

A Critical Review on Design and Development of Shredder Machine for Waste Recycling

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Abstract:

This paper represents the design and development done in shredding machine for waste recycling. The shredder has to be designed for effective waste recycling and also some modifications can be made to enhance its performance. In this paper, the previously work done on shredder machine has been represented and it is found that, shredder machine is very important and effective in waste recycling. Also, small scale shredders can also be developed which may be useful to small or medium scale entrepreneur. The commercial shredder available are very costly, so the small-scale shredder can be beneficial. Also, change in cutter blade design, feed rate, transmission system are useful parameters to be considered in design and development of shredder machine.

Keywords —Shredder Machine, Plastic Waste, Waste Recycling, Design of Shredder.

I. INTRODUCTION

In today's world, the major problem arising due to waste which are being produced in substantial amount in developing countries like India. So, there is a need of waste recycling. The waste can be classified as biodegradable and non-biodegradable waste. There are different sources of waste such as industrial, commercial, domestic and agriculture waste. So, for waste management and recycling Shredding machine plays an important role. A shredder is a machine that reduces the size of, and tears up, many different kinds of materials. Paper shredder to metal scalp shredder different machines have been developed with different design. The shredders have been designed to support a material reduction for recycling applications such as plastic recycling, e-waste, agriculture waste, wood recycling and tire shredding etc. Based on the purpose of use, shredders can be categorized as Consumer Shredders which is mostly used by consumers and Industrial shredders typically heavy-

duty and high-volume systems used to process such recycling material streams as e-waste, plastic, wood, and paper. Management of waste for recycling involves six basic stages; this includes the plastic collection, sorting, washing, shredding, melting, and pelletizing. Many of the researchers have developed and designed shredder machine for waste recycling but it is limited to domestic purpose only for small use which are cost effective and efficient about 60-70%.

II. DESIGN CONCEPT OF SHREDDER

The design concept of the shredding machine consists of four major subassemblies.

- The machine frame,
- Feeder unit of the hopper,
- Shredding unit and
- Drive mechanism.

The frame consists of base for prime mover and the hooper with shredding section. The hooper has

been designed for feeding the input and the shredding unit consists of cutting blades mounted on the shaft. The drive mechanism is the combination of belt drive/Chain drive with or without gear mesh drive/gear box. The prime mover supplies the required power for the operation of the machine. The belt/chain driven pulley shaft receives the power from the prime mover. The driven pulley drives the gear which rotates the shaft on which a shredding tool is mounted.

III. LITERATURE REVIEW

The machine consists of motor, spur gear, bearings, structural frame, cutter and shaft (single, dual etc). The machine frame is can be built using mild steel and High Carbon steel used for cutter tip preparation. cutters are mounted on shafts, which rotate parallel driven by a gear drive arrangement. The power from the electrical motor is transmitted to cutter shaft through a gear drive or belt drive or chain drive. Cut is made inside the chopping house that is hopper due to the effect of tensile, friction, and impact effect in cutting process.

A. E. Oladejo et. al. have developed a Shredded Machine for processing of Agro-chemical. According to Author, the shredding of twigs will provide an alternative for the use of Agro-chemicals. For this to happen, the twigs will first be shredded into small bits making it ready for transportation and further processing. The machine consists of three-phase electric motor, bearings, structural frame, cutters, hopper, shredding unit, discharge chute, belt drive and shaft. Four cutters are mounted on the shaft, which rotate by a belt drive. The power from the electric motor is transmitted to the cuttershaft through a belt drive. Cut is made inside the shredding unit due to the effect of tensile, friction and impact effect in shredding process. The twigs get shredded and the small bits are collected at the discharge chute of the shredder. The performance of the machine was evaluated and test results showed that there was a correlation between the weight of the shredded twigs and the shredding time. The shredding operation was done at 4 different time intervals (4

minutes, 8 minutes, 12 minutes and 16 minutes) with the same weight of twigs (40 kg) and the weight of small bits of twigs collected increases with time. The machine is user friendly and recommended for farmers and medium scale entrepreneurs.

Vaibhav Edke1 et. al, the plastic can be recycled by the plastic shredder machine. They have made Plastic shredder machine and made analysis of mechanism used in machine. So, they developed a machine which processes the plastic waste as cheap as possible by shredding where it's made for reducing cost of processing and transportation. According to them, benefit of this machine is the reduction of labor work which results in cost reduction.

Jaypalsingh Rana et. al, the water and food packaging industries extensively use plastic in their products. Plastic waste management needs to be of utmost importance as plastic waste is not congruent at all places. At present, the available shredder machine is too heavy and costly. So, they have designed and developed Plastic Shredder Machine which is light in weight and less costly. In this, they described the experimentation of plastic bottle cutting machines and analysis of mechanism used in the machine. They made a model for recycling of plastic wastage in the domestic area; industries as well as it can be useful to the scrap collectors. According to them, this machine will be a solution to the problem of space.

Abhay Katiyar et. al, works accounts for the study of the significant problems of organic wastes management which is an issue utmost concern in developing Countries like India. They have designed and constructed a Shredding machine. The machine will initially convert larger particle size of Collected organic waste into desired size such that it can be treated other chemical and biological processes in order to convert it into compost in least amount of time possible. Their methodology involves mechanical, chemical and biological processes for converting agricultural waste into compost making it highly efficient and eco-friendly

which is need of the hour. According to them, their shredder machine is more applicable and economically feasible.

Nitin Kumar Singh et. al, have constructed a shredding machine which crushes used bottles and cans and in waste management and disposal. The machine is designed and fabricated by using locally available raw materials which make it cheap and easy to maintain and repair.

Siddappa M. Kumkale et. al, use the shredder machine which converts the waste plastic bottles into small pieces; these pieces are converted into molten plastic in furnace and then injected into moulds to convert this molten plastic into useful products such as plastic bricks, writing pad etc. In this, they used plastic shredder machine used for cutting the waste plastic in small pieces to make waste management easier. They have designed this for shred the plastic waste, with the help of blades. The small pieces of plastic bottles are fed into the furnace and come in molten state. In this process, they used the Injection molding for producing the different products like plastic plates, cups, bricks etc.

Ankit B. Raut et. al, discussed about detailed study, design procedure and results of a paper shredder machine. A detailed study of various parts of shredder machine like stand (frame), transmission system and cutting system are made and designed separately. They made model for recycling of paper wastage (important documents, personal information like social security number, account number, credit card application and other personal information) in domestic area, industrial area etc. They made machine which reduces labor work which results in cost reduction and also reduction in time for shredding operation of paper.

Sekar Ravi developed a plastic shredder. According to Author, the purpose of this was to realize the importance of plastic shredder for what they serve, realize that the work can get done faster and more efficient when plastics are crushed. The shredding

machine are useful to handle plastic garbage more effective at the time of operation. The shredder blade is optimized for better grinding of the plastic waste into fine grained particles. In recycling, process of plastic waste required low energy due to compact form of plastic waste. It reduces the process time in industry. The machine used in this project is less of cost and thus the project is a cost effective one.

Dr. Fauzia Siddiqui et. al, Their paper deals with a detailed study & design procedure of a paper shredder machine. A detailed study of various parts of shredder machine like stand (frame), transmission system and cutting system are made and designed separately. They have designed 3D model of various parts on Dassult Systems "SOLIDWORKS 2014" and its motion study and the analysis of the stand in ANSYS 15.

Karolina Głogowska et. al, mentioned that Shredding is the component of the most important techniques of mechanical recycling of polymeric materials. It is often used as one of the main preparatory processes, associated with the constitution of composite materials. The preparation of composite material components by shredding depends specifically on the expected degree of fineness, appropriate size distribution and desired morphology of an elementary particle. Their work concerns mechanical shredding of polymeric materials in various types of mills and agglomerates. This paper presents the tests for verifying the influence of size and shapes of openings in sieves made in the shredder on selected parameters and properties of the obtained recyclate. During the shredding process, the following parameters were analyzed: electricity consumption, temperature inside the shredding chamber and the temperature of the obtained recyclate. Selected properties of the obtained recyclate, such as: geometric features of the recyclate dependent on the applied sieves, bulk density and the angle of natural repose were determined. Mouldings with a gating system, made of polypropylene, were the subject of shredding.

Zhankuaz Zhang et. al, has been presented on mathematical model of tangential tensional stress in the edge of a circular saw blade tension by multi-spot pressure was established by theoretical analysis for the equality control of circular saw blade. The multi-spot pressure exerting tensioning processes was assumed to include three mathematical processes out of which was the one-spot pressure process; the process of elastic deformation of disk with a through-hole subjected to uniform radial compressive stress; and the stress superposition process. The objective of the study was to establish a mathematical model for tangential tensioning stress in the edge of circular saw blades tensioned by multi-spot pressure based on the theory of elastic machines and finite element method.

Priyanka Potghan and Roopesh Tiwari, has been presented during the machining process the circular saw undergoes various stresses because of the cutting forces generated, which affects the tool life. Their project used Hyper Mesh Software method to reduce the stresses developed. The project involves the selection of an optimized saw out of three different saw blades (differ in design of type of slots cut) and calculating the stresses developed in the saw during cutting of four different specimens (differ in material). After comparing the results of stresses developed while cutting the four different specimens, maximum stress is calculated.

Vusal Jivishov, Elchin Rzayev, has been presented finite element modelling of the machining process became possible and can be conducted with minimal costs. Finite element methods are tools used for predicting variables such as stresses, strains, temperatures and cutting forces during the machining process. The most significant input parameter for the simulation are the material flow stress data, also known as material model. This paper investigates the influence of material model on the modelling of cutting forces.

ZolBahri Razali et. al, presented in their study report regarding on the conceptual design of the

grater machine, which meant to shred food wastes into small and fine size particle. Their study focusses on the waste management factor of the food waste produced in the home kitchen. The chosen material and blade design are to be evaluated for its characteristics and performance by using the FEM method. The analysis is taking all the constraints regarding the design as well as its advantages are to be considered in designing a new grating blade for the optimum end product making. This brings the meaning that the compact and small sizes design.

IV. CONCLUSION

After reviewing the above literature, it can be concluded that, the shredding machine is very useful for recycling of waste i.e., plastic, paper or agriculture waste. At present, the available shredder machines are too heavy and costly. So, we have designed and developed Plastic Shredding Machine which is light in weight and less costly. The shredder machine consisting of parts i.e., frame, transmission system and cutting section have to be designed separately. The methodology involves mechanical processes to convert the waste into useful product by adopting further processing such chemical and biological processing in case of agriculture waste. The shredder blade is optimized for better grinding of the plastic waste into fine grained particles. The preparation of composite material components by shredding depends specifically on the expected degree of fineness, appropriate size distribution and desired morphology of an elementary particle. The performance of the machine showed that there was a correlation between the weight of the shredded twigs and the shredding time. The benefit of this machine is the reduction of labor work which results in cost reduction.

REFERENCES

- 1] A. E. Oladejo, S. I. Manuwa and T. B. Onifade, "Design and fabrication of a shredder", IOP Conf. Series: Earth and Environmental Science [2020]
- 2] Vaibhav Edke¹, Swapnil Yemle², Prof. S. V. Raut³, Prof. G. E. Kondhalkar, "Case Study and Development of Plastic Shredding

- Machine”, International Research Journal of Engineering and Technology [2020]
- 3] Jaypalsinh Rana, Sahil Shah, Mit Shah, Mikul Prajapati, Harshil Mehta, “Design and Fabrication of Plastic Bottle Shredder”, International Research Journal of Engineering and Technology [2020]
 - 4] Abhay Katiyar, Abhishek Gaur, Aviral Shrivastava, Mohd Ahmar Khan, Navneet Pratap Singh, Dr. Rahul Saini, Ms. Gaganpreet Kaur, “Design and Construction of a Shredding Machine for Recycling and Management of Organic Waste”, International Journal of Trend in Scientific Research and Development [2019]
 - 5] Nitin Kumar Singh, Prakash Tiwari, Rishabh Upadhyay, Sadan Ahmed & Wasim Ansari, “DESIGN AND CONSTRUCTION OF SINGLE SHAFT SHREDDER MACHINE”, International Journal of Engineering Sciences & Research Technology [2019]
 - 6] Mr. Siddappa M. Kumkale, Mr. Kiran R. Ghorpade, Mr. Chandan A. Anagal, Mr. Shrishail V. Hiremath, “DESIGN AND FABRICATION OF SHREDDER MACHINE AND FURANCE FOR PLASTIC RECYCLING FOR ITS UTILIZATION”, Project Reference No.: 42S_BE_3127, [2019]
 - 7] Mr. Ankit B. Raut, Mr. Vinayak D. Wagh, Mr. Bhushan G. Pawar, “Design and Fabrication of Paper Shredder Machine”, International Journal for Research in Applied Science & Engineering Technology [2018]
 - 8] Sekar Ravi, “Utilization of Upgraded Shredder Blade and Recycling the Waste Plastic and Rubber Tyre”, Proceedings of the International Conference on Industrial Engineering and Operations Management Paris, France [2018]
 - 9] Dr. Fauzia Siddiqui, Harshad Patil, Swapnil Raut, Omkar Wadake, Swapnil Tandel, “Design and Fabrication of Paper Shredder Machine”, International Journal of Scientific & Engineering Research [2017]
 - 10] Karolina Glogowska1, Jakub Rozpędowski, “EXAMINATION OF SHREDDING PROCESS PARAMETERS AND THE PROPERTIES OF RECYCLATE” Advances in Science and Technology Research Journal [2016]
 - 11] Ayo, A.W., Olukunle, O.J., Adelabu, D.J. (2017) “Development of a Waste Plastic Shredding Machine”. International Journal of Waste Resources, 7(2), 1-4. DOI: 10.4172/2252-5211.1000281
 - 12] Adepo, S. O., Obanoyen, N. O. (2017) “Design and Construction Of A Plastic Shredding Machine”. Journal of Multidisciplinary Engineering Science and Technology. 4(9), 8190-8193
 - 13] Siddiqui, F., Patil, H., Raut, S. Wadake, O., Tandel, S. (2017) “Design and Fabrication of Paper Shredder Machine”. International Journal of Scientific & Engineering Research, 8(3), 18-25
 - 14] Vijay Ananth, S., Sureshkumar, T.N., Dhanasekaran, C., Kumar, A. (2018) “Design and Fabrication of Plastic Shredder Machine for Clean Environment”. International Journal of Management, Technology and Engineering. 8(XII), 4601-4606
 - 15] Sudhakar Reddy, Thunga Raju. (2018) “Design and Development of mini plastic shredder machine”. IOP Conf. Series: Materials Science and Engineering 455 (2018) 012119, IOP Publishing. doi:10.1088/1757-899X/455/1/012119. 1-6
 - 16] Atadious David and Oyejide Oluwayomi Joel. (2018) “Design and Construction of a Plastic Shredder Machine for Recycling and Management of Plastic Wastes”. International Journal of Scientific & Engineering Research. 9(5), 1379-1385
 - 17] Nagpurkar, C., Nandeshwar, B., Jagtap, R., Lilhare, A., Pawar, P., Bajod, S. (2018) “Fabrication of Paper and Plastic Shredder Machine”. International Journal of Research, 5(13), 670-673
 - 18] Pavankumar, S B., Sachin, K R, Shankar, R., Thyagaraja, B., Madhusudhan, T. (2018) “Design and Fabrication of Organic Waste Shredding Machine”. International Journal of Engineering Science Invention. 7(6), 26-31