



DESIGN AND MANUFACTURING OF PLASTIC SEPARATOR MACHINE USING CONVEYOR

¹Purushottam Navin Thakur, ² Amandeep Singh Raj Rathor, ³ Rohan Magadam, ⁴ Vaishnavi Taklikar, ⁵ Prof. D.D.Kumbharkarna,

¹Student, ²Student, ³Student, ⁴Student, ⁵Professor

¹Mechanical Engineering,

¹Trinity Academy of Engineering, Pune, India

Abstract: Plastic separation from wet organic waste is a very difficult to handle. There are many methods to separate plastic from dry waste. But there are very few methods to separate plastic from wet organic waste. 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 some of methods for separating the plastic from wet organic waste. 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. But this technology requires low cost and occupies a very less space. Simple components and mechanisms are used in this fabrication and an efficient plastic separating machine is built. The main purpose of our study is to design and fabricate cost effective plastic separating machine from wet organic waste. The main aim of the project is to make eco-friendly environment by recycling of waste plastic. First step is to feed waste in to the hopper. In next step waste automatically feed to crusher in which plastic dissect are formed. And by help of belt conveyor we separate plastic from wet organic waste.

Index Terms – Plastic waste, Municipal Solid waste, Mixed organic – plastic MSW, Torre faction separated product, recycling and renewable solid fuel.

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 lends to high levels of plastic used by humans. However, it is slow to degrade. Plastic pollution can unfavourably 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. Plastics are used in our daily lives in a number of applications. From greenhouses, mulches, coating and wiring, to packaging, films, covers, bags and containers. It is only reasonable to find a considerable amount of PSW in the final stream of municipal solid waste. So we decide to develop the machine that separate the plastic from wet organic waste. But this technology requires low cost and occupies a very less space. The main aim of the project is to make eco-friendly environment by recycling of waste plastic.

II. LITERATURE SURVEY

1) Techniques for separation of plastic wastes by Silvia Serranti, Giuseppe Bonifazi Department of Chemical Engineering, Materials & Environment, Sapienza University of Rome, Rome, Italy

Mechanical recycling, which is the processing of waste by physical means, represents the main approach to follow in order to recover plastics. This process typically includes different actions, such as collection, screening, manual and/or automatic sorting, size reduction, washing, extrusion, and granulation that may occur in different sequences and more than one at a time, according to the characteristics of the feed plastic waste, in terms of origin, size, shape, and composition.

2) Plastic Separation Module for Municipal Solid Waste by Gopinath , Suresh Kumar, Surya, Tamilselvan, Vijayasaravanan. Department of Mechatronics Engineering, Maharaja Engineering College, Avinashi, Coimbatore, India

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 lends 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.

3) Design and Development of Waste Sorting Machine S.J. Ojolo, J.I. Orisaleye, Adelaja, A.O., ilanko, Mechanical Engineering Department, University of Lagos, Nigeria Mechanical Engineering Department, Lagos State University, Epe Campus, Lagos, Nigeria Covenant University, Ota. Nigeria

The combined solid and liquid waste from residential, commercial, and industrial sources are referred to as municipal wastes and are often perceived as materials generated in urban areas which are unsuitable for further beneficial use, and intended to be discarded, incinerated, recycled in certain ways or considered inherently waste-like (Pankratz, 2001; Cheremisinoff and Graffia, 1995). Solid wastes are more difficult to burn due to the highly variable nature of the waste material in terms of composition and physical characteristics, spanning a wide range of bulk densities and moisture contents, resulting in a wide range heating values (Lee and Lin, 2000). Waste management basically involves the collection, transport, processing, recycling or disposal of waste materials, and is also carried out to recover materials from the waste. Waste management methods vary widely between areas for many reasons, including type of waste material, nearby land uses, and the area available.

4) Emotional responses to plastic waste: Matching image and message framing in encouraging consumers to reduce plastic consumption by Felix Septianto *, Michael S.W. Lee

The issue of environmental plastic pollution is a global concern (Haward, 2018), with plastic pollution of the marine environment a prominent example of the negative impact of humans on nature (Gall and Thompson, 2015 ; Law, 2017). In addition to plastic marine pollution, there are also many other negative issues related to plastic consumption, such as land pollution dependence on and depletion of non-renewable fossil fuels potential impacts on human and wildlife endocrine systems, and air pollution from inappropriate disposal (North and Halden, 2013 ; Thompson et al., 2009). Given the significance of the problem, the body of literature examining how consumers can be encouraged to reduce plastic consumption is growing (Sharp et al., 2010 ; Thomas et al., 2016 ; Wagner, 2017).

III. PROBLEM STATEMENT

- Plastic pollution involves the accumulation of plastic products in the environment that adversely affects wildlife, wildlife habitat or humans.
- There are many methods to separate plastic from dry waste. But there are very few methods to separate plastic from wet organic waste.
- The major problem is that they need a lot of space and also cost of the machine is high.
- So, need to develop machine that separate the waste from wet organic waste.
- As well as develop the machine which required less effort.

IV. WORKING PRINCIPLE

- When we put wet organic waste in the hopper, this waste is pass through the cutter blade.
- Because of this the available plastic is cut by the cutter in small pieces.
- Water is available in the container. When the waste is mix with the water, the plastic pieces is float on the water.
- We use the conveyor belt to separate the plastic from the waste.

V. METHODOLOGY

We have started the work of our project with literature review. After referring several papers, we got many ideas. From these ideas we started doing rough design of our project. After doing rough design we will start calculation of different parts. Once the calculation is completed, we will draw a 3d model in CATIA V5 R20. By referring this 3D model, we will buy the standard component required for the projects. After this we will start manufacturing work in workshop. By taking proper dimensions we will manufacture components one by one. Along with this electronics part will also be done. After this, assembly of the components will be done. Later testing will be started for getting various results. Simultaneously rough draft will be prepared. After completing testing work fair report will be done and submitted.

1. COMPONENTS

- Container
- Hopper
- Cutting blades
- Conveyor
- Motors

a) Container

A container is any receptacle or enclosure for holding a product used in storage. A container is shown in [fig.1:Container](#) Container is mainly use to store the substance. We use the container to mis the wet organic waste and the water. The wet organic waste is mainly feed with the help of hopper in container. Storage tanks are containers that hold liquids, or mediums used for the short- or long-term storage of heat or cold. In the USA, storage tanks operate under no (or very little) pressure, distinguishing them from pressure vessels. Storage tanks are often cylindrical in shape, perpendicular to the ground with flat bottoms, and a fixed flangible or floating roof. There are usually many environmental regulations applied to the design and operation of storage tanks, often depending on the nature of the fluid contained within. Reservoirs can be covered, in which case they may be called covered or underground storage tanks or reservoirs.

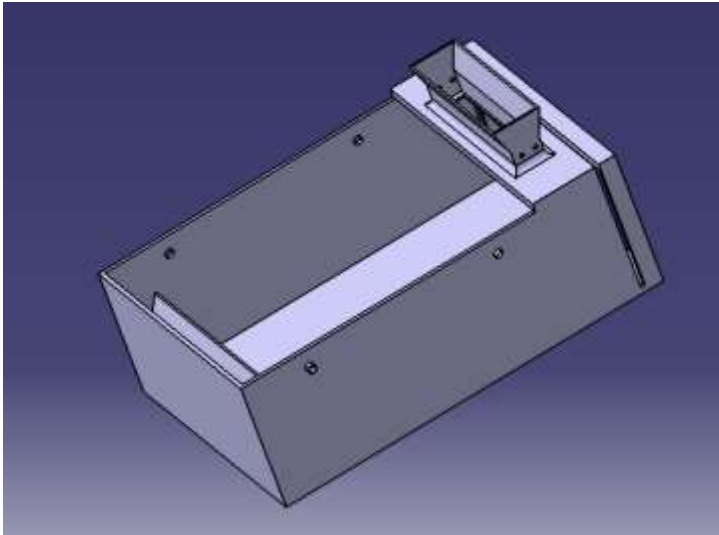


Fig.1. Containor

b) Hopper

Hopper as shown in [fig.2:Hopper](#) is a large, pyramidal container used in industrial processes to hold particulate matter that has been collected from outside. Hopper is usually large in size to allow for a greater connection. A hopper is a funnel shaped device used to move material from one receptacle to another. We put all wastage into container with the help of hopper. Hopper is directly connected to the container. A container for a loose bulk material such as grain, rock, or rubbish, typically one that tapers downward and is able to discharge its contents at the bottom. In our design hopper is in rectangular shape for more intake. Hopper is directly connected to the container. In hopper we attach the cutting blade.

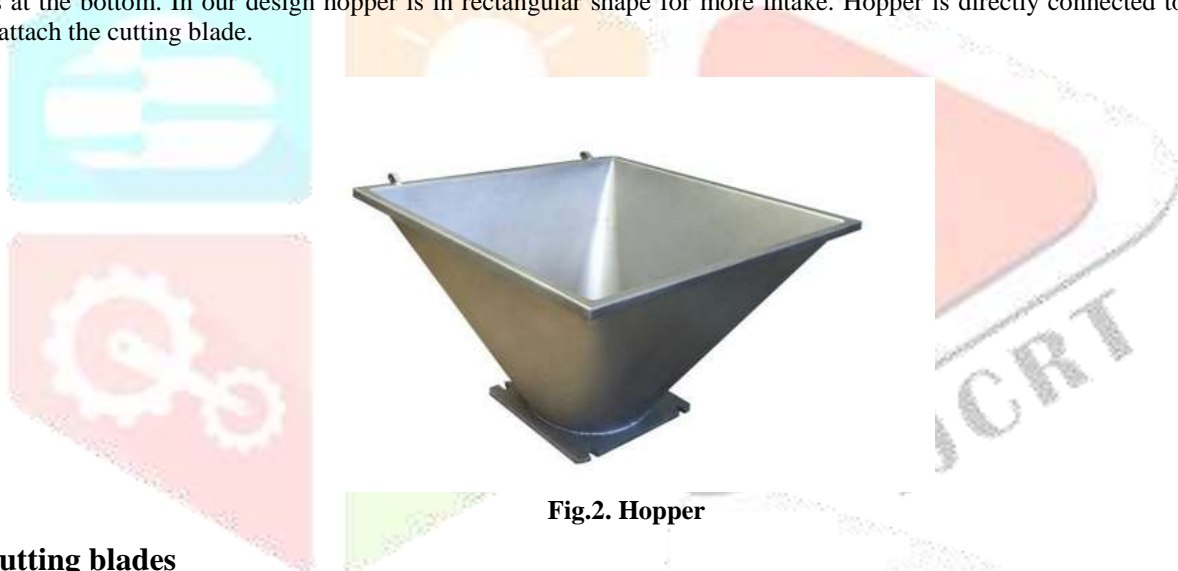


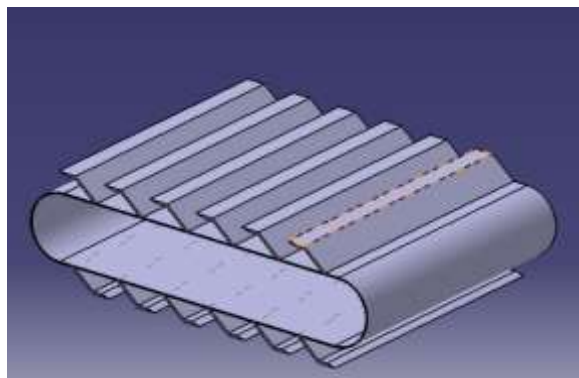
Fig.2. Hopper

c) Cutting blades

The cutting blade is mainly used to cut the plastic in small pieces. This cutting blade is run with the help of motor. The cutter blade is placed in the hopper. When we put wet organic waste in hopper the plastic is cut by blade and converted into small pieces. Because of cutting the plastic component, these pieces are easily float in the water.

d) Conveyor

A conveyor belt is the carrying medium of a belt conveyor system. A belt conveyor system as shown in [fig.3: conveyor](#) is one of many types of conveyor systems. A belt conveyor system consists of two or more pulleys. Belt conveyors are the most commonly used powered conveyors because they are the most versatile and the least expensive. Belt conveyors can be used to transport waste in a straight line or through changes in elevation or direction. A small container is attached to the conveyor that is used to collect the plastic from the water. When conveyor runs, container is collecting all plastic from the water and throughout from the system.



[Fig.3:conveyor](#)

e) Motors

Mainly motors are used to run the conveyor belt and the cutter blade. An electric motor is an electrical machine that converts electrical energy into mechanical energy. Most electric motors operate through the interaction between the motor's magnetic field and electric current in a wire winding to generate force in the form of rotation of a shaft. Electric motors can be powered by direct current (DC) sources, such as from batteries, motor vehicles or rectifiers, or by alternating current (AC) sources, such as a power grid, inverters or electrical generators. An electric generator is mechanically identical to an electric motor, but operates in the reverse direction, converting mechanical energy into electrical energy. Electric motors may be classified by considerations such as power source type, internal construction, application and type of motion output. In addition to AC versus DC types, motors may be brushed or brushless, may be of various phase (see single-phase, two-phase, or three-phase), and may be either air-cooled or liquid-cooled. General-purpose motors with standard dimensions and characteristics provide convenient mechanical power for industrial use. The largest electric motors are used for ship propulsion, pipeline compression and pumped-storage applications with ratings reaching 100 megawatts. Electric motors are found in industrial fans, blowers and pumps, machine tools, household appliances, power tools and disk drives. Small motors may be found in electric watches. Motor is shown in fig.



Fig 4:Motor

DESIGN

CAD: - **Computer-aided design (CAD)** is the use of computer systems (or workstations) to aid in the creation, modification, analysis, or optimization of a design. CAD software is used to increase the productivity of the designer, improve the quality of design, improve communications through documentation, and to create a database for manufacturing. CAD output is often in the form of electronic files for print, machining, or other manufacturing operations. The term **CADD** (for *Computer Aided Design and Drafting*) is also used.

Its use in designing electronic systems is known as electronic design automation (**EDA**). In mechanical design it is known as mechanical design automation (**MDA**) or **computer-aided drafting (CAD)**, which includes the process of creating a technical drawing with the use of computer software.

CAD software for mechanical design uses either vector-based graphics to depict the objects of traditional drafting, or may also produce raster graphics showing the overall appearance of designed objects. However, it involves more than just shapes. As in the

manual drafting of technical and engineering drawings, the output of CAD must convey information, such as materials, processes, dimensions, and tolerances, according to application-specific conventions.

CAD may be used to design curves and figures in two-dimensional (2D) space; or curves, surfaces, and solids in three-dimensional (3D) space.

CAD is an important industrial art extensively used in many applications, including automotive, shipbuilding, and aerospace industries, industrial and architectural design, prosthetics, and many more. CAD is also widely used to produce computer animation for special effects in movies, advertising and technical manuals, often called DCC digital content creation. The modern ubiquity and power of computers means that even perfume bottles and shampoo dispensers are designed using techniques unheard of by engineers of the 1960s. Because of its enormous economic importance, CAD has been a major driving force for research in computational geometry, computer graphics (both hardware and software), and discrete differential geometry

The design of geometric models for object shapes, in particular, is occasionally called *computer-aided geometric design (CAGD)*

a) USES:

Computer-aided design is one of the many tools used by engineers and designers and is used in many ways depending on the profession of the user and the type of software in question.

CAD is one part of the whole Digital Product Development (DPD) activity within the Product Lifecycle Management (PLM) processes, and as such is used together with other tools, which are either integrated modules or stand-alone products, such as:

- Computer-aided engineering (CAE) and Finite element analysis (FEA)
- Computer-aided manufacturing (CAM) including instructions to Computer Numerical Control (CNC) machines
- Photorealistic rendering and Motion Simulation.
- Document management and revision control using Product Data Management (PDM).

CAD is also used for the accurate creation of photo simulations that are often required in the preparation of Environmental Impact Reports, in which computer-aided designs of intended buildings are superimposed into photographs of existing environments to represent what that locale will be like, where the proposed facilities are allowed to be built. Potential blockage of view corridors and shadow studies are also frequently analysed through the use of CAD.

CAD has been proven to be useful to engineers as well. Using four properties which are history, features, parameterization, and high-level constraints. The construction history can be used to look back into the model's personal features and work on the single area rather than the whole model. Parameters and constraints can be used to determine the size, shape, and other properties of the different modelling elements. The features in the CAD system can be used for the variety of tools for measurement such as tensile strength, yield strength, electrical or electromagnetic properties. Also, its stress, strain, timing or how the element gets affected in certain temperatures, etc.

TYPES:

There are several different types of CAD, each requiring the operator to think differently about how to use them and design their virtual components in a different manner for each.

There are many producers of the lower-end 2D systems, including a number of free and open-source programs. These provide an approach to the drawing process without all the fuss over scale and placement on the drawing sheet that accompanied hand drafting since these can be adjusted as required during the creation of the final draft.

3D wireframe is basically an extension of 2D drafting (not often used today). Each line has to be manually inserted into the drawing. The final product has no mass properties associated with it and cannot have features directly added to it, such as holes. The operator approaches these in a similar fashion to the 2D systems, although many 3D systems allow using the wireframe model to make the final engineering drawing views.

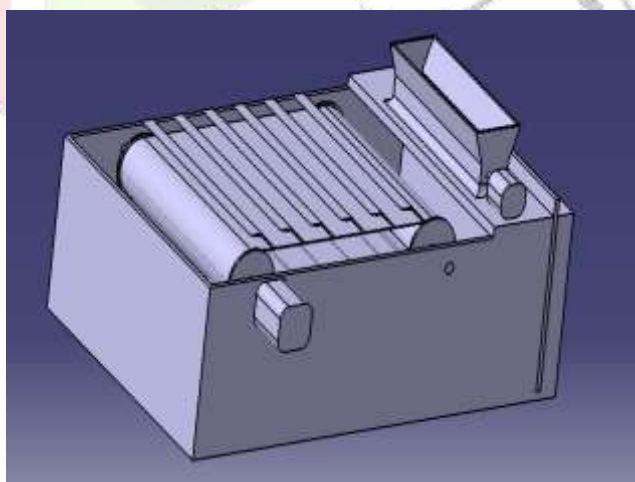
3D "dumb" solids are created in a way analogous to manipulations of real-world objects (not often used today). Basic three-dimensional geometric forms (prisms, cylinders, spheres, and so on) have solid volumes added or subtracted from them as if assembling or cutting real-world objects. Two-dimensional projected views can easily be generated from the models. Basic 3D solids don't usually include tools to easily allow motion of components, set limits to their motion, or identify interference between components.

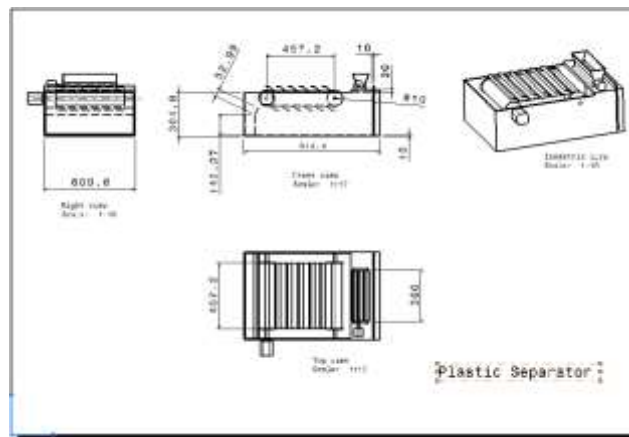
There are two types of *3D Solid Modelling*

- *Parametric modelling* allows the operator to use what is referred to as "design intent". The objects and features created are modifiable. Any future modifications can be made by changing how the original part was created. If a feature was intended to be located from the centre of the part, the operator should locate it from the centre of the model. The feature could be located using any geometric object already available in the part, but this random placement would defeat the design intent. If the operator designs the part as it functions the parametric modeler is able to make changes to the part while maintaining geometric and functional relationships.
- *Direct or Explicit modeling* provide the ability to edit geometry without a history tree. With direct modelling, once a sketch is used to create geometry the sketch is incorporated into the new geometry and the designer just modifies the geometry without needing the original sketch. As with parametric modelling, direct modelling has the ability to include relationships between selected geometry (e.g., tangency, concentricity).

Top end systems offer the capabilities to incorporate more organic, aesthetics and ergonomic features into designs. Freeform surface modelling is often combined with solids to allow the designer to create products that fit the human form and visual requirements as well as they interface with the machine.

CATIA:



DRAFTING:**2. WORKING METHODOLOGY**

In this system our aim is to remove the plastic parts from the wet waste. Firstly a wet form of waste is inserted into the tank. Then water is allowed to be inserted into the same tank. At the upper side a conveyor is used which removes the plastic, so accordingly water level is maintained. The working principle of the system is based on the density difference. As the density of plastic is low due to the addition of the water it starts floating on the water surface. This floating plastic is then collected with the help of conveyor mechanism. A motor is used to drive this belt and finally the plastic is collected at the other bottom side.

BASIC DESIGN CALCULATIONS FOR PLASTIC SEPERATOR MACHINE-**Given:**

Belt and roller material=Rubber and plastic

Density of high density polypropylene plastic=970 Kg/m³

Density of the belt material (ρ_{rubber})=1522kg/m³

As the density of rubber is much higher than the plastic material, we have to consider the maximum density to calculate the mass of conveyor belt. Hence here we are considering the density of the rubber material.

Thickness of belt (t)=5mm=0.005m

Diameter of roller (Φ)=50 mm=0.05m

Width of belt=Width of roller=(b)=0.450 m

Length of conveyor (l)=0.450 m

Now length of the conveyor belt is calculated as,

$$\begin{aligned} \text{Length of belt} &= (2 * \text{length of conveyor}) + [2 * (1/2 * \text{circumference of roller circle})] \\ &= (2 * 0.450) + 0.157 \end{aligned}$$

$$\text{Length of belt} = 1.57 = 1.6 \text{ m}$$

Mass of belt is calculated as,

$$\begin{aligned} M_{\text{belt}} &= \rho_{\text{belt}} * l * b * t \\ &= 1522 * 1.6 * 0.450 * 0.005 \\ &= 5.4792 \text{ kg} \end{aligned}$$

$$M_{\text{belt}} = 5.5 \text{ Kg}$$

Mass of rollers,

$$M_{\text{rollar}} = \rho_{\text{rollar}} * \pi/4(D)^2 * 0.3$$

$$=1522 * \pi/4(0.05)^2 * 0.3$$

$$=0.8965 \text{ kg}$$

$$M_{\text{rollar}}=1 \text{ kg}$$

Mass of conveyor calculated as,

Mass of conveyor= Mass of belt+ Mass of rollers

$$=5.5+1$$

$$M_{\text{conveyor}}=6.5 \text{ kg}$$

Now, total mass of plastic to be carried away by conveyor= 0.5 kg

Total weight of the system= $M_{\text{belt}} + M_{\text{rollar}} + M_{\text{plastic}}$

$$=(5.5+6.5+0.5)*9.81$$

$$W=122.625 \text{ N}$$

As the process is continue we have to maintain speed hence $N=10 \text{ rpm}$ is constant throught the system

So, linear speed of belt(V)= $2\pi*N/60$

$$V=1.04 \text{ m/s}$$

Now, total belt pulls=(weight of conveyor *(coefficient of friction between belt with paper bag) belt and conveyor)

$$=(122.625)*(0.4)$$

Total belt pull =49.05 N

Total power required to belt(P)=(total belt pull) * (belt speed)

$$=(49.05)*(1.04)$$

$$P=41.652 \text{ watt}$$

So accordingly we can select 12v & 5A battery which generate 60s watt power

Design of Motor attached to cutting mechanism (Hopper)-

For 12v & 2A motor for $N=60 \text{ rpm}$

Power of motor = $P=24 \text{ watt}$

Torque of the motor= $T=3.9 \text{ Nm}$ (available torque)A

Now to cut the waste with plastic we require 200 N force, and the diameter of shaft be 10 mm.

So, required torque is given as(T)= $F*R$

$$=200*0.005$$

$$T=1 \text{ N-m} \text{-----B}$$

As $A>B$ our design is safe.

a) Shaft Design-

In our design the power supplying motor is directly connected to the roller, and the roller is considered as shaft. Now at the starting point of calculation to calculate the total weight of belt and conveyor system, we have taken the diameter of roller(shaft) as 50mm. So, for the safe design the calculated shaft design diameter must be less than the considered value of the shaft diameter.

From Design Data Book -V.B.Bhandari- Page no-9.4, we can find out the outer diameter of the shaft.

As we are using 60 Watt power motor, with constant 10 rpm rotations, We can find out the required torque value as,

$$P=(2*3.14*N*T)/(60)$$

$T=57.29$ N-m.

This torque(T)= M_t =Torsional moment torque acting on shaft.

Hence,

$$D^4 = (584) \cdot (M_t) \cdot (L) / (G) \cdot (\theta).$$

L =Length of the shaft=450mm.

G =Modulus of rigidity=79300 N/mm²(For steel shafts)

θ =Angle of twist= 3 degree per meter length for line shafts.

Diameter of the shaft(D)=2.82 mm.

So, as our calculated shaft diameter value is much less than the considered value for same amount of power and torque transmission, our design is safe.

b) Design of bearing-

From design data book V.B.Bhandari-Page no-15.7 we can select bearing for the shaft diameter of 10 mm.

Here we select single row deep groove ball bearing designated as-6200(SKF)

Dimensions, load capacities of bearings is given as,

Inner Diameter of bearing=10mm

Outer diameter of bearing=30mm

Width of bearing=9 mm

Basic load ratings(C)=5070 N and (C_0)=2240 N

COST ESTIMATION

Cost estimation may be defined as the process of forecasting the expenses that must be incurred to manufacture a product. These expenses take into a consideration all expenditure involved in a design and manufacturing with all related services facilities such as pattern making, tool, making as well as a portion of the general administrative and selling costs.

a) PURPOSE OF COST ESTIMATION:

1. To determine the selling price of a product for a quotation or contract so as to ensure a reasonable profit to the company.
2. Check the quotation supplied by vendors.
3. Determine the most economical process or material to manufacture the product.
4. To determine standards of production performance that may be used to control the cost.

b) TYPES OF COST ESTIMATION:

1. Material cost
2. Machining cost

SR.NO.	COMPONENTS	MATERIAL	COST
1.	Reservoir	M.S.	1000
2.	Belt Conveyor	metal, rubber	2000
3.	2 motors	-	2000
4.	sheet metal	M.S.	1000
5.	Manufacturing Cost	-	2000

Total Cost = Components Cost + Manufacturing Cost = 8000/-

VI. SAETY PRECAUTIONS

The following points should be considered for the safe operation of machine and to avoid accidents: -

- All the parts of the machine should be checked to be in perfect alignment.
- All the nuts and bolts should be perfectly tightened.
- The operating switch should be located at convenient distance from the operator so as to control the machine easily.
- The inspection and maintenance of the machine should be done from time to time.

VII. RESULT

- We easily cut plastic in small pieces with the help of cutter.
- We separate the plastic pieces from the wet organic waste successfully.
- By using Conveyor belt we easily remove plastic pieces from wet organic waste.
- By using hopper, cutting blade and belt conveyor system is more effective compare to other.

VIII. FUTURE SCOPE

- Piston can be used to increase the speed.
- By using more rollers in belt conveyor is more effective.

REFERENCES

1. Techniques for separation of plastic wastes by Silvia Serranti, Giuseppe Bonifazi Department of Chemical Engineering, Materials & Environment, Sapienza University of Rome, Rome, Italy
2. Plastic Separation Module for Municipal Solid Waste by Gopinath , Suresh Kumar, Surya, Tamilselvan, Vijayaravanan. Department of Mechatronics Engineering, Maharaja Engineering College, Avinashi, Coimbatore, India
3. Design and Development of Waste Sorting Machine S.J. Ojolo, J.I. Orisaleye, Adelaja, A.O., ilanko, Mechanical Engineering Department, University of Lagos, Nigeria Mechanical Engineering Department, Lagos State University, Epe Campus, Lagos, Nigeria Covenant University, Ota. Nigeria
4. Emotional responses to plastic waste: Matching image and message framing in encouraging consumers to reduce plastic consumption by Felix Septianto, Michael S.W. Lee
5. Adzimah, S.K. and Anthony, S. (2009). Design of garbage sorting machine. American J. of Engineering and Applied Sciences 2 (2): 428-437
6. Hristovski, K., Olson, L., Hild, N., Peterson, D. and Burge, S. (2007). The municipal solid waste system and solid waste characterization at the municipality of Veles, Macedonia, International Journal of Integrated Waste management, Science and technology, volume 27, issue 11, 2007, pp. 1680-1689.
7. Shen, H., Pugh, R.J., Forssberg, E., 2002. Floatability, selectivity and flotation separation of plastics by using a surfactant. Colloids and Surfaces A Physicochemical and Engineering Aspects 196, 63e70
8. Al-Jayyousi, O., 2001. A methodology for evaluating environmental impact of solid waste disposal sites: case study from Jordan. Arabian Journal of Science and Engineering 26 (2C), 81-88.