IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

Impact Factor: 7.53

Volume 4, Issue 1, May 2024

Design and Fabrication of RecyclingNon Bio Degradable Materials Into Products

Mr. K. Vijayarajan[1], Abinash G[2], Naveenkumar S[3], Pugazhendhi P[4], Viswanathan C[5]

Assistant professor, Department of Mechanical Engineering[1]

Student, Department of Mechanical Engineering[2,3,4,5]

Anjalai Ammal Mahalingam Engineering College, Thiruvarur, Tamil Nadu, India

Abstract*: This project focuses on recycling non-biodegradable materials to help the environment from global waste and pollution. It investigates methods to transform non- biodegradable materials into new products, aiming to reduce environmental damage caused bysolid waste. It will select specific solvents that match the type of plastic to make recycling more effective. The combination of mechanical and chemical operation is used for achieving the objective of the project. The shredder machine is used for mechanical operation and the acetonesolvent is used for chemical operation. The process starts with collecting plastic materials and sorting them manually based on their properties. The sorted materials undergo various stages. The waste materials are cleaned with water and crushed using a shredder machine. Chemical treatment (acetone) is used to dissolve the crushed pellets. The acetone takes 2-3 hours to react with the plastic. After this period, the waste materials transition into a semi-solid stage. In thisstage, some adhesive materials are mixed with the dissolved plastic to improve the bonding strength and surface finishing of the final product. The semi-solid plastic is then fed into a diefor the development of new products such as table bushes and door handles. The solvent added to the plastic is evaporated after 30 minutes of drying in sunlight. After the evaporation of acetone from the die, the final product is obtained. The final specimens undergo mechanical testing such as hardness test, tensile test and compression test. By utilizing a shredder machineand acetone, this project demonstrates how non-biodegradable materials can be turned into useful products, helping to reduce waste and protect the environment.*

Keywords: non-biodegradable materials

I. INTRODUCTION

This project addresses the urgent issue of non-biodegradable waste by combining mechanical and chemical processes to turn it into valuable products. We start with a shredder machine that breaks down various types of non-biodegradable waste into smaller pieces. These shreds become the base material for chemical treatments. Chemical processes like polymer degradation or depolymerization modify the molecular structure of the waste, allowing us to create new products from the transformed materials. Our approach not only helps the environment by dealing with non-biodegradable waste but also supports resource recovery and circular economy principles. By blending mechanical and chemical methods, we aim to shift towards more sustainable resource use. Through experiments and innovation, this project aims to turn waste into valuableresources, contributing to a future where waste is seen as an opportunity rather than a problem.

II. METHODOLOGY

- Material Collection and Sorting: Begin by collecting non-biodegradable wastematerials from various sources such as households, industries, and commercial establishments. Sort the collected materials based on their composition and characteristics to facilitate efficient processing.
- Mechanical Shredding: Utilize a robust shredder machine equipped with sharp cutting blades to mechanically break down the collected waste into smaller fragments. Adjust the shredder settings based on the type and density of the materials to achieve optimal shredding efficiency.

- Chemical Treatment Design: Design chemical treatments tailored to the specific types of shredded waste materials. Research and select appropriate chemical agents and reaction conditions based on the desired molecular transformations, such as polymer degradation, depolymerization, or chemical functionalization.
- Laboratory Setup: Establish a well-equipped laboratory facility to conduct the chemical treatments safely and effectively. Ensure compliance with safety protocols and regulations regarding the handling and disposal of chemicals and waste materials.
- Chemical Processing: Implement the designed chemical treatments on the shredded waste materials in controlled laboratory conditions. Monitor reaction parameters such as temperature, pressure, and reaction time to optimize the efficiency and yield of the chemical processes.
- Product Development and Testing: Explore potential applications for the transformed waste materials and develop prototypes of value-added products. Conduct rigorous testing and evaluation to assess the performance, durability, andsustainability of the developed products.
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III. LITERATURE REVIEW

Title: Mechanical and chemical recycling of solid plastic waste

K. Ragaert et al The lifecycle of polymer materials involves the transformation of raw materials into products through various converting techniques, generating post-industrial (PI) waste during manufacturing, which istypically clean and mono-streamed, facilitating its recycling. At the end-of-life phase, products become post-consumer (PC) waste, often comprising mixed plastics of unknown composition and potential contamination. Collection schemes for PC plastic waste vary, with recycling being the preferred option, followed by energy recovery and landfilling as the least-preferred choice. Effortsto minimize waste generation include smarter packaging, alternative materials, and promoting reuse, necessitating consumer awareness. Effective valorization of waste through recycling technologies and policy support is crucial for sustainable waste management practices and environmental conservation.

Title: An overview of non-biodegradable bioplastics

Md Hafizur Rahman, Prakashbhai R. Bhoi et al The objective of this study is to provide an overview of bio-plastics in terms of the market volume, challenges, production methods, characterization and feasibility for upcycling of bio- plastics. This paper specifically focuses on the major non- biodegradable bioplastics, such as bio-PE, bio-PP, bio-PET, bio-PTT and bio-PA. Besides, compostable bioplastic, such as PLA is also addressed for comparison. These bioplastics represent nearly 50% of the current bioplastic market. In this review analysis, the pro- duction flowcharts of all these bioplastics have been discussed, with an insight into the pretreatment, hydrolysis, and fermentation processes. In addition, characterization of bioplastics is analyzed in terms of its downstream utilization for fuels and chemicals production.

IV. MATERIAL SELECTION

Material selection is a step in the process of designing any physical object.In the context of product design, the main goal of material selection is to minimize cost while meeting product performance goals. Systematic selection of the best material for a given application begins with properties and costs of candidate materials.

CONSTRUCTION SHREDDER MACHINESHREDER MACHINE:

A shredder machine is a mechanical device used to break down or shred various materials into smaller pieces. Typically employed in recycling facilities,offices, and industrial settings, shredders are versatile machines capable ofprocessing a wide range of materials, including paper, cardboard, plastic, metal, wood, and more. They work by using sharp blades or rotating hammers to cut or tear materials into smaller fragments, making them easier to manage, transport, and recycle. Shredders play a vital role in waste management and recycling processes, helping to reduce waste volume, ensure data security, and facilitate thereuse or repurposing of materials.

COMPONENTS OF SHREDDER MACHINE:

- Cutter
- Bush
- Shaft
- M.S Plates
- Bearing

V. CHEMICAL TREATMENT

CHEMICAL TREATMENT OF PLASTIC FOR RECYCLING:

Chemical treatment of plastic for recycling involves various processes aimed at breaking down, separating, or modifying the plastic to facilitate its reuseor conversion into new materials. Some common chemical treatments for plasticrecycling include:

- Depolymerization: This process breaks down polymers into their monomer components through chemical reactions such as hydrolysis or glycolysis. The resulting monomers can then be purified and used to produce new plastic or othermaterials.
- Solvent Extraction: Solvents are used to dissolve specific types of plastics, allowing for the separation of different polymer types. Once dissolved, the plastics can be separated based on their chemical properties or solubility.
- Additive Removal: Chemical treatments can be employed to remove additivesand contaminants from recycled plastics, such as dyes, fillers, or adhesives. Thishelps improve the quality and purity of the recycled material.
- Surface Modification: Chemical treatments can modify the surface properties of recycled plastics to enhance adhesion, compatibility, or performance in subsequent processing steps or applications.
- Cross-Linking Reversal: Some plastics are cross-linked during their original manufacturing process to improve properties like strength or heat resistance. Chemical treatments can be used to reverse cross-linking, allowing for thereprocessing or recycling of these materials.

These chemical treatments play a crucial role in the recycling of plastics by enabling the recovery of valuable materials and improving the efficiency and sustainability of the recycling process. However, it's important to consider the environmental impact and safety aspects of these treatments, as well as their compatibility with different types of plastics and recycling processes.

SOLVENTS USED FOR PLASTIC DISSOLVING:

There are various types of solvents used for dissolving plastics, depending on thetype of plastic being dissolved and the intended application. Some common solvents include acetone, methyl ethyl ketone (MEK), toluene, xylene, chloroform, and dichloromethane. However, it's important to use solvents safelyand responsibly, as many of them are hazardous and can pose health andenvironmental risks.

REACTION OF ACETONE WITH PLASTIC:

The chemical equation for the interaction of acetone with all types of plastic would be impractical due to the diverse nature of plastics and their interactions with acetone. Instead, I can provide a general description of the interactions based on the properties of acetone and common types of plastics:

Polystyrene (PS):

CH_3COCH_3+PS⟶ Solvated Polystyrene

Acetone (C_3H_6O) + Polystyrene ⟶ Solvent action, dissolution, orsoftening

Acrylic (PMMA):

Acetone (C_3H_6O) + Acrylic ⟶ Solvent action, dissolution, or softening

Polyvinyl Chloride (PVC):

Acetone (C3H6O) + Polyvinyl Chloride (C2H3Cl) → partial softening ordissolution of PVC

CH3COCH3 + PVC ⟶ Swelling or softening, minimal dissolution(depending on exposure time and conditions)

Polyethylene (PE) and Polypropylene (PP):

Acetone (C3H6O) + PE/PP ⟶ Minimal effect, possibly some swelling orsoftening with prolonged exposure

CH3COCH3+PE⟶ Swollen PE

Polyethylene Terephthalate (PET):

Acetone (C3H6O) + PET ⟶ Minimal effect, possibly some swelling orsoftening with prolonged exposure

Polyurethane (PU):

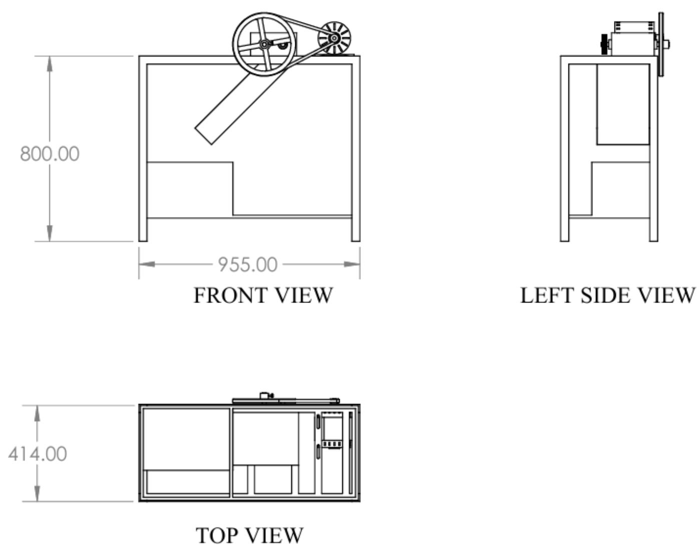
Acetone (C3H6O) + Polyurethane ⟶ Solvent action, dissolution, orsoftening

CH3COCH3+PU⟶ Dissolved PU

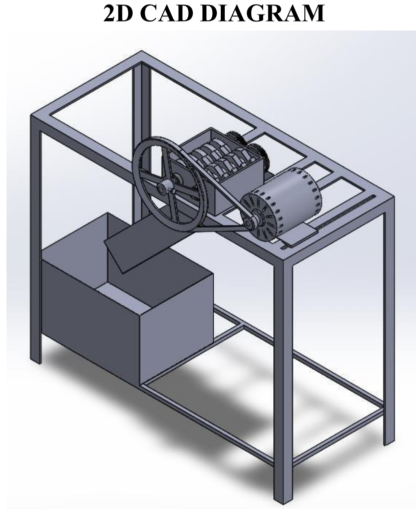
Polyvinylidene Chloride (PVDC):

Acetone (C3H6O) + PVDC ⟶ Minimal effect, possibly some swelling orsoftening with prolonged exposure

VI. CAD MODEL



2D CAD DIAGRAM



3D CAD DIAGRAM

DOI: 10.48175/IJARSCT-18091
ISSN 2581-9429 IJARSCT

VII. CONCLUSION

In conclusion, the project successfully examined the process of convertingnon-biodegradable waste into useful products such as table bushes and door handles by adopting a combined technique of mechanical and chemical processes. The shredder machine effectively crushed the plastic materials and the crushed pellets size is approximately 30 mm in length and 20 mm in width. Acetone is used to dissolve PVC-type plastic, and the chemical reaction between acetone and PVC is completed within the expected time period of 2-3 hours. Wooden materialis used as a die because wood does not react with acetone and molten plastic. Theaddition of adhesive materials significantly increases bonding strength, but an excess amount of adhesive is not suitable because it reduces the strength of the final product. Through the utilization of a shredder machine and acetone, this initiative demonstrates the recycling of non-biodegradable materials into valuable products, thereby mitigating the environmental impact of plastic pollution. As anticipated, the expected outcomes were achieved, and the resulting products were successfully tested for hardness, tensile strength, and compression.

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