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Automated Plastic Bottle Recycling Machine

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Abstract:
Abstract— Plastic is a non-biodegradable waste. It is noted that, around 60 to 90 per cent of waste generated is due to plastic debris. Plastic usage has become rampant in industries across the world as it is the most common and adaptable material for manufacturing and packaging their products. They have become an integral part of our lives that they cannot be easily replaced. This paper aims at recycling plastic bottles into a useful product. It involves the process of crushing, melting and moulding of used plastic bottles. The status of the process is displayed simultaneously on a LCD display. They are then crushed and melted at high temperatures. The molten plastic is eventually moulded into usable product. The recycling thus reduces the amount of trash generated due to the disposal of used water bottles if installed at public places. The process avoids the reuse of plastic water bottles beyond their shelf life. Thus, this paper is aimed at reducing the volume of waste generated and will aid in effective waste management. This machine has both social and economic value. Economically, it minimizes all expenditure for waste processing. Another important contribution is the impact on employment creation in rural areas. Socially, it improves environmental conditions like reducing landfill waste, preventing spreading of diseases due to plastic recycling, eliminating contamination due to plastics etc. Thus, this paper is a promising environment friendly solution for reducing pollution caused due to plastics.

Keywords: *moulding, non-bio-degradable, packing*

I. INTRODUCTION

Every year, nearly 13 million tonnes of plastic waste are added to oceans. Plastics do not decompose easily. Plastic bottles are commonly made from polyethylene terephthalate (Pet), which take 400 years to naturally decompose. In India, 80 % of total plastic consumption is discarded as waste and official statistics say the country generates 25,940 tonnes of plastic waste daily. At least 40% of this waste is uncollected. About 1 million plastic drinking bottles are purchased per minute all over the globe. Proper handling of used plastic bottles not only facilitates the conservation of precious resources like water, energy and crude oil but also reduces greenhouse gas emissions. Traditionally, plastic waste is processed by incineration or sending to land fill. The impact of burning one ton of hard waste creates about 62 cubic meter of methane equivalent to one tonne of CO_2. CO_2 gas pollutes environment, and plastic waste affects landmasses and oceans. This strongly points at a need for a recycling methodology for plastics so that their contribution towards pollution reduces to a certain extent.

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The procuring and reprocessing of used, waste or scrap plastic materials into useful products is known as recycling. The major goal of recycling is to reduce pollution due to plastics and to reduce the strain on the raw materials. From the environment point of view, it reduces the excessive pollution of landfills and oceans. Ocean plastic disposal is a major problem throughout the world. It is estimated that the oceanic plastic may triple within the next ten years. The careless disposal of plastics affect animals, birds and aquatic creatures which may choke on accidental ingestion of the plastics. This can be limited by recycling, which can protect several species of birds and animals from accidental ingestion of plastics. According to the Institute for Recycling Industries (ISRI), the usage of recycled material provides several benefits compared to virgin material such as the reduced demand for raw resources, as well as the decreased energy required for processing. In regard to diversion, recycling helps keep plastic material out of landfills. Plastic wastes are destroyed by the process of incineration at several landfills. This causes the emission of several toxic pollutants on heating, which can seep into the soil or groundwater. Hence recycling is the only solution to avert pollution.

Recycling of plastics greatly helps to conserve natural resources. Crude oil is used extensively in the manufacture of plastics. It is estimated that recycling one tonne of plastic can save as much as 3.8 barrels of oil, which is a fast depleting resource. Recycling also consumes lesser power than that required for the initial manufacturing. Recycling consumes only one-third of power required for manufacturing, thus conserving power and reducing the strain on the power grid. Thus, the economic strain is reduced by conserving the raw materials required.

Another important thing to be noted is that plastic manufacturing involves the release of a significant amount of greenhouse gases, which contributes to global warming. Since recycling greatly reduces the amount of crude oil and energy consumed, the emission of greenhouse gases like carbon dioxide is also reduced by a considerable amount. Plastic recycling greatly helps on the social front as well. It provides job opportunities at rural areas. Also, the recycled plastic products are made at a reasonably lower price, which would be beneficial for low income families.

The process of recycling of plastics is quite complex when compared to recycling of other materials like paper, glass and metals. This is due to the presence of dyes and other additives to virgin plastic. Thus, initially, sorting has to be done based on the plastic resin it is made of. After the process of separation has been carried out, compressing or crushing of the plastic bottles is done. This reduces the volume occupied by the bottles and also aids in the conversion to pellets. Cleaning of the plastic bottles is also done by thorough washing, in order to remove dirt and debris. They are then converted into smaller pellets by a grinding mechanism. These pellets can be used for manufacturing other products.

Due to the complexity involved in the process of recycling and the people's negligent attitude towards plastic disposal and its recycling, plastic recycling lags far behind recycling of other materials.

II. SYSTEM OVERVIEW

The proposed plastic bottle recycling machine not only converts the plastic bottles to pellets, but also produces a useful recycled plastic product as output. The working of the recycling machine is explained using a block diagram. Fig.(i) demonstrates the operation of the machine.

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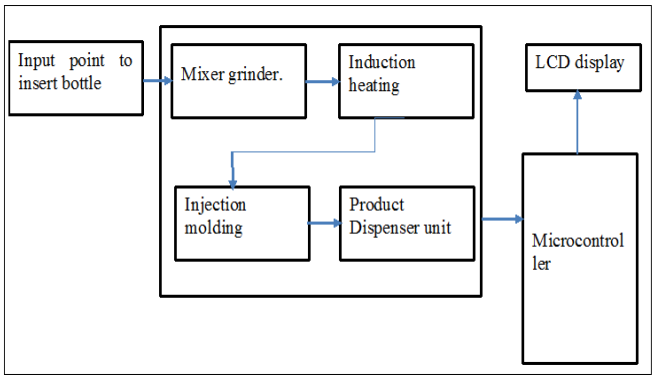

Fig (i)

A. Crushing and grinding

The bottle to be recycled is inserted into the provision provided for the insertion of plastic bottles. These plastic bottles are initially crushed and ground into fine pellets by using a mixer crusher. The fine plastic grains are then passed to a barrel through a hopper for heating.

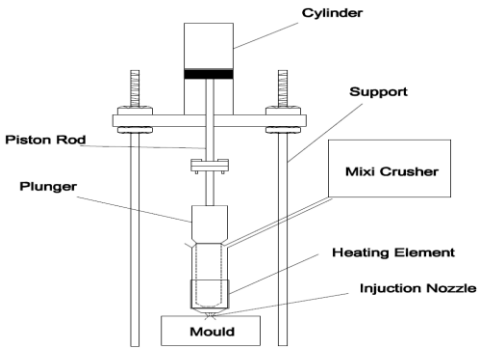

Fig (ii)

The fig (ii) shows the Layout of the Proposed System.

B. Induction Heating

The plastic is then heated and melted over a temperature of about 150-200˚C. The heating is done with the help of an induction coil which is wound around the barrel. Induction heating is done by passing alternating current through the coil. The barrel that is wound by the coil is heated due to the eddy currents that flow the material. As the barrel is heated to a high temperature, the plastic granules inside them are melted to a liquid state.

C. Injection Molding

The molten plastic is then molded into a new recycled product by means of injection molding. Pneumatic injection molding has been used in this paper. The pneumatic injection molding has the capability of increased productivity compared to manual molding. Also, it is cost effective when compared to hydraulic injection molding. Hence pneumatic injection molding is very useful for small and medium-scale industrial uses.

D. Air Compressor

Due to the pressure provided by the air compressor, the plunger moves down forcing the molten plastic to be injected into the dye. Once the plastic is melted, the air is compressed at a pressure of 3.2 bar. Therefore, during the first stroke, the compressed air pushes the cylinder in downwards direction. The molten plastic which is in the liquid form is therefore injected into the mold. Once the cavity of the mold is completely filled, the pressurized air is released making the cylinder to move in upwards direction during the second stroke. As the process is complete, the new plastic mold is removed from the die and the entire process is continued.

III. ALGORITHM FOR PROPOSED SYSTEM

The plastic bottles are inserted through the provided allotment as the input. Once the bottles are inserted and message is displayed using a LCD screen asking the user to enter their name and contact details. The number of bottles that are inserted are counted and stored in the memory of a microcontroller. If the number of bottles are sufficient for producing the mold, the recycling

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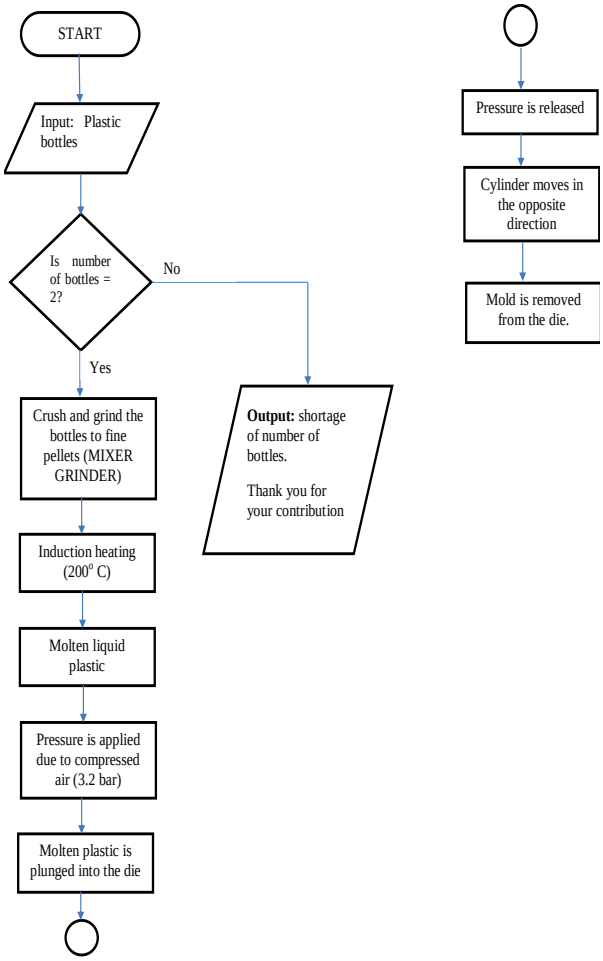
process is commenced. If not, then a message of gratitude and appreciation for contributing to make the earth green is displayed to the user. In the crushing unit, the plastic bottles are ground into fine granules. These fine particles are then heated to a very high temperature by using an induction coil. Once the melting point of the plastic is reached, the solid plastic granules are converted into molten liquid plastic. The molten plastic is then injected into a dye by applying high pressure. This is done with the help of an air compressor. Once the dye is filled with the liquid plastic, the mold is removed from the dye. The status of the entire process are also displayed in a LCD screen. Finally, the recycled plastic product is dispensed to the user.



Fig(iii)

IV. COMPONENTS USED IN HARDWARE

1. INJECTION UNIT

A. INJECTION CYLINDER:

The injection cylinder is used to supply power to inject the crushed pellets of the bottle into the heating element. The injection cylinder used in this machine is a double cylinder type which consists of cylinder body, piston and piston load. This injection cylinder helps in reducing the manual pressure by inserting the pellets automatically into the heating element. The design of cylinder consists of cylinder thrust, air consumption and mounting. The cylinder thrust helps in both extending and retracting directions due to the force. This movement helps in moving the piston back and forth from one end to another by alternating the port that receives high pressure air for opening and closing of gate. The pneumatic cylinder used in this machine is of 7bar, 50mm, 120mm stroke.

B. BARREL:

The barrel is made up of nitride steel. This kind of barrel is widely used for plastic pellets. The barrel consists of cooling channel, heater bands and thermocouple. The thermocouple is used to set the temperature in different set of the barrel. Residence time is defined as the time it takes for the plastic pellets to enter into the nozzle.

C.NOZZLE:

The nozzle is placed at the end of the barrel. It facilitates a path for the melted plastic to enter into the mould. The melt is heated by the heating element before entering into the cold channels of the mould. During the process of transferring the melt into the mould, there will be a heat transfer, if it is excessive it is advisable to remove the

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nozzle from the mould. Otherwise the melt may be frozen in the nozzle and may block the flow of further contents.

D.FLOW CONTROL VALVE:

The valve helps in controlling the part of the measured amount of pellets such that it prevents backflow of the excess pellets during the time of the injection. It helps in pellets stagnation. This valve can either be controlled manually or can be controlled automatically. This valve monitors the amount of pellets required to make the mould and limits the amount of pellets entering into the cylinder.

E. HEATING ELEMENT:

The heating element (40x55mm/1.77x2.17'' (dia x H)) helps to mould the plastic pellets at high temperature. It is set at 200 degree Celsius. This temperature is used to convert the plastic pellets into molten plastic. It weighs around 124g and it's made up of stainless steel and mica. Regulator is used to preheat the coil to melt the plastic pellets. The regulator is given an external supply.

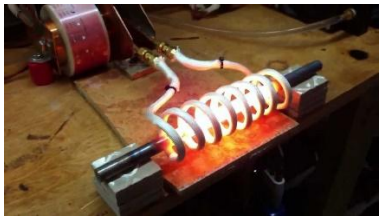

Fig (iv) Heating coil

2. CLAMPING UNIT:

F. COLLAR:

Collar (Fig (v)) acts as a channel that helps in delivering the molten plastic into the mould through cylindrical pipes. This helps in directing the plastic directly into the mould by helping in avoiding contact with the other parts, this helps in preventing the wastage of the recycled plastic.

Fig (v) Collar

G. CLAMP HOLDER:

Clamp holder is used to tightly close the mould with enough pressure so that the molten plastic gets filled into the cavity without any leakage during the process of injection. The pressure exerted by the clamp holder helps in

Cooling the mould instantly and gives the recycled product in less span of time.

H. DIE:

A die (Fig (vi)) is made up of mild steel. This is fabricated using CNC. Die consists of 2 halves namely "cover die" and "ejector die". Cover die always remains stationary while the ejector die is movable. When the 2 halves of the die are closed then its forms a cavity of desired shape that helps in shaping the mould. This die casting method is cheaper and quicker on comparing it with other casting methods such as sand mould casting. This method is widely used for non-ferrous materials with low fusion temperature.in this die core is known as the male portion which forms the internal shape of the mould while cavity is the female portion which provides the external shape of the mould.

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Fig (vi) Construction of the die

VI. CONCLUSION

In this paper, the various recycling methodologies of plastics was extensively studied and an attempt has been made to design a system that combines the processes of collection and crushing of plastic bottles as well as the molding of the powdered plastic into a new recycled product. Already plastic recycling machines have started being installed at several places all over the world. This is an attempt at designing a solution to the problem at a reduced cost. The recent plastic ban in Tamil Nadu has also served as an impetus to recycle the existing plastics as the main objective of the ban is to curb the further increase in plastics at landfills. But this ban does not cover packaged water bottles. Hence the paper serves to recycle these used bottles.

While the future of plastic recycling is quite promising, it still has a long way to tread ahead. A significantly high proportion of plastic wastes still go to landfills, for several reasons, including incomplete coverage of municipal recycling programs, inconsistent laws and confusion among the general public whether a material is recyclable or not, product design issues, as well as other issues.

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