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Review Paper on Multipurpose Waste Processing Unit

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Abstract - *The disposal and handling of municipal solid waste is still one of the major problems in modern societies even though significant efforts are taken towards reduce, reuse, and recycling of waste. Large amounts of garbage are getting piled up every day in almost every city across India which is incrementing the amounts of pollution. Based upon the study of research papers available on waste processing and filtration, different processing practices were adopted. Multipurpose waste processing unit majorly processes three types of waste that is dry, plastic and wet wastes in an efficient manner. It helps converting the above three types of waste into some sort of useful product. The dry waste is converted into required output using processes like shredding and incineration. Cement coated plastic granules are obtained from plastic waste using processes like shredding, melting and mixing. The wet waste is converted into compost which is used to increase the nutrients in soil. The flue gas emitting is filtered using a fabric filter. Thus, the traditional dustbins can be replaced with a convenient, eco-friendly, multipurpose bin.*

Key Words: Dry Waste, Plastic Waste, Wet Waste, Fabric Filters, Compost, and Cement Mortar.

1.INTRODUCTION

India is running out of space due to excessive waste generation. In day-to-day life, it is a tedious job to minimize the waste and it is certainly unfeasible when it comes to waste management Also, in metro cities it is a tough task to carry and dump the waste due to transport failures. The major failure in waste management is arising due to improper processing. Instead of dumping the waste, it can be processed and regenerated into useful things.

2. HISTORY

Alfred Fryer was the first to design and patent an incinerator for waste disposal in Nottingham, UK in 1874.They were originally known as destructors. Incinerators reduce the solid mass of the original waste by 80–85% and the volume (already compressed somewhat in garbage trucks) by 95–96%. It significantly reduces the necessary volume for disposal. Composting practices was first carried out in the early Roman Empire. Composting was modernized in early 1920's in Europe for organic farming. In the year 1921, the first industry for the transforming urban organic materials into compost was set up in Wels, Austria. The first recycling mill started in Conshohocken, Pennsylvania in 1972 which accepted residential plastics. Responding to the growing amount of plastic waste, plastic recycling started in the 1970s.

3. LITERATURE REVIEW

According to the requirements of the project, study of different research papers is done and a literature review for Multipurpose Waste Processing Unit is discussed in four different sections:

3.1: Dry waste unit:

Abhishek Nandan, Bikarama Prasad Yadav, Soumyadeep Baksi, Debajyoti Bose studied that there is an urgent need to implement the provisions of Municipal Solid Waste Rules 2000 adequately. The amount of waste remaining after treatment should be disposed of in closed landfills. Not only in urban cities, Effective Solid Waste Management should be implemented to rural areas as well. Being one of the most populous country and fastest growing economy, India cannot afford to ineffective solid waste management. It seems that policy framework is available only on paper, but ground reality is alarming one. Despite the fact that Solid waste management practices has been improving in recent years, the pace of improvement needs to be accelerated. Measures mentioned in MSW rules must be implemented NGOs should be involved in various components of waste management including public awareness [1].

Sudhakara Reddy, Thunga Raju said the developed model is simple, efficient, requires less time and cost effective when compared to the existing available model. The developed model is user friendly in operation and safe. The rotating elements like belt, pulley and gears are covered for the safety of operator also the overall performance of shredder machine was satisfactory. [2]

Akash.B. P, Christina, Darshan.K. S, Manoj studied the design shredder will able to cut all different types of plastic having thickness 7mm. Shredder will shred the plastic with less amount of time. E.g., plastic bottle -5secPlastic is essential part of our day-to-day life. But there is a big disadvantage of plastic that is plastic is difficult to decompose. So, we have to recycle the plastic and there are various methods for plastic recycling [3].

3.2: Plastic waste unit:

Nabjyoti Saikia and Jorge de Brito stated in their paper titled "Use of plastic waste as aggregate in cement mortar and concrete" that the application of plastic as an aggregate in cement mortar mixture is rare but is very useful and eco-friendly as well. This mixture is repellent to moisture and hazardous chemical attack. [4]

Prof. Alka Zadgaonkar and Dr. Umesh Zadgaonkar concluded in their paper titled "Waste to wealth: Conversion of Waste plastic into liquid hydrocarbons" that plastic molecules have longer carbon chains. Hence it is possible to convert waste plastic into fuel by the process of pyrolysis [5].

F. Pinto, P. Costa et al. worked on their paper named "Pyrolysis of plastic wastes. 1. Effect of plastic waste composition on product yield" and stated that thermal decomposition of plastic residues in an inert atmosphere and moderate temperature breaks the structure of plastic into smaller species which can be used as fuel [6].

R. S. Kognole, Kiran Shipkule et al. in their paper "Utilization of plastic waste for making plastic bricks" concluded that water absorption of plastics sand bricks is 0% and hence it can be used for construction [7].

3.3: Wet waste unit:

M.K. Manu, Rakesh Kumar, Anurag Garg in their paper "Performance Assessment of Improved Composting System for Food Waste with Varying Aeration and Use of Microbial Inoculums" studied that alkaline pH is important for evaluating compost maturity and stability. The acidic pH affects the rate of respiration of microbes and rate of degradation. The pH of the compost should be alkaline throughout and end of the composting process. [8]

M.A. Vázquez and M. Soto studied that the average content of organic matter in compost was 48 ± 19% VS, the carbon content of 25 ± 11% and nitrogen content of 2.1 ± 1.1%. C/N ratio is usually in the range of 10–15 in their paper "The efficiency of home composting programs and compost quality" [9]

J.K. Andersen, A. Boldrin, T.H. Christensen, C. Scheutz focused on the usage of composting reduces greenhouse gas (GHG) emissions, and eutrophication of natural water bodies in their paper titled as "Greenhouse gas emissions from home composting of organic household waste" [10].

3.4: Filtration unit:

"Book on Waste Incineration and Public Health" by National Research Council, Waste Incineration and Public Health, Washington, DC: The National Academies Press focused on the major pollutants that are emitted from the waste incineration process and their effects on human health as well. The flue gases that are emitted majorly include particulate matter, heavy metals like lead and mercury, dioxins, furans, sulphur oxides, nitrogen oxides and hydrochloric acid. Dioxins are the lethal and its worst component, 2, 3, 7, 8- tetrachlorodibenzo-pdioxin (TCDD), commonly known as Agent Orange is a toxic compound which causes cancer and neurological damage, disrupts reproductive, thyroid and respiratory systems. This book also stated the formation of various types of pollutants in different scenarios of combustion like complete or incomplete [11].

T.J Burnnan discussed about fabric filters as one of the air pollution control technique in his paper "The Use of Fabric Filters in Air Pollution Control". The shaking bag type of fabric filters has its efficiency on sub-micron material limited to 1 micron in size for efficiencies in excess of 95% and it's not too expensive with Air to Cloth ratio of 2:1. The reverse air type of fabric filters has a permeability i.e., amount of air that can pass through one square foot of the cloth of 60 to 75 whereas the permeability for shaking bad type is 100 to 125. The efficiency of reverse air type on 0.5 micron size particle is up to 98% with Air to Cloth ratio of 5:1. The pulsed air type of fabric filter has a permeability of 25-35 and it can trap down to 0.2 micron in size with an efficiency of 99.8% with Air to Cloth ratio of 8:1 to 14:1. Fabric Filters are more cost effective, requires less space and easy for maintenance as compared to venturi scrubbers as venturi scrubbers require very high horse power ratings on their fans and require sludge treatment, clarification, and disposal of material [12].

Dipti C Jagtap studied different parameters affecting the performance of fabric filters in her paper "Air Pollution Controller-Fabric Filter". Bag house performance is contingent upon inlet and outlet gas temperature, opacity pressure drops and gas velocity chemical composition, moisture, acid dew point and particle loading are some of the essential factors [13].

2. METHODOLOGY

Information is collected from various sources like technical research papers, webinars, technical books and websites. By attending the lecture series of ATAL Innovation Mission based on Waste Management, helpful information is obtained regarding the waste generation in Mumbai and suburban. The information is sorted into three wastes i.e., plastic, dry and wet according to the content of papers. The information was studied thoroughly and the best one suiting the requirements of the project was chosen for further steps.

A survey was conducted of an eight storied building having 4 flats on each floor and on an average, there were 4 people living in each flat. This was considered as prerequisite information and by assuming per capita per day waste generation as 0.436 kg per capita per day. The volumes of dry, plastic and wet waste were calculated as 14880 cm3, 26000 cm3 and 52000 cm3 respectively.

Considering the volume generation of different types of waste, the method for processing of waste was decided. According to the literature review and information gathered, there are three different units for processing of dry, plastic

and wet waste. The methods adopted in the individual units are as follows:

2.1: Dry Waste Unit:

The waste is first crushed with the help of shredder and it falls in the incineration zone of the dry waste compartment. After incineration the ash is filtered out using a strainer and the fine ash is collected in a tray below the incineration zone. The flue gases emerging from the incineration zone is passed on to the fabric filter which will filter out the gases emitted. The output obtained is in the form of ash which can be utilized for production of increasing the strength of bricks.

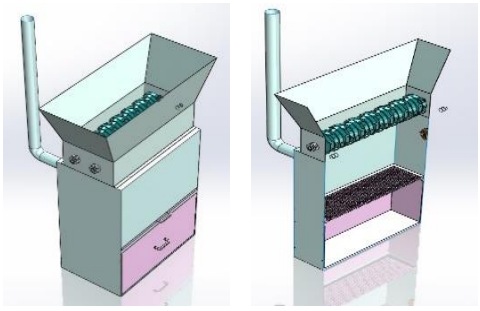

Fig -1: Dry waste unit

2.2: Plastic Waste Unit:

The plastic waste which is accumulated in the hopper is shredded to a smaller size and heated to a temperature causing the plastic to melt. The melted plastic is extruded through a plate of small holes by pressure of a plunger. The drops of molten plastic so formed fall in a box containing cement. Two forks are incorporated for uniform coating of cement over the plastic pellets so formed. The cement coated plastic pellets so formed are them made to fall in the lowest drawer and then drawn out. The cement coated plastic granules can be used for construction purposes like cement and concrete mortars.

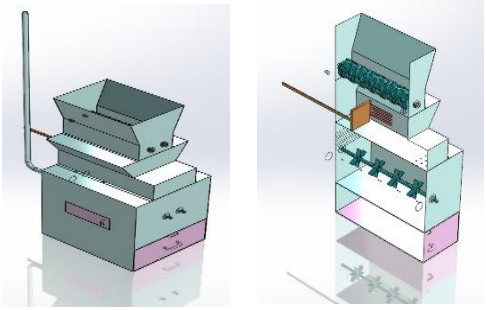

Fig -2: Plastic waste unit

2.3: Wet Waste Unit:

At first, the wet waste is dropped on the shredder though a hopper and the shredder will shred this waste into small pieces. These pieces will then fall in the mixing chamber which contains soil and chemical compost powder. This mixture is then churned with the help of blades rotating with a shaft. With proper aeration and mixing of this mixture, a compost will be produced in a week or two. The compost will be used for increasing nutrients in soil and gardening.

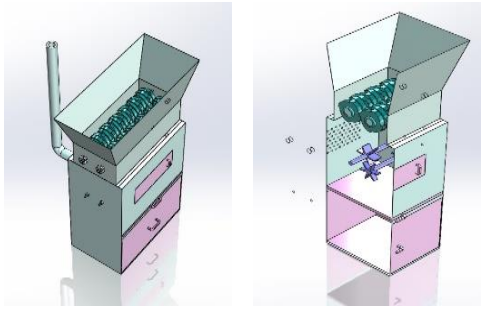

Fig -3: Wet waste unit

2.4: Fabric filter:

The flue gases emitted from these units are merged into a fabric filter tower, passes through stacks of fabric filters and then clean air is discharged into the atmosphere.

Based upon volume of waste generated, dimension calculation for various components of the unit was done. Then, design of these components was done on a CAD software and material was selected according to the standard material library in that software. Simulation and analysis of the processing unit was performed on the same software.

3. EXPECTED OUTCOMES

A. All type of dry waste like paper, thermocol, clothes and wood etc. will be crushed using shredder and converted into small pieces. After burning the dry waste, we will get ash out of it which can be used further in production of bricks.
B. After converting plastic into liquid form in the melting zone, it will be mixed with sand and water which will form small cement coated plastic granules which can be used in cement and concrete mortars.
C. All types of wet wastes like kitchen wastes will be converted to useful compost. This compost will be used for growing of plants at your home by increasing the nutrients in the soil.

4. FUTURE SCOPE

With changing definitions of civilization, waste processing systems need to get advanced in order to cope up with increasing generation of waste. Hence an efficient waste processing system like this is need of hour. The unit can be implemented at residential complexes, malls, commercial hubs, transport centers. There are many infrastructure mega projects coming up in Mumbai and neighborhood. Hence, this unit can prove to be a best solution to the waste processing activities hereafter.

5. CONCLUSION

The waste processing system consisting of three different processing systems is still not in existence. It is the need of the hour as increasing use of plastic is causing increased

pollution, more and more use of land for dumping grounds. The good news is that waste can be processed and can be used in a better form. The waste is generally treated of no use but can fit as a replacement for many conventionally practiced activities. Using plastic in cement mortar mixture improves the moisture resistance capacity of the mixture and the same mixture remains unaffected by water and chemicals. For 20% replacement of cement mortar almost 72% reduction in compressive strength was observed. However, 16% reduction in compressive strength was observed for 50% reduction in volume. Reduction in tensile strength and flexural strength is less significant compared to the compressive strength. Dry waste converted into ash can be mixed with cement mortar mixture or can be mixed with sand for making bricks. Hence the ash usually regarded of no use finds its usability here. The wet waste generated in every house has an inherent property to work as compost when processed properly. Hence, every type of waste is processed in this unit.

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