Comparative Analysis of Plastic Bottle Crusher Machine: A Review

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Abstract--**Plastic is widely used in our home and daily products and daily use from wrapping of our daily need products to containers bottles used to store oil, water, chemicals, etc. Plastics is a chemical compound and it is hard to decompose hence it will become an environmental (nightmare) disaster. To solve this issue plastic recycling is the only option and therefore this paper delves into the study of portable plastic crusher machine which will help to recycle the plastic easily and ease at the collecting place. The previous work on shredder devices has been described in this paper, and it has been discovered that shredder machines are essential part in regulating plastic bottle. The large plastic crusher available in the market are not economical and suitable for small business, hence there is a need to develop a small-scale shredder which are very useful for small scale business.**

Index Terms —**Shredder Machine, Plastic Waste pollution, Waste Recycling, Design of Shredder, environmental waste management**

I. INTRODUCTION

The project emphasis on the need to develop and design a portable PET bottle crusher machine, the main objective is to make this machine easily available to small and medium level scrape dealer who will use this machine at their facility and thereby help in recycling the waste plastic and also reduce the size of the plastic waste approximately by 70%which will help them to transport the waste plastic in a lost effective manner. This project provides a solution for a cost-effective portable plastic bottle crusher for local plastic recycling business and thereby encourages the public at large to use plastic recycling more seriously and to make the environment sustainable.

Plastic crushing is a process of reducing the pieces into smaller cuts section of granular size which is in size of ½ inches (12mm) or less. This process involves cutting crushing the plastic waste by passing it through counter rotating heavy metal discs with protruding pieces which pull the bottles from the hopper, using optimum force they shred the bottle into smaller granular pieces.

This machine will operate on a machine which will help to operate the machine with a single button; this machine will be a very safe way of doing bottle crushing and help the workers with unwanted injuries, in all this portable machine will be a safe, secure, cost effective and environment friendly way of recycling plastic waste.

General questions asked such as:

a) Are portable plastic crushing machine easily available in market?

b) How cost effective it will be for the scrap yard owner?

c) What the design requirements for an easy are person operation of machine and a safer machine.

Safety is a main concern of the user as the cutting blades are involved and person operating has to be very attentive and other of presence of fine dust particles in the air which can damage the lungs so it has to be used using a face mask.

This portable crusher is useful for small scale owners in meeting their demand and also saving cost on labor and transportation.

"Noor Hasyimah Abu Rahim and Ahmad Nor Haziq Muhammad "This paper presents an advanced on the spot and quick way to recycle the bottles at the consumers point itself and cuts all the scrap dealers etc.it decreases the time to recycle and aptly rewards the common people by monetary terms and encourages them to recycle the bottles.[22]

Darshan R, Gururaja S (2017) the project aims to design a portable bottle crusher that could be easily installed and operated by the person in a safe environment. The machine is designed such that it requires optimum had to crush bottles and uses minimum energy and is not expensive to run. [24]

I.M.Sanjay Kumar Dr. T.R. Hemanth Kumar (2015)This project is main focus is on developing a plastics shredder machine in developing countries and performance evaluation of the machine by generating plastics works in a controlled environment in the institute of petroleum training

institute, Effurun, Nigeria and results are obtained for the optimum efficiency and the resultant stress and pressure required and measured on different components of the machine and getting the shredded plastic work size.[25]

II. RECYCLABLE PLASTIC WASTE

There are two types of plastics Thermoplastic and Thermoset plastic that refer to substances (particularly synthetic resins) that become plastic when heated and solidify when cooled and can repeat these cycles. Only the thermoplastic, however, is recyclable. Weak bonds hold thermoplastic molecules together. The plastic substance can be repeatedly use and softened, reshaped to new objects if enough heat is applied [16]. And various types of plastics that do not fit into any of these categories are the seven plastic types [17].

Sr.No.	Thermoplastic
1	Polyethylene Terephthalate (PETE)
2	High-Density Polyethylene (HDPE)
3	Polyvinyl Chloride (PVC)
4	Low-Density Polyethylene (LDPE)
5	Polypropylene (PP)

III. SHREDDER MACHINE

The papers aims to review the
i) The design of the various shredder machine and ii) Performance of the shredder machine.
The shredder design machine consist of
i) A shaft and set of blade mounted on the shaft,
ii) A motor gearing,
iii) Hopper on top and a metal frame
A single or double shaft can be used in the design of a shredder machine. The blade also comes in variety of shapes and sizes.
The design of the shredder machine may have a single or a double shaft. The blade also comes in variety of shapes and sizes. Thus the design related o the shaft, blades details and orientation of the blades are considered in the following section.

3.1Single and double shafts shredder machine:

After studying various plastic shredder machines, it can be concluded that for portable plastic shredder machine having a single shaft with blades will be helpful in reducing the overall weight of the machine [18]. The blades will be mounted on a round shaft with identical width spacer in between blades and shaft with the help of gear box will be fixed to the motor machine blades will have S-shaped cutting notches which helps to pull plastic bottle inside the and cut into pieces[19]. The blade will be arranged in a spiral manner, and similarly fixed blades will be placed on the other side of the frame. As the shaft rotates the blades move and start cutting the plastic bottles.

3.2 Blades geometry:

For the purpose of a portable plastic shredder machine, the blades of the shredder machine have various geometrical shapes. On the single shaft, S-shaped cutting blades are/will be utilised, and my design takes this into consideration.

3.2.1 Number of cutting edge:

The number of cutting teeth affects the machine's performance by varying the point of contact at the moment of cutting and the distribution of forces along the piece.[20]. I'm thinking about using a double-edged S-shaped blade for a portable plastic shredder. The two-edged blade has been discovered to work efficiently and with less time spent working. Various numbers of blade edges have been utilised by other investors and researchers, with various results.

3.2.2 Cutting angle of blade:

The cutting angle, which is defined as the angle between the teeth and the blade structure, is an essential part of the blade. A higher cutting angle allows for a broader grasping area, which results in improved cutting performance and efficiency. Shredder blades with cutting angles ranging from 50° to 80° were commonly utilised [16, 25-27]. There are two types of grasping surfaces on the S-blade: curvature and flat grabbing surfaces.

3.2.3 Thickness of blades:

The thickness of the blades has an impact on the shredding force, the stress concentration on the cutting edges, and the blades' safety factor, as well as the shedders' particular cutting energy and shredding efficiency [21]

COMPARISON OF LITERATURE AVAILABLE OF CRUSHER MACHINE

Sr No	Name of Author & Year	Method of Analysis	Advantages & Disadvantages	Result	Conclusion
1	V N. Kshirsagar, S.K.Choudhary [1] (2014)	The machines are totally automatic, using electronics such as sensors, microcontrollers, and integrated circuits, as well as mechanical components, so crushed cans or bottles do not need to be separated from the bin, and the machine does not run idle.	Electronic component like Sensor IC's were used in this machines. Speed & other parameters can be control. Because of the electronic component, it is expensive. Comparatively lesser life of a electronic component	Reduction in volume decreased by approximately 70%	Because a sorting mechanism has been implemented to separate the bottles and cans to avoid human fatigue, human efforts as well as time can be reduced.
2	C Pedraza, R Angel [2] (2018)	The complex force circumstances of the crusher, as well as the stress characteristics and fatigue life of the blade, were investigated using the transient finite element approach of analysis.	FEM is used to create and develop industrial goods and applications, as well as to simulate complicated physical systems. Skill operator need to require for operation.	The results of the Von Misses stress load simulations will be presented; the punctual load investigated in the study is 8825 N	The significant degree of over sizing in the "S" geometry component is noticeable; this is explained by the shape of the design, which has two leaves in contact in the process, lowering stress on the element.
3	B M. Ogunedo, B C. Chukwudi [3] (2020)	The purpose of the plastic shredding machine employed in this study is to conserve energy and natural resources that would otherwise be used to manufacture new plastic.	The five processes of recycling plastic garbage are sorting plastic trash into plastic types, washing sorted plastics to remove impurities, shredding washed plastics, and extruding by melting shredded pellets into sizes suited for diverse plastic goods.	The machine shreds 150kg of plastic waste in 6.98 minutes with 97.8% efficiency and an MTC of 0.35kg/s using 3.7kW of mechanical power.	The design and construction of a low-cost, high-efficiency plastic shredding machine for small firms has been completed.
4	N D Jadhav, A Patil [4] (2018)	The resulting plastic bottle is a one-of-a-kind, compact, and portable plastic bottle shredding machine.	A cost-benefit analysis has been demonstrated. This article did not provide a systematic empirical equation.	It was computed what % of volume decreased. For all input dimensions and plastic bottle quality, the bottle has a capacity of 0.0019 m3.	The cutting force necessary to cut a plastic, as discovered empirically, is well within the range of force that an average human can apply ergonomically.
5	S. V Ananth1, T N. Sureshkumar [5] (2018)	The authors proposed a method for identifying a plastic shredder machine's whole coat reduction strategy for a clean environment.	A systematic approach is discussed to estimate the fabricating.	The machine was created in order for the company to have a more efficient performance and for plastic rubbish to be less expensive and more effective during operation.	Plastic shredding machines are commonly used in industry to control plastic trash. The entire cost of the recycling process is decreased by using this plastic shredding machine.
6	M A. Shaikh V D. Kadam [6] (2018)	SOLIDWORKS 14 was used to create the design. Frame/stand, shaft, washers, gears, pulley, and other components are designed along the blade.	Low cost apparatus with CAD software is used in this research paper.	According to the author's calculations, the Plastic Bottle Crusher Machine reduces the volume by about 80%.	In this research work, a low-cost shredder machine manufacturing system is reviewed, as well as the analysis of performance characteristics and pertinent results.

7	V N. Kshirsagar S. K. Choudhary [7] (2014)	The usage of a can or plastic bottle crusher machine, as well as a thorough examination of the equipment's mechanical. Analysis is critical, and by examining various aspects of the machine, the machine's quality and longevity can be improved.	The author explains the effectiveness of methods for bottle crusher machines. This approached may be applied to different automatic bottle crusher machines.	It is possible to construct the most efficient and long-lasting machine by analysing machine components. The volume of cans and plastic bottles can be reduced by up to 70%.	Utilizing the ansys workbench software, it was discovered where the most stress and total deformation occurs in the machine, and that by using this machine,
8	N Matara, S Pranoto [8] (2021)	The study's purpose is to compare two types of blades: rectangular and star-shaped blades. CAD software was used to model the two blades' designs (Computer-Aided Design).	The proposed technique is verified using CAD software by simulation with experimental verification.	The Abaqus CAE application was used to conduct the analysis. Abaqus is a simulation programme for complex analytical modelling, analysis, monitoring, and visualisation.	A safety factor of 15 is discovered when a 1000N load is applied, which is larger than 1, showing that the blade design is safe for crushing plastic.
9	D Atadious O Joel [9] (2018)	In the setting of Petroleum Training Institute, Effurun, Nigeria, the machine was examined for performance utilising generated plastic trash.	The main benefit of this technology is that it is minimal in cost and has a strong design, both of which are needed parameters during the manufacturing of this machine.	According to the data, the machine has a hopper capacity of 0.066 cubic metre, a centrifugal tension of 9.74 N	The machine was used to shred collected plastic trash, and the findings show that the machine's performance is satisfactory.
10	E.K. Orhorhoro, A.E. Ikpe [10] (2016)	During the design of the plastic bottle crushing machine, the force required to crush the plastic bottles was estimated, materials for the construction of each unit component low cost.	Mild steel was used to construct the machine since it is relatively inexpensive in Nigeria and has good machining qualities.	The mass of properly crushed plastic bottles and the average of waste plastic bottles supplied into the crushing	Twenty times with varied masses of plastic wastes of varying weights were tested using the plastic crushing machine.
11	S Reddy, ThungaRaju [11] (2019)	The notion of a plastic shredder machine is used in this methodology, which includes mechanical and electrical components such as a frame, hopper, electric motor, V-belt drive system, shredder setting parameters, and stability.	The rotating elements, such as the belt and pulley, as well as the gears, are completely covered, ensuring the operator's safety.	The developed model is simple, efficient, time-consuming, and cost-effective when compared to the existing available model.	The overall performance of the shredding machine was satisfactory when considering the quantity of powder produced in relation to time.
12	Akash.B. P, Christina, [12] (2019)	To avoid using unsafe and hazardous techniques to dispose of plastic trash, a development of plastic waste management is required.	The reduction of labour effort, which leads to cost savings, is one of the machine's advantages. These shredders have relatively high operating costs as it requires constant electricity and maintenance.	The blade is examined using the static structural approach with the help of the Ansys program. For more accuracy, the blade is initially meshed with a tetrahedral meshing type.	Recycling discarded plastics is a good way for the polymer industry to improve their environmental performance. A plastic shedding machine is used to shred the plastic. We invented and manufactured a plastic shredding machine as a result.
13	O. I. Okunola, [13] (2019)	Shredding is defined as the transmission of a force amplified by mechanical advantage through a material made of molecules that bond together more strongly and resist deformation more than the molecules in the material being crushed; as a result, the shredder material must be	Plastic recycling is extremely low in underdeveloped nations like Nigeria, leading in an increase in the purchase of more plastics, even at greater costs.	In underdeveloped countries, plastic recycling is minimal, resulting in an increase in the purchase of more plastics, even at increasing hazards.	Instead of relying on manual methods, a comprehensive examination of the design is carried out, and something even better is generated. Finally, we find that for the farmer, employing a machine

		tougher and stronger than PET bottles.			rather than manually chopping twigs is the better alternative.
14	Sekar Ravi [14] (2018)	Because machinery is so important in business, this machine will be designed to increase the company's performance and make the disposal of plastic waste more efficient.	Industrial shredding is a method of reducing the size of a variety of materials that are considered scrap.	This blade is a stronger part in the shredding machine because it is more resistant to deformation and main stresses than previous designs.	This blade is a better part in the shredding machine because it is more resistant to deformation and main stresses than prior designs.
15	A E Oladejo, S I Manuwa [15] (2001)	The power from the electric motor is transmitted to the cutter shaft through a belt drive.	The shredding procedure was done at four different time intervals (4 minutes, 8 minutes, 12 minutes, and 16 minutes) with the same weight of twigs (40 kg), and the weight of little bits of twigs obtained increased with time.	To test the shredder machine's performance, the total quantity of small pieces chopped for various time periods was employed.	Instead of focusing on manually operated procedures, a comprehensive examination of the design is conducted, and something even better is generated.

IV.CONCLUSION

After going through all the above submitted literature, the plastic shredder machine is the only option for recycling of waste PET bottles. To make the plastic bottle recycling achieving widespread and more effective utilization, their arise need to design and develop a portable PET bottle crusher machine, the main objective is to make this machine easily available to small level scrape dealer who will use this machine at their facility and thereby help in recycling the waste plastic and also reduce the size of the plastic waste approximately by 70%which will help them to transport the waste plastic in a most effective manner

The portable plastic shredder will consist of a single shaft with optimum number of blades connected to a power source. The plastic waste has to be finely grained so that it will be easily stored and transport which will also same on the cost of the storage and transportation and same money for small business and make them profitable.

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