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Design and Development of Can Crushing Machine

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Abstract **- A can crusher machine is used to crush the cans for storing in bin efficiently. The crushing of cans plays a significant role in economy and ultimately helps to society. The process of cans crushing is also human and environment friendly. From literature studies it was learnt that the existing cans crushing machines are automated and can overcome the limitation of manually crushing but cost of automated cans crushing machine is high. In present study, the can crusher machine is developed economically which is automatic and eco-environment friendly. The experiments were conducted for finding the optimal pressure and force values required for effectively crushing the cans. This work helps to increase the storing capacity of cans for user. Thus, transportation cost reduces significantly due to process improvement efficiency.**
Keywords: **Automation, Cans, Crush Size, Design Consideration, Productivity.**

I. INTRODUCTION

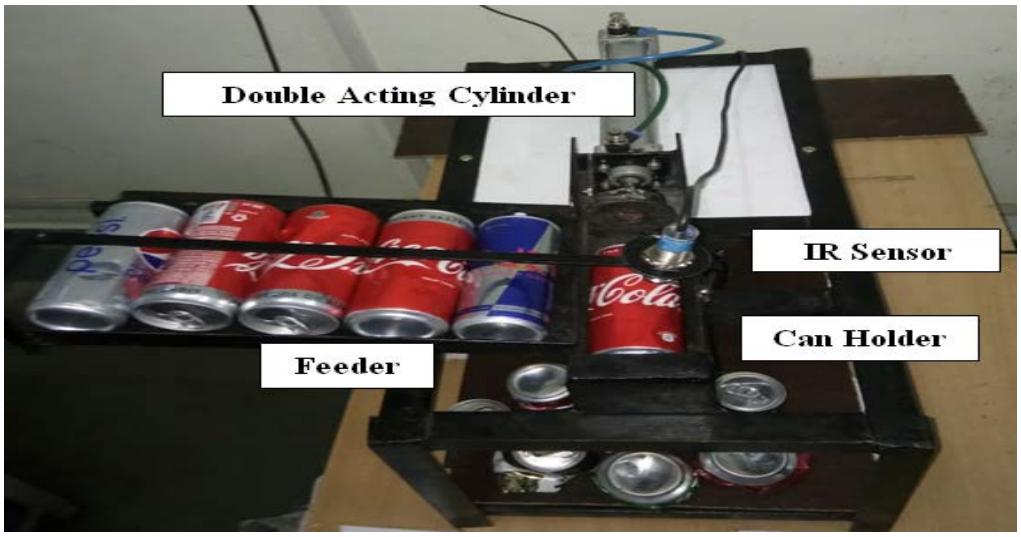
A can crusher is used for crushing the cans or plastic bottle providing more space to storage in bins after use. In order to reduce the waste, can crushing machine reduces the volume of aluminum cans by approximate 75% through which transportation volume will increase and transportation cost will be reduced. The crushing of cold drinks cans and other beverage cans is obtained easily using this machine. The machine is useful for wide application and can be placed anywhere in cafeteria, park, restaurant, and bars. The major problem associated with cans is storage, as lot of space required, and transportation cost increased. Thus, crushing the can speedily and recycling helps to maintain eco-friendly environment and reduce the cost [1-3].

Now days, in India, the amount of waste coming in large quantity in the form of tinny cans are being recycled on a large scale. Most of the population of India uses the cold drinks and other products packaging by cans. These tinny cans are durable, flexible, lightweight, strong and recyclable. Thus, crusher is required to crush such tinny cans in less time. The cans crushing machine creates economical crushing and protects environment by providing more storage of used cars in less space [4-6]. The available can crusher crush the tinny cans of low strength material made of aluminum, copper, brass, bronze material etc. The machine can also crush the medium strength material by necessary modification. Similarly, to increase the efficiency of the machine; the machine needs to be modified by changing the mechanism to crush multiple tinny cans at a time for better productivity [7-8]. The design of cans crushing machine is designed for PET bottles and experiments were conducted for finding the optimal values of force to deform the bottle material. FEA analysis was also carried out on cutting blade to observe the material response to stresses and corresponding deformation [9].The design of crusher for crushing plastic bottles based on force and ergonomic factor is considered for human convenient and safety view. Thus, it helps to reduce waste and disposal [10]. The required stroke length and quick return mechanism for crushing is stated in paper [11]. The design and fabrication of double acting can crush machine is developed to obtain optimal force using pneumatic system for achieving economical production [12-13]. The different mechanisms are used such as slider crank mechanism; scotch yoke mechanism, to generate the force for crushing the cans. The parameters such as force, stroke length, diameter of cylinder is important for proper working of crushing process. The working principal is based on different systems like pneumatic and mechanical [14]. Considering large scope of improvement in design and manufacturing of automatic can crusher, in present work, the pneumatic mechanism is used. The main objective of present work is to develop the automatic can crusher from economic and productivity aspects.

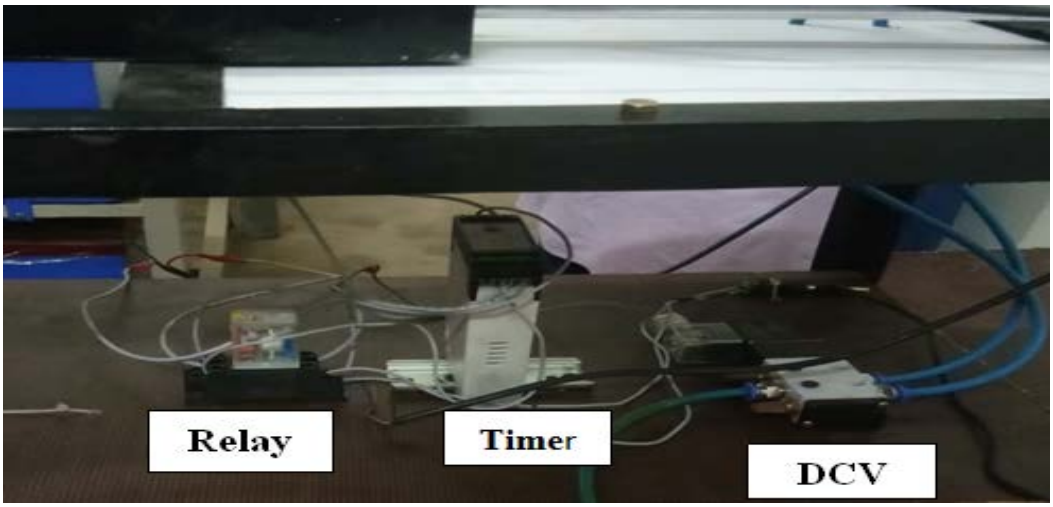
II. EXPERIMENTAL SETUP

The experimental setup of cans crushing machine is shown in Figure 1. The cans of material aluminum are used during experimentation and pneumatic system for crushing the cans.

The required process parameters and design consideration is considered for finding the piston force during forward and return stroke. The different parts such as 5/2 direction control valve, flow control valve, double acting cylinder, relay and ultrasonic sensor are used for developing the experimentation setup.



(A)



(B)

Fig.1Experimental setup

III. DESIGN OF CRUSHER PART

The design of pneumatic cylinder is important to find the force required for crushing the cans effectively. For designpneumatic cylinder, clavarino's equation of closed end cylinder at both ends is used [15]. The thickness of cylinder (t) is determined for ductile material (aluminum) using Eq. (1).

$$t = r_i \left[\frac{\sigma_t + (1-2\mu)p}{\sigma_t - (1+\mu)p} - 1\right] \quad \ldots (1)$$

where,

σ_t = Ultimate tensile strength (200N/mm^2)
μ = Poisson's ratio for cylinder material (0.29)
r_i= Inner radius of cylinder (20 mm)
p = pressure assumed in working cylinder (3bar)
Factor of safety (FOS) =1.5.

Based on determined thickness, the piston force acting during forward stroke (F_a) and return stroke (F_R) obtained using Eqs. (2-3) are 376.98 N and 343.06 N respectively.

$$F_a = \frac{\pi}{4}(D^2) \quad \ldots (2)$$

$$F_R = p - \frac{\pi}{4}(D^2 - d^2) \quad \ldots (3)$$

Where,

D = Piston diameter (40 mm)
d = Piston rod diameter (12 mm)

IV. EXPERIMENTATION

The frame is fabricated to mount the pneumatic system, crush tool and other parts. The compressor is used to generate the compressed air which is fed to double acting cylinder by hose pipe and 5/2 solenoid direction control valve (DCV). The crush tool is provided at end of the pneumatic cylinder rod to crush the aluminum cans. After inserting the cans in crushing drum, the infra-red IR sensor automatically sense the cans and compressed air is used by solenoid DCV to double acting cylinder. When DCV operate the piston, moves forward and crush the cans, again return back to its initial position.

The pressure and force generated by compressed air helps to crush the cans using crush tool. Thus advancement of guide ways is carried out during forward and reverse motion. The preliminary experiments were conducted for pressure range from 1bar to 5 bar to obtain optimized value of air pressure for effective crushing. The cans of sizes 250 ml and 500 ml and pressure range from 3bar to 5bar is considered during experimentation. The crush size after crushing at different pressure and crushing rate per minute are the prime objectives to find the machine productivity. The length of cans is measured before experimentation and obtained 134 mm and 168 mm for 250 ml and 500 ml cans respectively.

V. RESULTS AND DISCUSSION

Based on experiments performed, Figure 2 shows the cans length after crushing at different air pressure. From Figure 2, it is observed that for 250 ml cans of length 134 mm, the crushing reduces length up to 46 mm, 33 mm, and 24 mm at 3bar, 4bar and 5bar air pressure, respectively. Thus, length reduction by 66%, 75% and 82% are obtained at 3bar, 4bar, and 5 bar air pressure, respectively. Similarly, for 500 ml cans, the length after crushed found 65 mm, 47 mm and 36 mm at 3bar, 4bar and 5bar pressure.

Thus, reduction of length after crushing for 500 ml cans of length 168 mm is obtained by 61%, 72%, and 79% at 3bar, 4bar and 5bar pressure, respectively. The crushing rate of cans per minute at different air pressure is shown in Figure 3.

It is observed from Figure 3 that, number of 250 ml cans crushed per minute obtained 18, 24 and 27 whereas during crushing of 500 ml cans, the crushing cans per minute obtained are 14, 18 and 23 at 3 bar, 4 bar and 5 bar pressure respectively. From results it is observed that for 250 ml cans size, the cans crush per minute observed more compared to 500 ml cans size at same air pressure.

Thus, the process performance in-terms of storage capacity and productivity is improved significantly by using developed automated pneumatic crushing machine compared to conventional method of cans crushing.

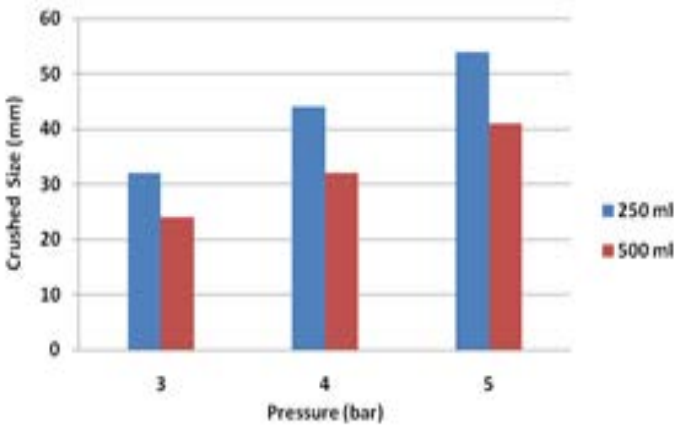


Fig.2 Cans Crush Size at Different Air Pressure

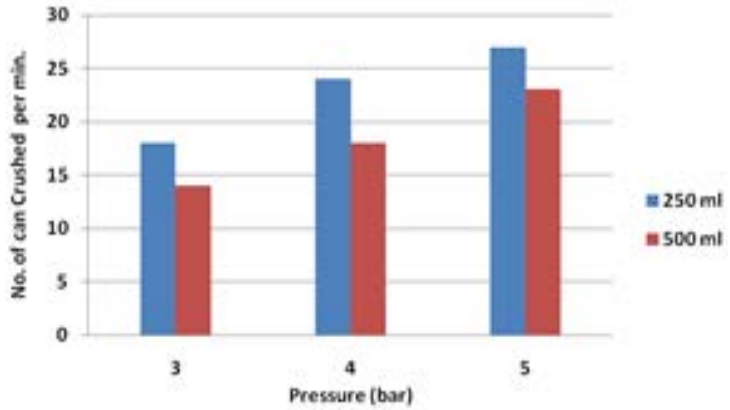


Fig.3 Cans Crush Per Minute at Different Air Pressure

VI. CONCLUSION

The following results are obtained based on experimentation using developed cans crushing machine.

1. It is observed that, the length reduction of 250ml cans size after crushing is obtained by 66%, 75% and 82% using compressed air pressure at 3bar, 4bar, and 5 bar respectively. Similarly, for 500ml cans, the length reduction by 61%, 72%, and 79% is obtained at the same air pressure. At 5 bar air pressure, the better crushing is obtained for both the sizes of cans.

2. The number of cans crushed per minute obtained is more at 5 air bar pressure. The number of cans crush per minute obtained are 27 and 23 at 5 bar air pressure during crushing of 250 ml and 500 ml sizes cans. Thus, production rate in terms of cans crushing per minute and crushing length improves significantly for both cans sizes.

Thus, present work helps to store more cans in container. The developed crushing machine helps to reduce the transportation cost and improved productivity significantly. Hence the developed machine is economically beneficial to user and it is human-environment friendly.

REFERENCES

[1] K. Bhaskar and M. Yohan, "Design and fabrication of solar powered can crushing machine," *International Journal of Technical Innovation in Modern Engineering and Science*, Vol. 3, No. 10, pp. 98-102, 2017.

[2] N. Senthil Kannan, D. Naveen Prasad, R. Nirmal Kumar, and R.S. Premvishnu, "Design of mechanical crushing machine," *International Research Journal of Engineering and Technology*, Vol. 3, No. 1, pp. 921-926, 2016.

[3] V. Kshirsagar and S. Choudhary, "An automatic can or plastic bottle crusher machine," *International Journal for Scientific Research and Development*, Vol. 2, No. 2, pp. 66-68, 2014.

[4] A. S. Shinde, A.D. Landge A.K. Biradar, and S.M. Kondawar, "Design and fabrication of aluminum tin can crusher," in 2017 *International Conference on Ideas, Impact and Innovation in Mechanical Engineering* (ICIIIME), 2017, Vol. 5, No. 6, pp. 39-44.

[5] R. Rajesh *et al*., "Design and fabrication of can crusher," *International Journal of Innovative Research in Science, Engineering and Technology*, Vol. 5, No. 8, pp.105-110, 2016.

[6] K. Sontakke *et al*., "Design and fabrication of automatic can crusher," *International Journal of Interdisciplinary Research*, Vol. 2, No. 7, pp. 219-223, 2016.

[7] SayedJafar and ShaikhNadeem, "Fully automatic can crusher," *International Journal of Mechanical and Industrial Technology*, Vol. 2, No. 2, pp. 155-159, 2015.

[8] D.P. Patel and K.S. Parmar "Swing jaw plate in jaw crusher machine," *International Journal of Engineering Development and Research*, Vol. 4, No. 1, pp. 123-127, 2016.

[9] A.E. Ikpe, and O. Ikechukwu, "Design of used PET bottles crushing machine for small scale industrial applications," *International Journal of Engineering Technologies*, Vol.3, No. 3, pp. 156-168, 2017.

[10] R. Darshan and S. Gururaja, "Design and fabrication of crusher machine for plastic wastes," *International Journal of Mechanical and Production Engineering*, Vol. 5, No. 10, pp. 55-58, 2017.

[11] N. Nagarajan, S. Srinivasan and A. Balthilak, "Design and fabrication of cane crushing machine," *International Journal of Current Engineering and Scientific Research*, Vol. 4, No. 7, pp. 6-12, 2017.

[12] D. Vimal Kumar *et al*., "*Design and fabrication of the double acting can crush machine*," *International Journal of Novel Research and Development*, Vol. 2, No. 4, pp. 86-90, 2017.

[13] A. Elfasakhany, J. Marquez, E. Rezola, and J. Benitez, "Design and development of an economic autonomous beverage cans crusher," *International Journal of Mechanical Engineering and Technology*, Vol. 3, No. 3, pp. 107-122, 2012.

[14] S. Husain, and M. Sheikh, "Can crusher machine using scotch yoke mechanism," in 2014 *International Conference on Advances in Engineering & Technology* (ICAET), pp. 60-63,2014.

[15] K. Mahadevan, and K. Balaveera Reddy, Design data handbook for Mechanical Engineers, 4th Ed., CBS Publishers and distributors, India, 2013.