAN CRUSHER

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Abstract - The Can Crushing process is a main part of the Wastage Collecting industries. Normally the Can Crushing machine is manually hand operated one for Wastage collecting industries. In our project is "Pneumatic Can Crusher".

Automation in the modern world is inevitable. Any automatic machine aimed at the economical use of man, machine, and material worth the most. In our project is Pneumatic Actuator and control Valve unit is used for automation.

The Cane Crushing machine works with the help of pneumatic Single acting cylinder. The piston is connected to the moving and Pressing Die Arrangement. It is used to press the wastage cool drinks can. The machine is portable in size, so easily transportable.

The main aim to make such a mechanical oriented project is to reduce the scrap volume and use it for recycle purpose properly. Now a day there is widely usage of cans have been done in hotels and canteen and for their storage large volume of space is required. These research papers include design and structure analysis of can crusher. There are so many researchers who have done work on design and analysis, but still there are so many areas of scope regarding this design and analysis. This project involves processes like design, fabrication and assembling procedures. Even though there are many types of the can crusher machine in the market, the completion of the new model provides more practical usage than previous one.

1. INTRODUCTION -

This is an era of automation where it is broadly defined as replacement of manual effort by mechanical power in all degrees of automation. The operation remains an essential part of the system although with changing demands on physical input as the degree of mechanization is increased.

Degrees of automation are of two types, viz.

1. Full automation.
2. Semi automation.

In semi automation a combination of manual effort and mechanical power is required whereas in full automation human participation is very negligible.

The main purpose of the project is to get knowledge of design and fabrication. The design is an environment friendly and uses simple properties such as mechanical single slider and automation properties which use microcontroller and sensor. The design is done so that knowledge of designing, mechanism and forces analysis are increased. In order to reduce the waste, we planned to create a can crushing machine that will reduce the volume of aluminum cans by approximate eighty percent. This machine primarily usage is to save space and for recycling. It can be placed anywhere in park, restaurant, canteens, etc. in today's life most of the food items are packed in canned. Cold drinks and other beverages are also coming in cans. Commercial establishments like cafeteria and bars, must deal with leftover cans. Storage is often a problem and cans consume lot of space, thereby increasing total volume of trash. The transportation cost is also high for moving such a huge number of cans. Thus, this machine will help to recycle and maintain eco-friendly environment also.

This project involves the process of designing the different parts of the crusher machine considering the forces and ergonomic factor for people to use. This project mainly about generating a new concept of can crusher that would make easier to bring anywhere and easier to crush cans.

After design has completed, it was transformed to its real product where the design is use for guidelines.

1.1 Concept -

This machine is basically working on the principle of Single Slider Crank Mechanism which is the heart of this machine and it converts rotary motion into a reciprocating machine to crush the Cans/Plastic bottles. In this, link 1 is fixed and link 2 which is a crank is rotating about fixed link 1 and converts this rotary motion into the reciprocating motion of slider (corresponds to the link 4) by means of connecting rod which corresponds to the link 3. This is the inversion of single slider crank which is obtained by fixing link 1.

2. DESIGN -

The main aim of this is to study the complete design of Automatic can crusher machine. In this design and calculation procedure parameters have been taken into consideration from design data book, thesis, journals to carried out this project.

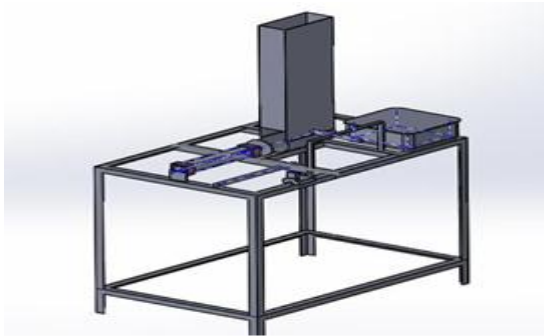


Fig: 1 - Assembly of machine (CAD model)

2.1 Cylinder -

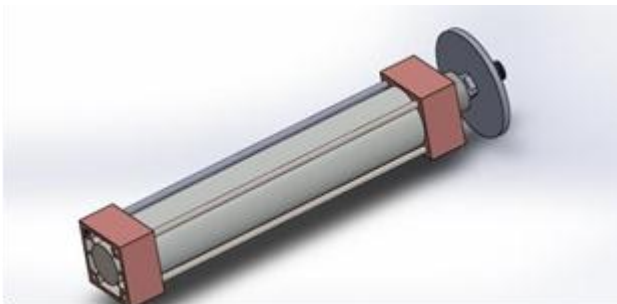


Fig: 2 - Cylinder

The material used for the cylinder is aluminium, which is having specification of 50 diameter, 100mm in length and permissible load (ft.) 180N/mm². We have selected 50mm diameter cylinder to get proper force intended on can and it get crushed, here is the calculation carried out: -

$$\text{Thickness} = \frac{D}{2} \left(\sqrt{\frac{\text{ft.} + P}{\text{ft.} - P}} - 1 \right)$$

t = 0.68mm Therefore t = 3mm

The outer diameter of the cylinder,

$$\text{Outer diameter } D_o = D_i + 2(t)$$

$$= 50 + 2(3)$$

$$= 50 + 6$$

$$= 56 \text{ mm}$$

Therefore, Force generated by cylinder $F = P \times A$

$$A = 3.14 / 4 \times D^2 \quad A = 3.14 / 4 \times 50^2 \quad A = 1964 \text{ mm}^2$$

$$F = 2.45 \times 1964 = 4808 \text{ N} = 490 \text{ kg.}$$

2.2 Hollow pipe -

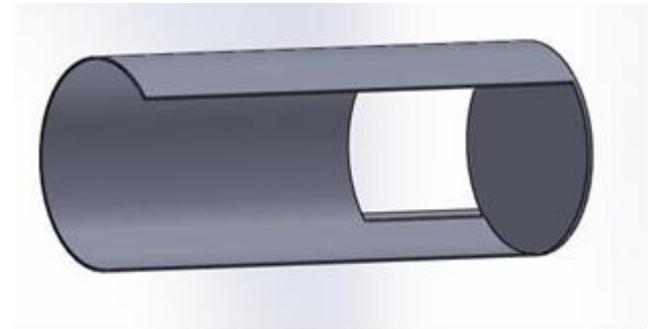


Fig: 3 - Hollow pipe

This component is made up of mild steel and it is used when cans are put in a rectangular box after which it holds the cans and main important factor is to grip it and get it crushed one by one. To design this component mild steel is taken on which design is marked then it is cut by hack saw machine according to the marked then this pipe structure is faced from both the ends. Gas cutting is done on the rectangular pipe using gas cutter. Then welding is done on the rectangular face.

2.3 Frame -



Fig: 4 - Frame

We have selected standard L section frame of material mild steel. The frame is supported due to possibility of vibration are more. Therefore, for foundation purpose pad plates are provided in between two legs a support of angle is given to avoid splitting of edge. Hinge of male type is fabricated, and female is welded in frame and slotted plate known as table plate welded with male hinged accept on frame. Below the table plate toe angle are welded on legs. On this 'S' shaped brackets are mounted, these brackets are used as bearing housing. In this brackets bearing are fitted. Bearing Arbor is fitted which is main part of the machine and whole accuracy depends on it. The

shaft is made according to IS-C-45 on centre lathe machine in workshop and alignment of the shaft is supported between the centre lathes during fabrication.

2.4 Design of weld joint -

Checking the strength of the welded joints for the safety. The transverse fillet weld welds the side plate and stiffness plates, the maximum load which the plate can carry for transverse fillet weld is,

$$P = 0.707 \times S \times L \times fs$$

Where, S = size of weld, L= contact length =25mm

The load of shear along with the friction is 30kg = 300N
Hence, eqn becomes

$$300 = 0.707 \times 3.4 \times 25 \times fs$$

$$\text{So, } fs = \frac{300}{0.707 \times 3.4 \times 25}$$

$$Fs = 5 \text{ N/mm}^2$$

Since the above calculated are smaller so permissible value fs is taken as 21 N/mm² which is very safe.

3. CALCULATION AND GENERAL WORKING -

- Can Crusher Calculations:

Can Dimensions: 2.625in in diameter (1.3125in in radius), 4.875in in height

Volume - 1 uncrushed can

$$V = \pi r^2 h$$

$$V = \pi \times 1.3125^2 \times 4.875$$

$$V = 26.38 \text{ in}^3$$

Volume - 1 can reduce by 70%

$$V = \pi r^2 h \times .3$$

$$V = \pi \times 1.3125^2 \times 4.875 \times .3$$

$$V = 26.38 \times .3$$

$$V = 7.914 \text{ in}^3$$

Height of a crushed can (height reduced by 70%)

$$h = 4.875 \times .3$$

$$h = 1.4625 \text{ in.}$$

Volume - 20 uncrushed cans

$$V = \pi r^2 h \times 20$$

$$V = \pi \times 1.3125^2 \times 4.875 \times 20$$

$$V = 26.38 \times 20$$

$$V = 527.66$$

Volume - 20 cans reduce by 70%

$$V = \pi r^2 h \times .3 \times 20$$

$$V = \pi \times 1.3125^2 \times 4.875 \times .3 \times 20$$

$$V = 26.38 \times .3 \times 20$$

$$V = 7.914 \times 20$$

$$V = 158.28 \text{ in}^3$$

Criteria and Constraints

- Criteria:

1. Self-loading
2. Inexpensive
3. Reliable
4. Not time consuming
5. Simple

- Constraints:

1. Maximum space the design can occupy is 18"x24"x30".
2. Materials that can be used are wood, PVC, metal brackets, metal hinges, screws and nails.
3. Minimum of one simple machine.
4. Crushed aluminum can must immediately fall into the aluminum can bin without human intervention.
5. The aluminum can bin must slide in and out of the crusher.
6. The aluminum can bin must be sized to hold 20 crushed cans.
7. All parts of the can crusher must be fabricated.
8. The design is to be one unit.
9. Must be manually operated.

The engine is attached at compressor site. The compressor is made ON till the pressure in storage tank reaches 5 bar pressure. Here, the minimum operating pressure is 3bar to crush the can. The flexible hose coupled with the compressor tank and the air storage tank installed on the air engine .Here we use combination of electronic circuit, 5/2 solenoid valve for running cylinder compressor .the utility valve which supplies the air from the air tank to the direction control valve is gradually opened. The 5/2 direction control valve is operated as can placed in front of the opto sensor.

A can crusher for environmental protection is generally composed of a pneumatic system to drive a piston forward or reverse backward. When the piston is move forward a plate which act as a bore of the piston moves along the piston crushes the can. A separate pneumatic cylinder is used to push the can in crushing zone. A groove formed at an inner bottom portion to drain any residue left in a can to a collecting bin.

The working of the project picture has been made and its image format is taken and uploaded here: -

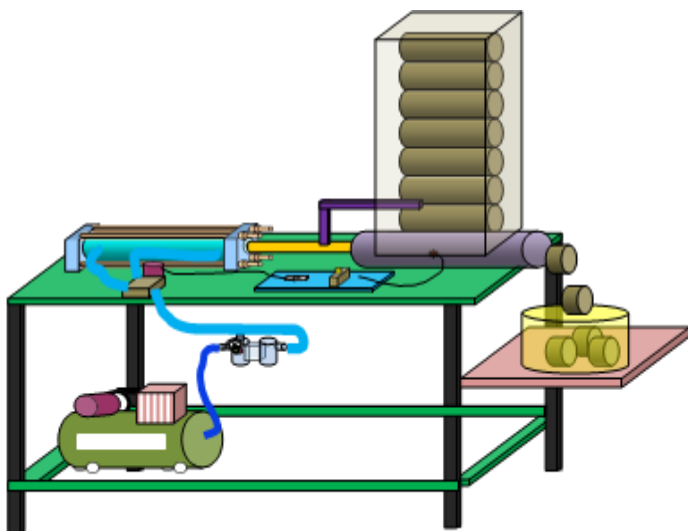


Fig: - 5 Entire CAD model of Machine

Holder that is hollow pipe. In this the sensor is fitted with respect to the hollow cylinder which emits the signal and forward to the micro controller which gives the forbidden to actuator to crush the cylinder.

3.1 Test Plan -

TEST CRITERIA	HOW TESTED	EXPECTED RESULT	ACTUAL RESULT
Reliability	Crush a can, measuring size before and after crushed	The can will be crushed to 70% of its original height	
Durability	Crush a can, open and close the drawer of the bin that stores aluminum cans	The aluminum can bin will slide in and out with ease	
Bin Must Hold 20 Crushed Cans	Put 20 cans crushed in the bin	All 20 cans will be crushed	
Self-Loading	Put 3 cans into the self-loading mechanism and crush all three cans	The crusher will be able to self-load appropriately without any complications	
Can Must End-up In Bin After Being Crushed	Crush a can and see if it falls through the appropriate hole into the bin	The can will fall through the hole into the bin	

3.2 Prototype -

Our work process worked okay at first, but we should have added more detail in it to make the parts easier to build. As we got deeper into building, we noticed how unreliable our build process was. We were constantly making changes to our build process. By the time we got to the building of the crushing mechanism, we stopped using the build process all together. We believed that our build process was not reliable because we made it too simple. We should have made it with more detail.

We had to make various changes in our design to ensure that it would be able to work. Some of the changes we made to the crushing mechanism where we ended up putting the walls on the opposite sides because we found out that it would be able to crush the cans easier. For our outside bin, we made the hole that the cans would fall through bigger because, at first, the hole was too small, and the cans barely fell through.

3.3 Test and monitor -

TEST CRITERIA	HOW TESTED	EXPECTED RESULT	ACTUAL RESULT
Reliability	Crush a can, measuring size before and after crushed	The can will be crushed to 70% of its original height (It will be 1.5" tall)	The can was crushed to 1.5" in height
Durability	Crush a can, open and close the drawer of the bin that stores aluminum cans	The aluminum can bin will slide in and out with ease	The aluminum can bin slid in and out with much ease
Bin Must Hold 20 Crushed Cans	Put 20 cans crushed in the bin	All 20 cans will be crushed	Bin could hold 20 cans and still had some space
Self-Loading	Put 3 cans into the self-loading mechanism and crush all three cans	The crusher will be able to self-load appropriately without any complications	The self-loading mechanism held 3 cans with about an inch worth of space at the top
Can Must End-up In Bin After Being Crushed	Crush a can and see if it falls through the appropriate hole into the bin	The can will fall through the hole into the bin	They can fell into the bin with ease

4. MAINTAINENCE AND SAFETY -

4.1 Maintenance -

No machine in the universe is 100% maintenance free machine. Due to its continuous use it is undergoing wear and tear of the mating and sliding components. Also due to the chemical reaction takes place when the material comes in the contact with water, makes its corrosion and corrosion. Hence it is required to replace or repair. This process of repairing and replacing is called as maintenance work.

4.2 Autonomous maintenance activity -

1. Conduct initial cleaning & inspection.
2. Eliminate sources of dirt debris excess lubricants.
3. Improve cleaning maintainability.
4. Understand equipment functioning.
5. Develop inspection skills.
6. Develop standard checklists
7. Institute autonomous inspection
8. Organize and manage the work environment
9. Manage equipment reliability.

4.3 Equipment improvement -

1. Restore obvious deterioration throughout.
2. Establish plan select pilot area, determine bottleneck.
3. Study and understand the production process.
4. Establish goals for improvement.
5. Clarify the problem, collect the reference manuals contact resources.
6. Conduct evaluation through such techniques as RCM analysis, FMECA, FTA (Root cause failure analysis).
7. Determine improvement priorities, costs and benefits.
8. Execute improvement in pilot area standardize technique and document what you have done.
9. Monitor results and optimize based on those results.

4.4 Equipment responsibilities for operator -

1. Operation with the proper standard procedure.
2. Failure prevention.
3. Failure resolution.
4. Inspection.
5. Cleaning.
6. Lubricating.
7. Lightning fasteners.
8. Minor repairs.
9. Trouble shooting.

5. CONCLUSIONS –

The above design procedure is been adopted for the fabrication of fully automatic can crusher machine which will make the product durable for the long time as well as make it efficient and helps to understand the concept of design. Thus, with the help of this design we can fabricate an automatic can crusher machine to simply reduce the volume of cans as well as to reduce the human fatigue. At the start of this project, we did not know much about how to build a can crusher. Our first priority was to research can crushers in how they work, how to build them, and we had to make sketches of a frame, bin, and crushing mechanism. Once we got in our group, we noticed how different our designs were and we started picking which design we would like to go with. Once we had our design picked out, we were ready to go through and make all decisions that were necessary to finish and complete our project successfully.

When we were ready to build, we started with the bin inside and outside parts. Once done with building the bin parts, we started to work on the frame of the crushing mechanism. We saved the building of the crushing mechanism for last because we knew it would take the longest to build.

Ultimately, this was a project that served as an important learning experience for all four of us. We were able to complete the project by a given date, coming in during study hall, before and after school. We also managed to polish a lot of the skills we attained while working on the project. Overall, our project was quite successful, and we were able to meet our goal at the close of the project.

REFERENCES –

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- [2] Khurmi R. S. – Design of Machines
- [3] Design Data Book by PSG Tech.