

Plastic Separation Module for Municipal Solid Waste

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ABSTRACT: Plastic separation from municipal waste technology is a very difficult to handle. Only possible way is to destroy the plastics, they will burn or dump in ground. As the population of a country increases, the waste produced by them also increases tremendously. There are lot of methods for disposing the wastes such as landfills, incineration, etc. Machines which assist these methods are readily available in the market. The major problem with these types of machines is that they need a lot of space and also cost of the machine is high. This technology requires low cost and occupies a very less space. Simple components and mechanisms are used in this fabrication and an efficient waste separating machine is built.

I. INTRODUCTION

Plastic pollution involves the accumulation of plastic products in the environment that adversely affects wildlife, wildlife habitat or humans. Plastics that act as pollutants are categorized into micro, macro debris based on size. The prominence of plastic pollution is correlated with plastics being inexpensive and durable, which leads to high levels of plastic used by humans. However, it is slow to degrade. Plastic pollution can unfavorably affect lands, waterways and oceans. Living organisms, particularly marine animals can also be affected through entanglement, direct ingestion of plastic waste or through exposure to chemicals within plastics that cause interruptions in biological functions. Humans are also affected by plastic pollution, such as through the disruption of the thyroid hormone axis or hormone levels. Burning of plastic in the open air, leads to environmental pollution due to the release of poisonous chemicals.

Biswajit Ruj et al (2015) Separation of plastic from various types of waste streams represents one of major problematic process in energy recovery through different thermochemical processes. The sorting of plastics is a very essential step in different waste management technique. Manual sorting is suitable when plastic component are present in large amount but it is a labor intensive process^[1].

A.Ahsan et al (2014) This study addresses the role of the city authority to meet the demand of the city dwellers in solving this emerging socio environmental issue and the initiatives taken by some nongovernmental organizations and community based organizations. The problems and constraints of the solid wastes management system are also identified to find a sustainable management concept for the urban are as of Bangladesh^[2].

Sesha Sai Ratnamala Bommareddy et al (2017) The aim of that paper is to consider the new capital city of A.P "AMARAVATHI" as a case study which is going to handle a huge population in upcoming years. Municipal solid waste is the key alert which would be soon knocking the city with managing and handling issues^[3].

Vipin Upadhyay et al (2012) Solid waste management is a worldwide phenomenon. Improper management of solid waste (SW) causes hazards to inhabitants. It is a big challenge all over the world for human beings. The problem of solid waste management (SWM) is also prevailing in the urban environment of MNIT Campus^[4].

Archana Babu S et al (2016) Efficient waste management is one of the major problems of the present era. The traditional way of manually segregating the waste utilizes more human effort, time and cost. This work proposes An

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Economic Automated Waste Segregator (AWS) which is a cheap and easy to use solution for a segregation system at households, so that it can be sent directly for processing^[5].

II. MATERIALS AND EQUIPMENTS

The major parts that are effectively employed in the waste separating machine using belt conveyor drum are described below:

3.1 BATTERY

An electric battery is a device consisting of one or more electrochemical cells with external connections provided to power electrical devices such as flashlights, smartphones, and electric cars. When a battery is supplying electric power, its positive terminal is the cathode and its negative terminal is the anode. The terminal marked negative is the source of electrons that when connected to an external circuit will flow and deliver energy to an external device. This battery gives 12V and 7.5Amps power supply to the module. Figure 3.1 shows battery.

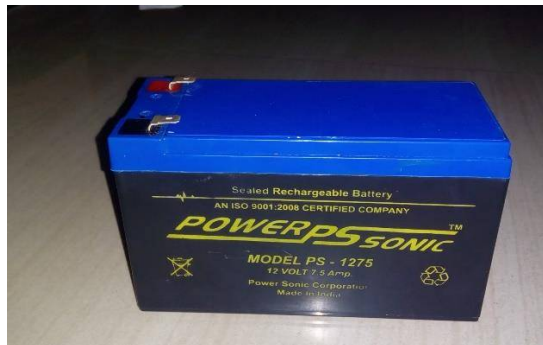


Figure 3.1 Battery

3.2 BEARING

Bearings are used for reducing the frictional force while the rotating motion. The bearings are pressed smoothly to fit into the shafts because if hammered the bearing may develop cracks.



Figure 3.2 Ball Bearing

Bearing is made up of steel material and bearing cap is mild steel. Bearings can be classified into major groups, namely sliding bearing and rolling bearing. Depending on the types of rolling elements, or into radial bearings and thrust bearings depending on the directions of the loads that could be mainly supported by them. Figure 3.2 shows ball bearing.

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3.3 SHAFT

Most shafts are made from steel, either low- or medium-carbon. However, high quality alloy steel, usually heat treated, may be chosen for critical applications. Other metals, e.g. brass, stainless steel or aluminium, may be used where corrosion is a problem or lightness is required.

3.4 MOTOR

An electric motor is a machine which converts electrical energy to mechanical energy. Its action is based on the principle that when a current-carrying conductor is placed in a magnetic field, it experiences a magnetic force whose direction is given by Fleming's left hand rule.



Figure 3.3 DC Wiper Motor

Figure 3.3 shows the DC wiper motor. The very basic construction of a DC motor contains a current carrying armature which is connected to the supply end through commutator segments and brushes and placed within the north, south poles of a permanent or an electro magnet. Now to go into the details of the operating principle of DC motor its important that we have a clear understanding of Fleming's left hand rule to determine the direction of force acting and the armature conductors of DC motor.

3.5 FRAME

This is made of mild steel material. The whole parts are mounted on this frame structure with the suitable arrangement. Boring of bearing sizes and open bores done in one setting so as to align the bearings properly while assembling. Provisions are made to cover the bearings with grease.

3.6 RACK AND PINION



Figure 3.4 Rack And Pinion

Figure 3.4 shows rack and pinion. A rack and pinion is a type of linear actuator that comprises a pair of

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gears which convert rotational motion into linear motion. A circular gear called "the pinion" engages teeth on a linear "gear" bar called "the rack"; rotational motion applied to the pinion causes the rack to move relative to the pinion, thereby translating the rotational motion of the pinion into linear motion.

Rack and pinion combinations are often used as part of a simple linear actuator, where the rotation of a shaft powered by hand or by a motor is converted to linear motion.

3.7 CONVEYOR SETUP

A conveyor system is a common piece of mechanical handling equipment that moves materials from one location to another. Conveyors are especially useful in applications involving the transportation of heavy or bulky materials. Many kinds of conveying systems are available, and are used according to the various needs of different industries. There are chain conveyors (floor and overhead) as well. Chain conveyors consist of enclosed tracks, I-Beam, towline, power & free, and hand pushed trolleys. We use rubber material for conveyor.

3.8 SHEET METAL

Sheet metal is metal formed by an industrial process into thin, flat pieces. It is one of the fundamental forms used in metalworking and it can be cut and bent into a variety of shapes. Countless everyday objects are fabricated from sheet metal. Thicknesses can vary significantly; extremely thin thicknesses are considered foil or leaf, and pieces thicker than 6 mm (0.25 in) are considered plate. Sheet metal is available in flat pieces or coiled strips. The coils are formed by running a continuous sheet of metal through a roll slitter.



Figure 3.5 Water Tank

We use sheet metal for making the water tank. The sheet metal has been cut by the cutter for required dimensions and it has been made as the tank by bending and welding process. Figure 3.5 shows water tank.

3.9 BELT AND PULLEY

Belt and pulley system has been used for power transmission from one place to another place. In our model, we use one belt and pulley system. The one pulley has been connected with the conveyor roller and another one has been connected with the crusher shaft.

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IV. METHODOLOGY

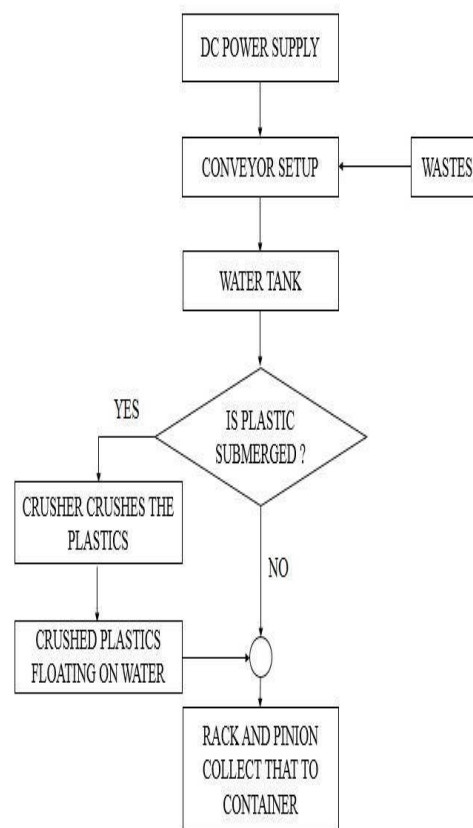


Figure 4.1 Block Diagram

Figure 4.1 shows the block diagram of the plastic separation module. The experimental setup of our project consists of a roller on which the conveyor rests. Near to the conveyor a container in which the crusher is provided. This crusher is used to separate the wastes easily. The motion to the crusher is delivered with the help of the DC motor. The conveyor is operated by using the DC motor and the spur gears. Another motor is used to operate the rack and pinion arrangement which separate the wastes that are crushed.

The end of the rack is attached with a block which moves along with the rack and pinion assembly. The power to all the motors is supplied with the help of the lead acid battery. The wastes irrespective of their type are fed to the conveyor manually. The wastes from the conveyor are automatically fed to the crushing container. The crusher which is operated by a motor crushes the wastes and reduces its sizes. That is the larger pieces of the wastes are broken down into smaller granules.

The waste whose weight is more just stays down the container. The waste which is light enough jumps up the thrushes as the crushing process is carried out. At this time, the rack and pinion is operated. The rack and pinion helps to convert the rotary motion of the motor to the linear motion. Hence the rack and the block moves linearly and pushes away the light weight wastes which comes out of the space at the side of the container.

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4.2 CALCULATION

For proper meshing of gears, the gear would be meshed must have more or less same pitch value.

$$P = \frac{\pi D}{T}$$

Where,

P = Pitch

D = Pitch Diameter

T = Number of Teeth

4.2.1 Pitch Calculation For Pinion Pitch Diameter (D) = 4 cm Number of Teeth (T) = 25

$$P = \frac{\pi \times 4}{25}$$

$$P = 3.632 \text{ cm}$$

Rack :

Number of teeth = 74

Rack length = 38cm Addendum = 0.1cm Dedendum = 0.05cm

4.2.2 Water Tank Details

- Length = 25 cm
- Breadth = 25 cm
- Height = 25 cm

$$\text{Volume} = a^3$$

$$= 25^3$$

$$= 15.625 \text{ cm}^3$$

Sheet thickness = 0.1 cm

4.2.3 Specifications of Conveyor Belt Material = Rubber Belt Length = 124 cm Width = 10 cm

Roller Diameter = 4 cm Roller Length = 13 cm Shaft Length = 25 cm Shaft Diameter = 1.3 cm

4.2.4 Specifications of Crusher Diameter = 4 cm Length = 18.5 cm

Shaft Diameter = 1.3 cm Shaft Length = 25 cm Crusher Blade Details:

- Number of Blade = 14
- Blade Length = 6 cm
- Blade width = 3 cm

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4.2.5 Specifications of Collector Box Collector Box Length (l) = 24 cm Breadth (b) = 16 cm
Height (h) = 6 cm

Volume = l X b X h

$$= 24 \times 16 \times 6$$

$$= 2,304 \text{ cm}^3$$

4.2.6 Specifications of Belt

Belt size = A20

Type = V-belt

4.2.7 Specifications of Battery

Voltage = 12V Amphere = 7.5Amp

4.2.8 Specifications of Gear Motor

Revolution per minute = 30rpm

Voltage = 12V

4.2.9 Specifications of conveyor Motor

Revolution per minute = 100rpm

Voltage = 12V

4.3 FRAME DIMENSIONS

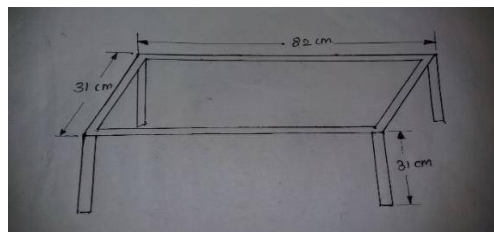


Figure 4.2 Frame Dimensions

Figure 4.2 shows frame dimensions.

- Height of the frame = 31cm
- Length of the frame = 82cm

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- Width of the frame = 31cm
- Thickness of the frame = 0.2cm

4.4 ADVANTAGES

- Simple in construction.
- Easy to fabricate and highly reliable.
- The components used are easily available.
- The wastes can be separated within shorter period of time.
- No need of skilled operators to operate this system.
- Repairing and replacing of the parts is not a difficult task.
- Efficient method of waste separating process.

4.5 APPLICATIONS

These types of waste separating machines using belt conveyor drum have a wide range of applications in the fields like,

- Municipal corporations,
- Waste disposal industries,
- Waste recycling departments,
- All industries.

V. RESULT AND DISCUSSIONS

Existing MSW models that are successfully being implemented.

- Door step Collection and transportation of the Waste generated
- Waste minimization and promotion of waste for recycling
- Stakeholders engagement in the implementation
- Processing, Treatment and Disposal of Waste
- State Level Institutional programs and arrangements.

VI. CONCLUSION

The proposed system is aimed towards the welfare infantry to minimize the causalities to a great extent. Municipal Solid Waste collection from the households at door step and transportation of MSW through trucks and mini vehicles which is collected by from door to door and from small bins on street. This collected municipal waste is transported for the disposal and treatment plants where a successful model idea is suggested which can give up good end results of complete treatment of solid waste by automated solid waste method where plastic is separated automatically and all the bio degradable material is formed as a slurry and released through the equipment.

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