VISVESVARAYA TECHNOLOGICAL UNIVERSITY

JnanaSangama, Belagavi – 590018

A Project Report
On

"DESIGN AND FABRICATION OF BIODIESELUSING PLASTIC WASTE MATERIAL"

Submitted in partial fulfillment of the requirements as a part of the curriculum,

Bachelors of Engineering in Mechanical Engineering

Submitted by

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CERTIFICATE

Certified that the project work entitled "**Design and Fabrication of Biodiesel using Waste Plastic Material**"is a bonafide work carried out by **Mr. Deepak K S, Mr. Zameer khan badami, Mr. Kashinath, Mr. Rushab S,**bonafide students of **CMR Institute of Technology** in partial fulfillment for of the requirements as a part of the curriculum, **Bachelors of Engineering in Mechanical Engineering,** of **Visvesvaraya Technological University, Belagavi** during the year **2019-20**. It is certified that all correction/suggestion indicated for Internal Assessment have been incorporated in the report deposited in the departmental library. The project report has been approved as it satisfies the academic requirements in respect of the project work prescribed for the bachelor of engineering degree.

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DECLARATION

We, students of Eighth Semester, B.E, Mechanical Engineering, CMR Institute of Technology, declare that the project work titled **"Design and Fabrication of Biodiesel using Waste plastic Material"** has been carried out by us and submitted in partial fulfillment of the course requirements for the award of degree in **Bachelor of Engineering in Mechanical Engineering** of **Visvesvaraya Technological University, Belagavi,** during the academic year 2019-20

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ACKNOWLEDGMENTS

This project work marks the end of an unforgettable journey of obtaining my Master’s degree. I have not travelled in vacuum on this memorable path, and am indebted to many people for making it a great and challenging experience.

I am extremely indebted to my Professor Dr. S .Gopi for accepting to be my internal guide and supporting my thesis. His understanding, encouragement and personal attention instilled in me the confidence to carry out my project work.

I would like to thank Dr. Vijayanand Kaup, Head of Department, Mechanical Engineering, CMR Institute of Technology, for his continuous support and guidance. I am also grateful to Dr. Sanjay Jain, Principal, CMR Institute of Technology for providing the necessary facilities to carry out the project.

It has been an honor to study for 3 years at CMR Institute of Technology, Bangalore, under the guidance of a constant encouraging faculty members. I would like to thank all the faculty and staff of CMR Institute of Technology, Bangalore who helped me throughout the course of my dissertation. Also, I would also like to recognize my fellow graduate students for their constant support and help.

This journey became much simpler and enriching experience when we traveled together. This thesis is the result of all the people who guided and provided constant support when I really needed. Thank you doesn’t seem sufficient but it is said with appreciation and respect to all for their support, encouragement, care and understanding.

ABSTRACT

There is an increase in the production and consumption of plastics as the day go by. All plastics need to be disposed after their usefulness, as waste. The needs to manage this waste from plastic become more apparent. This leads to pyrolysis, which is a way of making to become very useful to us by recycling them to produce fuel oil. In this study, plastic wastes (polyethylene) were used for the pyrolysis to get fuel oil that has the same physical properties as the fuel used in aviation industry. The experiment was carried out in such a way on, thermal pyrolysis (without the aid of a catalyst). Some of the plastics wastes that are suitable for pyrolysis are: HDPF (high density polyethylene).

Thus the problems faced by the increasing in plastic waste and the increasing fuel crisis can be eliminated by making a system which can decrease the pollution due to plastic and increasing the availability of the alternative fuel. This was made by converting the waste plastic into useful alternative oil by means of pyrolysis process.

DESIGN AND FABRICATION OF BIODIESEL USING PLASTIC WASTE MATERIAL

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CHAPTER 1

INTRODUCTION

Plastics are polymeric materials, a material built up from long repeating chains of molecules. Polymers such as rubber occur naturally, but it wasn't until the development of synthetic polymers around 1910 that the polymers tailored to the needs of the engineer first started to appear. One of the first commercial plastics developed was Bakelite and was used for the casting of early radios. Because the early plastics were not completely chemically stable, they gained a reputation for being cheap and unreliable. However, advances in plastic technology since then, mean that plastics are a very important and reliable class of materials for product design.

Plastic is a marvel of polymer chemistry, plastics have become an indispensable part of our daily life. But repeated reprocessing of plastic waste, and its disposal cause environmental problems, pose health hazards, in addition to being a public nuisance. The biggest current threat to the conventional plastics industry is likely to be environmental concerns, including the release of toxic pollutants, greenhouse gas and non-biodegrable landfill impact as a result of the production and disposal of petroleum based plastics.

Waste Scenario

The consumption of plastics have increased from 4000 tons/annum (1990) to 4 million tons/annum (2001)and it is expected to rise 8 million tons/annum during the year 2009.

Nearly 50 to 60% of the total plastics are consumed for packing. Once used plastic materials are thrown out.They do not undergo bio-decomposition. Hence, they are either land filled or incinerated. Both are not ecofriendlyprocesses as they pollute the land and the air.

Waste tyres in India are categorized as solid waste or hazardous waste. It is estimated that about 60% of(retreaded) waste tyres are disposed via unknown routes in the urban as well as rural areas. The hazards ofwaste tyres include- air pollution associated with open burning of tyres (particulates, odour, visual impacts,and other harmful contaminants such as polycyclic aromatic hydrocarbon, dioxin, furans and oxides of nitrogen), aesthetic pollution caused by waste tyre stockpiles and illegal waste tyre collecting and otherimpacts such as alterations in hydrological regimes when gullies and watercourses become waste sites.

Biodiesel Background

Biodiesel is a fuel derived from vegetable oils or animal fats that can be used either as a replacement for petroleum diesel or blended with petroleum diesel for use in a standard diesel engine. Diesel engines were originally designed to run on strait vegetable oil (SVO) but, during the 20th century, petroleum diesel fuel became more readily available and economical as a fuel source for diesel engines. Modern diesel engines are designed to operate on diesel fuel and not SVO. Biodiesel is produced from a chemical reaction between a vegetable oil (and an animal fat), an alcohol, and a catalyst.

Biodiesel

Biodiesel quality depends on the inputs and processing techniques used in its production.Most small scale producers will be limited to producing biodiesel for personal use. Unfortunately for small scale producers, the cost of testing a batch biodiesel is likely to exceed the value of the fuel produced.

Biodiesel Extraction Processes

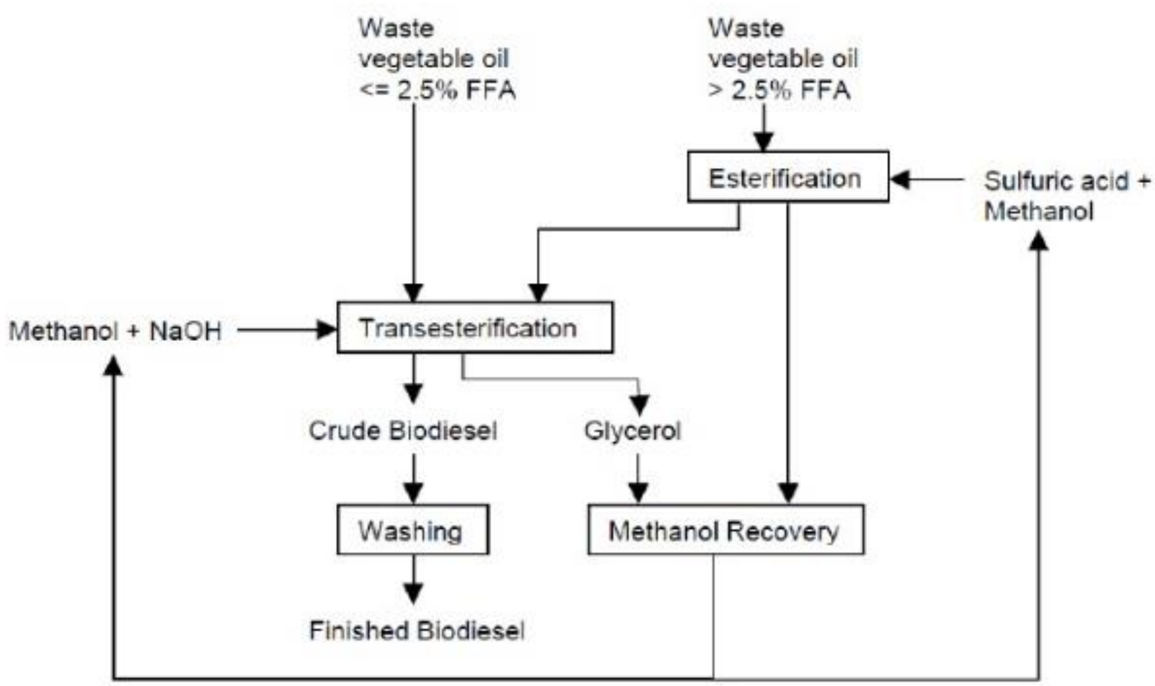

Figure. Process flow chart

Plastics are inexpensive, lightweight, strong, durable, corrosion-resistant materials, with high thermal and electrical insulation properties. The diversity of polymers and the versatility of their properties are used to make a vast array of products that bring medical and technological advances, energy savings and numerous other societal benefits. As a consequence, the production of plastics has increased substantially over the last 60 years from 0.5 million tonnes in 1950 to over 260 million tonnes today. In Europe alone the plastics industry has a turnover in excess of 300 million euros and employs 1.6 million people. Almost all aspects of daily life involve plastics, in transport, telecommunications, clothing, footwear and as packaging materials that facilitate the transport of a wide range of food, drink and other goods. There is considerable potential for new applications of plastics that will bring benefits in the future, for example as novel medical applications, in the generation of renewable energy and by reducing energy used in transport.

Some plastics wastes are suitable for pyrolysis such as: HDPE (high density polyethylene), LDPE (low density polyethylene), polypropylene' polystyrene' polyvinyl alcohol, polyoxy-methylene, polyamide, polyurethane, polyphenylene, polyvinyl chloride etc. But for tire pupose of this study low density polyethylene (LDPE) was used since it is.

Commonly found littered around our environment' Polyethylene is an excellent source of hydrocarbon products. It is highly resistant to thermal degradation, requiring a temperature of above 400oC in order to exhibit sufficiently high degradation rates. The high temperature causes the loss of selectivity, increased secondary reactions, coke formations and reduced catalyst life.

Waste management is a common problem for both developed and developing countries, because of the fact that as the population increases, the quantity of waste generated also increases. Waste collection, segregation and disposal have been a long-standing unresolved problem and will remain a problem in the future if there is no initiative made to solve it. Mismanagement of waste will result to serious environmental problems such as surface and ground water contamination, flooding, air pollution and climate change. Tanaka said that with the growing Philippine population and high economic growth expected in the coming years, the amount of solid waste to be managed is increasing on an alarming rate. Westfall M.S. and Allen N. (2004) noted that in Metro Manila alone, some 1500 tons daily is dumped illegally on private land, rivers, and creeks or openly burned, adding to heavily polluted air. Knoblauch, A. J. (2009) reported that plastic production and disposal contribute to an array of environmental problems. Chemicals added to plastics are absorbed by human bodies. Some of the compounds have been found to alter hormones or have other potential human health effects. Plastic debris, laced with chemicals and often ingested by marine animals, can injure or poison wildlife. Floating plastic wastes, which can survive for thousands of years in water, serve as mini transportation devices for invasive species, disrupting habitats. Plastic buried deep in landfills can leach harmful chemicals that spread into groundwater. Although the impact of waste plastic to our health and environment may not always cause noticeable harm or destruction, research indicates that plastic waste in landfill and in badly managed recycling systems could be having an impact from the chemicals contained in the plastic. Plastic is generally derived from petroleum and when placed in landfills becomes carbon sink and if incinerated it increases carbon emissions. Since incineration is less accepted and the cost of state-of-the-art landfill facility is unaffordable, finding economically feasible and environment friendly means of waste recycling and reduction is challenging. The researcher came up with the idea to design and fabricate a device that can be used in turning waste plastics into a resource. The waste plastic oil converter employs the pyrolysis method of converting waste plastics into oil. The advantage of pyrolysis over landfill and incineration is in terms of environmental protection because it reduces the risk of air, water and soil pollution. In pyrolysis, the possibility of recycling is improved, because the resulting product such as gas and liquid can be used as combustible fuel to substitute fossil fuels.

Energy is defined as the ability to produce change or do work and that work can be divided into several main tasks. Energy is the main way for growth of economical development. From the present point of view we can see that a country economically successful if it utilize its own reserve of renewable and nonrenewable source of energy. Energy from Waste offers a Pyrolysis technology, which has the ability to produce a clean, high calorific value fuel gas from a wide variety of waste and biomass streams. Pyrolysis for energy conversion from carbonaceous wastes is defined as the thermal degradation of organic matter either in total absence of air or with a lack of a stochiomtrically needed amount of oxygen to the extent where gasification does not occur. In this thesis waste plastic is taken into consideration. Because every year a great amount of plastic is manufacture as the same amount plastic waste is produced. Plastic has great negative impacts on environment. Plastic is mainly made from petroleum, it is estimated that 7% of the world's annual oil production is used to produce and manufacture plastic.

Plastics

As a brief introduction to plastics, it can be said that plastics are synthetic organic materials

produced by polymerization. They are typically of high molecular mass, and may contain other substances besides polymers to improve performance and/or reduce costs. These polymers can be molded or extruded into desired shapes.

There are two main types of plastics: thermoplastics and thermosetting polymers.

Thermoplastics can repeatedly soften and melt if enough heat is applied and hardened on cooling, so that they can be made into new plastics products. Examples are polyethylene, polystyrene and polyvinyl chloride, among others.

Thermosets or thermosettings can melt and take shape only once. They are not suitable for repeated heat treatments; therefore after they have solidified, they stay solid. Examples are phenol formaldehyde and urea formaldehyde.

Target Waste Plastics

Waste plastics are one of the most promising resources for fuel production because of its high
heat of combustion and due to the increasing availability in local communities. Unlike paper and wood, plastics do not absorb much moisture and the water content of plastics is far lower than the water content of biomass such as crops and kitchen wastes. The conversion methods of waste plastics into fuel depend on the types of plastics to be targeted and the properties of other wastes that might be used in the process. Additionally the effective conversion requires appropriate technologies to be selected according to local economic, environmental, social and technical characteristics.

In general, the conversion of waste plastic into fuel requires feedstocks which are non-hazardous and combustible. In particular each type of waste plastic conversion method has its
own suitable feedstock. The composition of the plastics used as feedstock may be very different and some plastic articles might contain undesirable substances (e.g. additives such as flame-retardants containing bromine and antimony compounds or plastics containing nitrogen, halogens, sulfur or any other hazardous substances) which pose potential risks to humans and to the environment. The types of plastics and their composition will condition the conversion process and will determine the pretreatment requirements, the combustion temperature for the conversion and therefore the energy consumption required, the fuel quality output, the flue gas composition (e.g. formation of hazardous flue gases such as NOx and HCl), the fly ash and bottom ash composition, and the potential of chemical corrosion of the equipment,

Types of Plastics:

The problems of waste plastics can‘t be solved by land filling or incineration, because the safety deposits are expensive and incineration stimulates the growing emission of harmfulgreenhouse gases like COx, NOx, SOx and etc. These types of disposal of the waste plastics release toxic gas which has negative impact on environment. Plastic wastes can also classified as industrial and municipal plastic wastes according to their origins, these groups have different qualities and properties and are subjected to different management strategies. Plastic wastes represent a considerable part of municipal wastes furthermore huge amounts of plastic waste arise as a by-product or faulty product in industry and agriculture. The total plastic waste, over 78% weight of this total corresponds to thermoplastics and the remaining to thermosets. Thermoplastics are composed of polyolefins such as polyethylene, polypropylene, polystyrene and polyvinyl chloride and can be recycled.

1. **Municipal Plastic Wastes:**

Municipal plastic wastes (MPW) normally remain a part of municipal solid wastes as they are discarded and collected a household wastes. The various sources of MPW plastics includes domestic items (food containers, milk covers, water bottles, packaging foam, disposable cups, plates, cutlery, CD and cassette boxes. fridge liners, vending cups, electronic equipment cases, drainage pipe, carbonated drinks bottles, plumbing pipes and guttering, flooring. cushioning foams, thermal insulation foams, surface coatings, etc.), agricultural (mulch films, feed bags, fertilizer bags, and in temporary tarpaulin-like uses such as covers for hay, silage, etc.), wire and cable, automobile wrecking, etc. Thus, the MPW collected plastics waste is mixed one with major components of polyethylene, polypropylene, polystyrene, polyvinyl chloride, polyethylene terephthalate, etc. The percentage of plastics in MPW has increased significantly.

2. **Industrial Plastic:**

Wastes Industrial plastic wastes are those arising from the large plastics manufacturing, processing and packaging industry. The industrial waste plastic mainly constitute plastics from construction and demolition companies (e.g. polyvinylchloride pipes and fittings, tiles and sheets) electrical and electronics industries (e.g. switch boxes, cable sheaths, cassette boxes, TV screens, etc.) and the automotive industries spare-parts for cars, such as fan blades, seat coverings, battery containers and front grills). Most of the industrial plastic waste has relatively well physical characteristics i.e. they are sufficiently clean and free of contamination and are available in fairly large quantities.

CLASSIFICATION OF PLASTICS:

Plastics are classified into two types, they are

1) High-density polyethylene

2) Low-density polyethylene

1) High-density polyethylene:

Polypropylene and polystyrene. Also, plastics are classified by their chemical structure of the polymer's backbone and side chains. Some important groups in these classifications are the acrylics, polyesters, silicones, polyurethanes, and halogenated plastics. Plastics can also be classified by the chemical process used in their synthesis, such as condensation, poly addition, and cross-linking.

2) Low-density polyethylene:

Low-density polyethylene (LDPE) is used for its toughness, flexibility, and relative transparency. LDPE is used to make bottles that require extra flexibility. To take advantage of its strength and toughness, it is used to produce grocery bags and garbage bags, squeezable bottles, shrink wrap, stretch films, and coating for milk cartons. It can also be found in toys, container lids, and packaging. Polypropylene (PP) is known for its high melting point, which makes it ideal for holding hot liquids that cool in the bottles (for example, ketchup and syrup). It can be manufactured to be flexible or rigid. PP is used to make containers for yogurt, margarine, takeout meals, and deli foods. It is also use for medicine bottles, bottle caps, and some household items.

In this project work pyrolysis method is used to convert household plastic wastes like food containers, milk covers, water bottles, packaging foam, and waste cooking oil cover. Nearly 15 tonnes of plastic cover is wasted in single village. This waste plastic cover is also used in Belagavi, dharawad, hubli, vijayapur, karwar district‘s etc. for the period of 4 months that will leads to mass plastic waste. This highest portion of plastic is disposed to landfill. By survey nearly 150 tonnes to 200 tonnes of plastic cover is disposed into land in single district. By estimating 5000 tonnes to 6000 tonnes of plastic will be wasted from household sources in the state. Waste plastics have been shredded then washedbefore pyrolysis.From above factors from municipal plastic waste havebeen used as raw materials.Waste plastics have been washed before pyrolysis. In this work milk plastic cover and edible oil covers are selected as feed stocks to convert waste plastic into useful liquid fuel compounds.

Fig. Raw Materials Used To Produce Liquid Fuel

- **Plastic Pyrolysis oil:**

Pyrolysis is a thermo chemical decomposition of organic material at elevated temperatures in the absence of oxygen (or any halogen). It involves the simultaneous change of chemical composition and physical phase, and is irreversible. The word is coined from the Greek-derived elements pyro "fire" and lysis "separating".

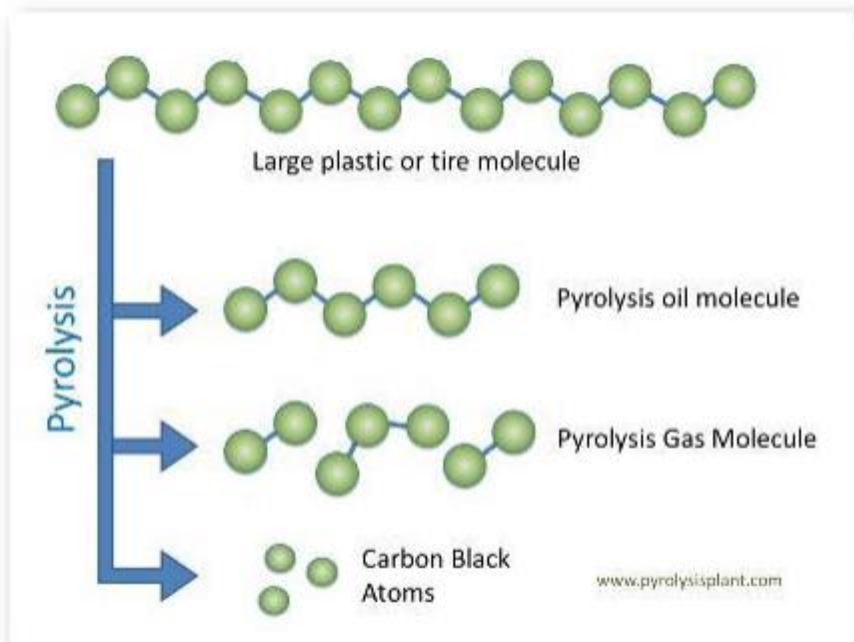

Fig. Breaking of Hydrocarbon chain in Pyrolysis Process

Pyrolysis differs from other high-temperature processes like combustion and hydrolysis in that it usually does not involve reactions with oxygen, water, or any other reagents. In practice, it is not possible to achieve a completely oxygen-free atmosphere. Because some oxygen is present in any pyrolysis system, a small amount of oxidation occurs. Bio-oil is produced via pyrolysis, a process in which biomass is rapidly heated to 450–500°C in an oxygen-free environment and then quenched, yielding a mix of liquid fuel (pyrolysis oil), gases, and solid char. Variations in the pyrolysis method, biomass characteristics, and reaction specifications will produce varying percentages of these three products. Several technologies and methodologies can be used for pyrolysis, including circulating fluid beds, entrained flow reactors, multiple hearth reactors, or vortex reactors. The process can be performed with or without a catalyst or reductant.

1.1 PROBLEM STATEMENT:

1. Design and fabricate a device that can be used in turning waste plastics into a resource.
2. Also to fabricate the model of the same which would able to show the characteristics of the systems working according to need.
3. Design and develop a prototype model of showing the concept of waste management which will show the working of application of plastic waste material.

1.2 OBJECTIVE

This project attempts to show how human has been utilizing the energy and explore prospects of optimizing the same one of the alternative fuels is household plastic waste oil.Fuel obtained from pyrolysis process shows nearly same properties as that of diesel fuel. So we can use plastic oil as alternative fuel.

The objectives of this project are given below.

1. To collect the household plastic waste from different places.
2. Drying and Storing of plastic waste.
3. To develop and fabricate the pyrolysis unit to produce liquid fuel from plastic waste.
4. Conversion of household plastic waste in to liquid fuel.
5. To purify the produced liquid fuel by water washing method.
6. To conduct the different experiments to determine the different properties of liquid fuel.
7. Compare the properties of liquid fuel with diesel fuel.

1.3 METHODOLOGY:

Design concept generation refers to the actual conceptual design where the design concept is an approximate description of the technology, working principles and form of the product. It has a detailed description on how the product will satisfy and meet customer requirements. Existing design constraints may even be solved by having a good development in the design concept.

For this project, many alternative concepts have been generated. The various generated concepts were then individually evaluated to find the most appropriate concept for the product. The concepts that gave the most advantages were considered as the best concept and a waits further evaluation. The product sketch for the chosen concept was further drafted.

Design concept generation is usually expressed in the form of sketches or rough 3-D model sand often accompanied by a brief textual description for the overall design concepts.

- Literature review
- Identification of the problem
- Finding solution of the problem
- Data collection
- Design of product
- Market survey for required components
- Purchase of required components system
- Manufacturing and assembly
- Testing and experimentation.
- Evolution of result of the project.

CHAPTER 2

LITERATURE REVIEW

2.1 Design, Fabrication and Performance Study of a Plastic Waste to Oil Converter

Asma-Ul-Husna

Pyrolysis is one of the most important thermo chemical energy conversion methods for renewable energy sources. In this paper the conversion of waste Plastic/Polythene into pyrolytic oil by air tight reactor has been taken into consideration. The raw and crack plastic particle was pyrolized in an electrically heated 7.5 cm diameter and 18 cm high air tight reactor with nitrogen as a carrier gas. The reactor was heated by using electric heater. The parameters varied were running time and feed particle size. The different temperatures were found to influence the product significantly. The maximum liquid yield was 66 wt% at 3500 C for a feed size of 3 cm2 at a Nitrogen gas flow rate of 2 liter/min with a running time of 40 minutes. The pyrolysis oil obtained at these optimum process conditions was analyzed for some of its properties as an alternative liquid fuel.

A Plastic material is any of a wide range of synthetic or semi-synthetic organic solids used in the manufacture of industrial products. Plastic are typically polymers of high molecular mass, and may contain other substances to improve performance and reduce production cost. Monomers of plastic are either natural of synthetic organic compounds [4]. The word plastic is derived from the Greek word “Plastikos” meanings capable of being shaped or molded. There are mainly two types of plastics: Thermoplastic and Thermosetting polymers. Thermoplastics are the plastics that do not undergo chemical change in their composition when heated and can be molded again and again. Examples include polypopylne, polystyrene, polyvinyl chloride and polytetrafluooethylene (PTFE) [5]. Thermosets can melt and take shape once; after they have solidified, they stay solid. In the thermosetting process, a chemical reaction occurs that is irreversible. Polythylene is classified into several different categories based mostly on its density and branching. The mechanical properties of PE depend significantly on variables such as the extent and type of branching, the crystal structure and the molecular weight [6]. Such as- Ultra high molecular weight polyethylene (UHMWPE), High density polyethylene (HDPE), Linear low density polyethylene (LLDPE), Medium density polyethylene (MDPE), Low density polyethylene (LDPE) etc.

Environmental impact of plastic waste Due to their insolubility in water and relative chemical inertness, pure plastics generally have low toxicity. Some plastic products contain a variety of additives, some of which can be toxic. For example, plasticizers like adipates and phthalates are often added to brittle plastics like polyvinyl chloride to make them pliable enough for use in food packaging, toys, and many other items. Traces of these compounds can leach out of the product. Owing to concerns over the effects of such lactates, the European Union has restricted the use of DEHP (di-2- ethylhexyl phthalate) and other phthalates in some applications. Some compounds leaching from polystyrene food containers have been proposed to interfere with hormone functions and are suspected human carcinogens. Whereas the finished plastic may be non-toxic, the monomers used in the manufacture of the parent polymers may be toxic. In some cases, small amounts of those chemicals can remain trapped in the product unless suitable processing is employed. For example, the World Health Organization's International Agency for Research on Cancer (IARC) has recognized that vinyl chloride, the precursor to PVC, as a human carcinogen [7]. Beside this

- Plastic are durable and degrade very slowly.
- Burning plastic can release toxic fumes and large amount of CO_2.
- The harmful chemical pollutants are responsible for the depletion of the Ozone layer. y Plastic trash is polluting the oceans and washing up on beaches.
- Reducing fertility of soil.

Electric heater heated the reactor, which is full with well cracked waste plastic particle. Stainless steel nut-bolt, gasket paper and liquid gasket shield is used make it air tight. The produce gas is passes from reactor to water container through a copper pipe. The gas is escape in the water and condensed. The liquid is stored as a layer on the surface of the water. The oil is collected by a tap using gravitational force. The nitrogen gas is used as a carrier gas and it also produce an inert environment within the reactor.

Limitations of this system

1. The range of the thermometer is 360˚C.
2. To avoid the leakage stainless steels nut bolt is used.
3. The thermometer must be fixed with the flange.
4. Gasket sheet with liquid gasket cement must be used.
5. Prevention of the leakage is the main challenge in this setup.
6. For tire waste feed material the condensing system is not enough.

2.2 Converting Waste Plastics into a Resource:

This compendium of technologies aims to present an overview of the technologies available for converting waste plastics into a resource. It emphasizes the typical methods for converting waste plastics into solid, liquid and gaseous fuels as well as the direct combustion of waste plastics for specific applications.

As a brief introduction to plastics, it can be said that plastics are synthetic organic materials produced by polymerization. They are typically of high molecular mass, and may contain other substances besides polymers to improve performance and/or reduce costs. These polymers can be molded or extruded into desired shapes. There are two main types of plastics: thermoplastics and thermosetting polymers.

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2.3 Catalytic applications of waste derived materials

James A. Bennett :

Waste biomass has been increasingly targeted as a renewable feedstock for the production of fuels2–4 and more recently platform chemicals.5 Although by definition required in small amounts, the cost of the catalyst in a given process is potentially one of the most significant expenses, particularly in a process using waste biomass as starting material.6 Using waste material to generate the catalyst in addition to the target product makes the system more cost effective and environmentally friendly. There are an increasing number of reports of the preparation of heterogeneous catalysts from waste materials. The nature of the waste source affects the properties of the resulting catalyst, and therefore catalysts for a given application are often made from similar groups of materials. This review will summarise the aforementioned reports from the literature, with the various catalysts being classified by application. The synthesis of heterogeneous catalysts from waste materials has become increasingly popular over the past two decades. Most reports utilise abundant waste streams generated on the millions to hundreds of millions of tonnes per annum scale, which is important if catalysts obtained from them are to be utilised in major industrial processes. Amongst the most abundant resources are waste biomass from agriculture (inedible crops7 and animal parts8), sewage,9 mining and metal fabrication,10 in particular the iron and steel industry.11 Aside from generating highly active, selective and stable catalysts, a suitable waste stream should be simple and safe to collect, and its use for the purpose of catalyst manufacture should raise no ecological concerns. Any collection or handling costs must be factored into catalyst production costs, and will reduce the benefits of such a waste derived product. Consumption of waste materials is highly advantageous where there are existing financial or environmental costs associated with their disposal, as these may be alleviated or negated by its diversion to a valuable catalyst product. Sustainability of the waste stream must also be considered, for example food waste is likely to be generated at ever rising levels due to global population growth,12–14 whereas future technological developments and changes in regulations/legislation (e.g. EU Waste Framework Directive15) may downscale certain process, diminishing the scale of waste they generate. Waste stream valorisation through utilisation as a raw material must not encourage or justify an increase in the rate of its generation, as this is clearly in conflict with the goals of green chemistry.

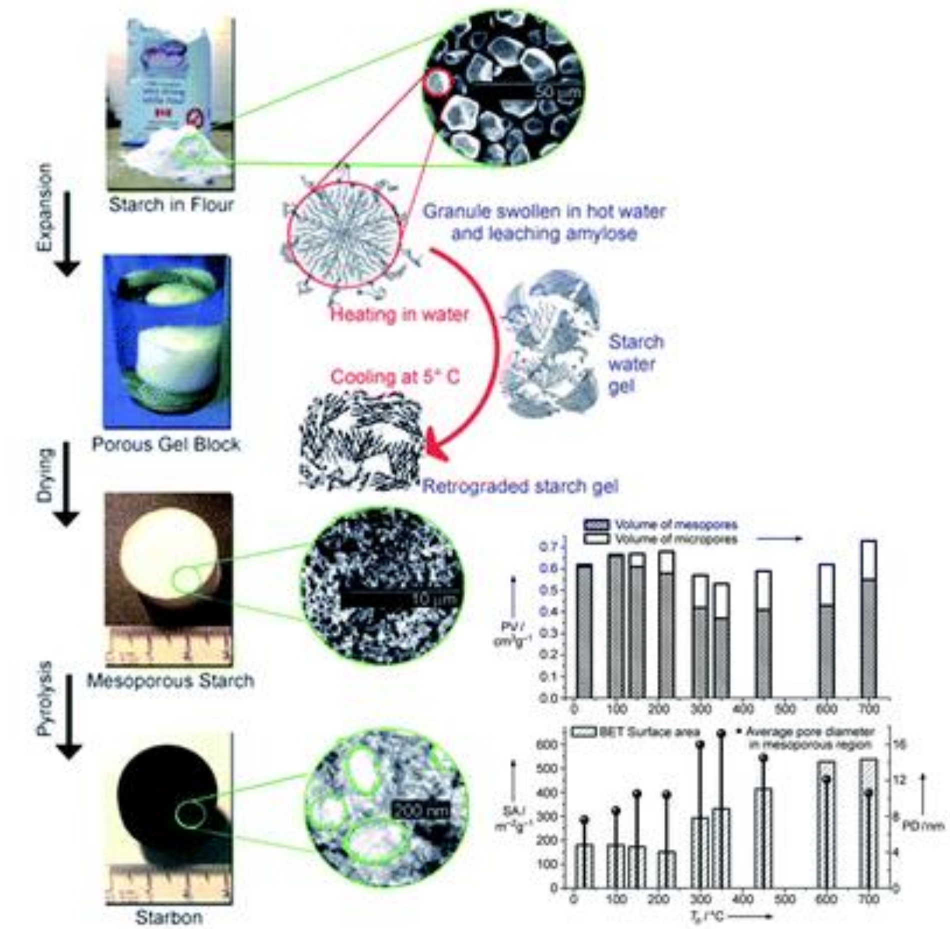


Fig. Preparation and surface properties of mesoporous Starbons

2.4 Design and Characterization of a Model Polythene Recycling Machine for Economic Development and Pollution Control in Nigeria

Gbasouzor Austine Ikechukw:

Consequent on the environmental degradation caused by the littering of polythene materials in our cities, a polythene-recycling machine was designed and constructed. The machine melts washed polythene products of various sizes and shapes, and pelletized them for industrial use. The machine was designed to convey polythene materials used as satchels, bags or sheets, feed through a hopper and transferred to the hot zone through a screw conveyor chamber. The screw conveyor was driven by an electric motor that turns or rotates at a predetermined speed. The hot zone was heated with a resistance heating element and the heat being controlled or regulated by a thermocouple. When the polythene material gets to the hot zone which was maintained at 200°c (within the temp range of 150 -300°c) Khanna, O.P. (2005,) it is melted or softened. The resulting soft material-was extruded through the orifice or die at the end of the chamber. The out-feed product was collected as raw materials for the plastic industry.

The twentieth century has witnessed a tremendous advancement in the polythene manufacturing industries and products. Babajide (2004) stressed that on the introduction of structural Adjustment Programme (SAP) by the Babangida administration, many Nigerians looked inwards for opportunities of self employment and wealth generation. On the heels of this self-reliance,, government spearheaded in the lead by setting up a number of agencies to either provide the platform for the actualization of individual selfemployment programme or provide basic infrastructure in that direction. Chief among such agencies were the National Directorate of Employment (NDE) and the Directorate of Foods, Roads and Rural Infrastructure (DFRRl). Nigerians responded quickly and embraced these government policies. One area that was found fertile in entrepreneurship was the manufacturing of polythene, especially those used for the packaging of goods. In no distance future much success was recorded to the extent that food items such as eba, moi-moi, pounded yam, etc which were wrapped in leaves, were now wrapped in "plastic". Gbasouzor Austin Ikcchukwu is a PhD researcher and Lecturer in the Department of Mechanical Engineering, Anambra State University, P. M. B. 02 Uli. Nigeria, E-mail: unconditionaldivineventure@yahoo.com Phone: 2348034247458. 2348063896067. 2348028283035 Owuama Keneddy Chinedu is a PhD researcher and Lecturer in the Department of Mechanical Engineering, Anambra State University, P. M. B. 02 Uli. Nigeria. Ekwuozor S.C is a senor Lecturer in the Department of Industrial and Production Engineering, Nnamdi Azikiwe University, Awka Again, cold water business for the thirsty transit passengers developed. This gave rise to iced water which was first wrapped in transparent plastic bags for sale. Later on the enterprise went several rungs up the ladder, and the "pure water" industry emerged. The business became completely stabilized with the National Agency for Food and Drug Administration and Control (NAFDAC) endorsement. Alongside the transparent polythene are the black polythene shopping bags generally known as "poly bags", made in various sizes and thickness. The resulting effect of these polythenes put into use is that virtually all our villages, towns and cities are littered with both used and unused polythene bags. Okonkwo and Eboatu (1999) however emphasized that the concern here is about the nature of these polythene products, which science has proved to be nonbiodegradable. That means that these plastic bags and wrappers remain where they are dropped, choking our soil, and suffocating our environment. The implication is that ground water which gets to the surface by capillary action is blocked by the plastic product which has serious implication on agricultural activities. Furthermore, our poor refuse disposal habits gave room for “pure water” bags and other plastic products to be dumped just anywhere. This accounts for much of the blockage in gutters in the cities which in turn causes flooding that wash away our roads, pull down structures and cause other environmental problems.

2.5 Use of Waste Plastic and Waste Rubber Tyres in Flexible Highway Pavements

Rokade S:

Plastics are user friendly but not eco-friendly as they are non-biodegradable. Generally it is disposed by way of land filling or incineration of materials which are hazardous. The better binding property of plastics in its molten state has helped in finding out a method of safe disposal of waste plastics, by using them in road laying. Modified Bitumen is one of the important construction materials for flexible pavements. Use of plastic waste (LDPE) and Crumb Rubber i.e. the rubber obtained from the waste tyres of vehicles, in the construction of flexible pavement is gaining importance. It is also worth mentioning that, the modifier raw-material has been sourced from disposed waste plastic and crumb rubber. This not only allows us to collect modifier rawmaterial at low cost, but also provides a solution towards ecological menace posed by increased use of plastics (non-biodegradable). In the present study, an attempt has been made to use waste plastic, Low Density Polyethylene (LDPE) and Crumb Rubber, blended using dry process for LDPE and wet process for CRMB. Marshal method of bituminous mix design was carried out for varying percentages of LDPE and Crumb Rubber to determine the different mix design characteristics. In India, it is estimated that over 33 lakh kilometers of road exists. The road transport carries close to 90% of passenger traffic and 70% of freight transport. Investigations in India and countries abroad have revealed that properties of bitumen and bituminous mixes can be improved to meet requirements of pavement with the incorporation of certain additives or blend of additives. These additives are called "Bitumen Modifiers" and the bitumen premixed with these modifiers is known as modified bitumen. Modified bitumen is expected to give higher life of surfacing (up to 100%) depending upon degree of modification and type of additives and modification process used. Different types of modifiers used are Polymers, Natural Rubber and Crumb Rubber.

Waste Scenario:

The consumption of plastics have increased from 4000 tons/annum (1990) to 4 million tons/annum (2001) and it is expected to rise 8 million tons/annum during the year 2009. Nearly 50 to 60% of the total plastics are consumed for packing. Once used plastic materials are thrown out. They do not undergo bio-decomposition. Hence, they are either land filled or incinerated. Both are not ecofriendly processes as they pollute the land and the air. Waste tyres in India are categorized as solid waste or hazardous waste. It is estimated that about 60% of (retreaded) waste tyres are disposed via unknown routes in the urban as well as rural areas. The hazards of waste tyres include- air pollution associated with open burning of tyres (particulates, odour, visual impacts, and other harmful contaminants such as polycyclic aromatic hydrocarbon, dioxin, furans and oxides of nitrogen), aesthetic pollution caused by waste tyre stockpiles and illegal waste tyre collecting and other impacts such as alterations in hydrological regimes when gullies and watercourses become waste sites.

2.6 USE OF PLASTIC WASTE IN FLEXIBLE PAVEMENTS

Miss Apurva J Chavan:

Disposal of waste materials including waste plastic bags has become a serious problem and waste plastics are burnt for apparent disposal which cause environmental pollution.

Utilization of waste plastic bags in bituminous mixes has proved that these enhance the properties of mix in addition to solving disposal problems. Plastic waste which is cleaned is cut into a size such that it passes through 2-3mm sieve using shredding machine. The aggregate mix is heated and the plastic is effectively coated over the aggregate. This plastic waste coated aggregate is mixed with hot bitumen and the resulted mix is used for road construction. The use of the innovative technology will not only strengthen the road construction but also increase the road life as well as will help to improve the environment. Plastic roads would be a boon for India’s hot and extremely humid climate, where temperatures frequently cross 50°C and torrential rains create havoc, leaving most of the roads with big potholes. In my research work I have done a thorough study on the methodology of using plastic waste in bituminous mixes and presented the various tests performed on aggregates and bitumen.

A material that contains one or more organic polymers of large molecular weight, solid in its finished state and at some state while manufacturing or processing into finished articles, can be shaped by its flow, is called as ‘Plastic’. Plastics are durable and degrade very slowly; the chemical bonds that make plastic so durable make it equally resistant to natural processes of degradation. Plastics can be divided in to two major categories: thermoses and thermoplastics. A thermoset solidifies or “sets” irreversibly when heated. They are useful for their durability and strength, and are therefore used primarily in automobiles and construction applications.

CHAPTER 3
SYSTEM DESCRIPTION

What is plastic ?

The term “plastics” includes materials composed of various elements such as carbon, hydrogen, oxygen, nitrogen, chlorine, and sulphur. Plastics are macromolecules, formed by polymerization and having the ability to be shaped by the application of reasonable amount of heat and pressure or any other form of forces. It is one of the few new chemical materials which pose environmental problem. Polyethylene, polyvinyl chloride, polystyrene is largely used in the manufacturing of plastics.

Why do we need to convert waste plastic into fuel?

• According to a recent study performed by the Environmental Protection Agency (EPA) approximately billion of tons of waste plastic are generated in the world every year.

• Statistics show that approximately 10% of this plastic is recycled, 25% is incinerated and the remaining 65% is dumped in landfills.

• The cost of waste plastic management is around $2800/ton of waste plastics.

• Incineration is an alternative to landfill disposal of plastic wastes, but this practice could result in the formation of unacceptable emissions of gases such as nitrous oxide, sulfur oxides, dusts, dioxins and other toxins.

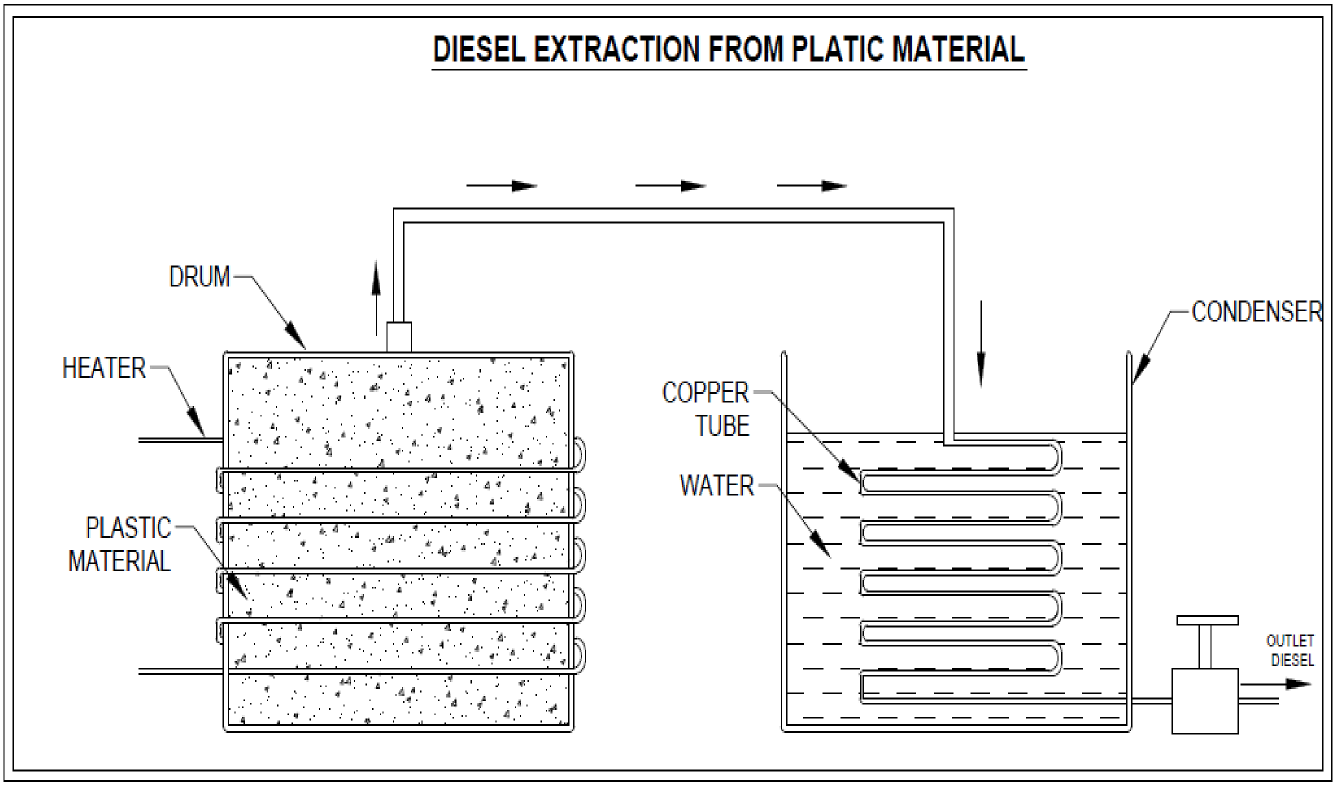
• The option of secondary recycling or mechanical recycling, which is the reprocessing of plastic waste into new plastic products with a lower quality level, is not showing any signs of growth in the recycling industry

• The method of converting the polymers present in the waste plastics into Fuel.

Selection of plastic:

Resin	Thermo Fuel system suitability
Polyethylene (PE)	Very good
Polypropylene PP)	Very good
Polystyrene (PS)	Very good (gives excellent fuel properties).
ABS resin (ABS)	Good. Requires off-gas counter measure
Polyvinylchloride (PVC)	Not suitable, should be avoided.
Polyurethane (PUR)	Not suitable, should be avoided
Fiber Reinforced Plastics (FRP)	Fair. Pre-treatment required to remove fibers.
PET	Not suitable, should be avoided.

3.1 WORKING DIAGERAM



3.2 WORKING PRINCIPLE

In our experiments, commercialize available shredded plastics were procured and washed before pyrolysis. One of the most favorable and effective disposing method is pyrolysis, which is environmental friendly and efficient way. Pyrolysis is the thermal degradation of solid wastes at high temperatures (300-900nC) in the absence of air (and oxygen). As the structure of products and their yields can be considerably modified by catalysts, results of pyrolysis in the absence of catalyst were presented in this article Pyrolysis of waste plastics was carried out in an indigenously designed and fabricated reactor. Fig shows the scheme of the process involved in the experiments. Waste plastics had been procured form the commercial source and stored in a raw material storage unit. Raw material was then fed in the reactor and heated by means of electrical energy. The yield commenced at a temperature of 350^0C. The gaseous products resulting from the pyrolysis of the plastic wastes is supplied through the copper tube. Then the burned plastic gas condensed in a water cooled condenser to liquid fuel and collected for experiments.

Steps involved in process:

Feeding- Feed the feedstock‘s to reactor through feeder and closes the feeder inlet.

Heating- To increase the temperature of reactor, heat the product of reactor inside by using heating source.

Condensing- The plastic get evaporated at high temperature, this vapor is condensed to atmospheric temperature by using straight and spiral tube condensers.

Figure 3: Condensing

Liquid collection-Out coming product from the condenser is collected at liquid collector. At the end of condenser provide a cyclone separator to separate the plastic liquid fuel and noncondensible gases. These noncondensible gases are reuses to heat the pyrolysis unit.

Water wash, Purification and pH test- This involves many purification processes. In this method we take equal proportion of plastic fuel and water in a container and shake well, allow it for 5-7 hours to settle down. Now water along with some crystals is collected at bottom and pure plastic fuel is collected at the top container.

3.3. MAIN DEVICES USED IN THE PROCESS:

HEATING COIL:

Electric heating is a process in which electrical energy is converted to heat. Common applications include space heating, cooking, water heating and industrial processes. An electric heater is an electrical device that converts electric current to heat.The heating element inside every electric heater is an electrical resistor, and works on the principle of Joule heating: an electric current passing through a resistor will convert that electrical energy into heat energy. Most modern electric heating devices use nichrome wire as the active element; the heating element, depicted on the right, uses nichrome wire supported by ceramic insulators.

Fig. heating coil

NiCrome (nichrome) Wire can be obtained by purchasing a "heating spiral" from an electrical contractor, the one illustrated at right is rated at 1 KW (on a 230v supply) and cost £3.99 in 2001. It is in the form of a tightly wound spiral shown in the inset at left.

Heating Spiral Close Up

Before we can make use of it it requires to be straightened... It is tough stuff, but this can be achieved by placing one end in a vice and by pulling and curling using a round hardwood dowel and industrial gloves. This removes the waviness from the original spiral and the curved shape that results will not hinder the rest of the process.

The NiCrome wire needs about 4 amps flowing to get red hot, but the voltage will only be in the one volt region for a single turn coil (I describe on a separate page the making of a suitable transformer) multiple turn coils of thinner wire can be heated from a 12 volt battery, or a battery charger, or battery under charge.The form of the coil affects the shape of the finished tip. The number of turns, the overall diameter, arrangement of turns all have an effect. In addition, tubular shields can be positioned coaxially between glass tube and coil so as to mask some of the heat from the glass.Single turn coil with brass tube support wires that are arranged at the same spacing as the pitch of the electrical connectors. The coil illustrated is about 8 mm ID.

Additional electrical connectors fitted to extended brass tubes can also be used as a 'plug and socket' arrangement for interchanging the coils, with the added rigidity helping to preserve the coils which tend to become brittle with use.Electrical Connector BlockMelamine Connector Block. The connections to the coil can be made via a "chocolate block" connector (the white one). This is so called as they are usually supplied as a strip of twelve and can be cut to length simply with a knife. The near right version is made of hard thermosetting plastic that can be parted using a hacksaw and this type is more resistant to the high temperatures that we will encounter.

CONDENSER:

In systems involving heat transfer, a condenser is a device or unit used to condense a substance from its gaseous to its liquid state, by cooling it. In so doing, the latent heat is given up by the substance and transferred to the surrounding environment. Condensers can be made according to numerous designs, and come in many sizes ranging from rather small (hand-held) to very large (industrial-scale units used in plant processes). For example, a refrigerator uses a condenser to get rid of heat extracted from the interior of the unit to the outside air. Condensers are used in air conditioning, industrial chemical processes such as distillation, steam power plants and other heat-exchange systems. Use of cooling water or surrounding air as the coolant is common in many condensers.

Applications:

1.Air cooled – If the condenser is located on the outside of the unit, the air cooled condenser can provide the easiest arrangement. These types of condensers eject heat to the outdoors and are simple to install. Most common uses for this condenser are domestic refrigerators, upright freezers and in residential packaged air conditioning units. A great feature of the air cooled condenser is they are very easy to clean. Since dirt can cause serious issues with the condensers performance, it is highly recommended that these be kept clear of dirt.

2.Water cooled – Although a little more pricey to install, these condensers are the more efficient type. Commonly used for swimming pools and condensers piped for city water flow, these condensers require regular service and maintenance. They also require a cooling tower to conserve water. To prevent corrosion and the forming of algae, water cooled condensers require a constant supply of makeup water along with water treatment. Depending on the application you can choose from tube in tube, shell and coil or shell and tube condensers. All are essentially made to produce the same outcome, but each in a different way.

3.Evaporative – While these remain the least popular choice, evaporative condensers can be used inside or outside of a building and under typical conditions, operate at a low condensing temperature. Typically these are used in large commercial air-conditioning units. Although effective, they are not necessarily the most efficient. Prior to beginning your install, make sure you choose a condenser that will provide you with the most efficient use.

Copper tube

Heat exchangers are devices that transfer heat in order to achieve desired heating or cooling. An important design aspect of heat exchanger technology is the selection of appropriate materials to conduct and transfer heat fast and efficiently.

Copper has many desirable properties for thermally efficient and durable heat exchangers. First and foremost, copper is an excellent conductor of heat. This means that copper's high thermal conductivity allows heat to pass through it quickly. Other desirable properties of copper in heat exchangers include its corrosion resistance, biofouling resistance, maximum allowable stress and internal pressure, creep rupture strength, fatigue strength, hardness, thermal expansion, specific heat, antimicrobial properties, tensile strength, yield strength, high melting point, alloyability, ease of fabrication, and ease of joining.

The combination of these properties enable copper to be specified for heat exchangers in industrial facilities, HVAC systems, vehicular coolers and radiators, and as heat sinks to cool computers, disk drives, televisions, computer monitors, and other electronic equipment. Copper is also incorporated into the bottoms of high-quality cookware because the metal conducts heat quickly and distributes it evenly.

Non-copper heat exchangers are also available. Some alternative materials include aluminium, carbon steel, stainless steel, nickel alloys, and titanium.

It cools the entire heated vapour coming out of the reactor. It has an inlet and an outlet for cold water to run through its outer area. This is used for cooling of the vapour. The gaseous hydrocarbons at a temperature of about 350°C are condensed to about 30 – 35°C

 It is the part of machine which condenses the vapours coming out from the catalytic cracker.

 The condenser must condense the very hot vapors in an efficient manner to give the condensate.

 Clogging in the condenser must be prevented.

 This can be achieved by increasing the diameter of the pipe.

 In this machine, we are using a spiral condenser to increase the efficiency of condensation.

Pyrolysis/Thermal Degradation:

Pyrolysis is a process of thermal degradation of a material in the absence of oxygen. Plastic is fed into a cylindrical chamber. The pyrolytic gases are condensed in a specially designed condenser system, to yield a hydrocarbon distillate comprising straight and branched chain aliphatic, cyclic aliphatic, and aromatic hydrocarbons, and liquid is separated using fractional distillation to produce the liquid fuel products.

The plastic is pyrolysed at 370°C–420°C. (1) Evenly heating the plastic to a narrow temperature range without excessive temperature variations, (2) Purging oxygen from pyrolysis chamber, (3) Managing the carbonaceous char by-product before it acts as a thermal insulator and lowers the heat transfer to the plastic, (4) Careful condensation and fractionation of the pyrolysis vapours' to produce distillate of good quality and consistency.

Advantages of pyrolysis process are

(a) Volume of the waste is significantly reduced.

(b) Solid, liquid, and gaseous fuel can be produced from the waste,

(c) storable/transportable fuel or chemical feed stock is obtained,

(d) Environmental problem is reduced,

(e) Desirable process as energy is obtained from renewable sources like municipal solid waste or sewage sludge, (f) The capital cost is low.

parameters of a Pyrolysis unit:

a) Melting point of the substance

   If melting point is high, substance easily vaporizes & more oil is obtained.

b) Density

   If density is lower, substance easily vaporizes & more oil is obtained.

c) Quality of substance

   More is quality, more is the yield of oil.

d) Moisture content

More is moisture, less is the oil yield.

e) Reactor Temperature

More is the reactor temperature, more is the yield.

f) Heating rate

More is the heating rate, more is the yield.

g) Reactor size

There is an optimum for the reactor size to get maximum oil yield.

h) Feed rate

Feed rate is given according to the demand for the oil.

f) Maintaining a uniform temperature

For continuous production it should maintain a uniform temperature.

g) Types of condenserused Condenser design also effects the production of maximum product yield.

Table: Product types of some plastics pyrolysis

Main products	Type of plastics	As a feedstock of liquid fuel
Liquid hydrocarbons	Polyethylene (PE) Polypropylene (PP) Polystyrene (PS) Polymethyl metacrylate (PMMA)	Allowed. Allowed. Allowed. Allowed.
Liquid hydrocarbons	Acrylonitrile-Butadiene-Styrene copolymer (ABS)	Allowed. But not suitable. Nitrogen-containing fuel is obtained. Special attention required to cyanide in oil.
No hydrocarbons suitable for fuel	Polyvinyl alcohol (PVA) Polyoxymethylene (POM)	Not suitable. Formation of water and alcohol. Not suitable. Formation of formaldehyde.
Solid products	Polyethylene terephthalate (PET)	Not suitable. Formation of terephthalic acid and benzoic acid.
Carbonous products	Polyurethane (PUR) Phenol resin (PF)	Not suitable. Not suitable.
Hydrogen chloride and carbonous products	Polyvinyl chloride (PVC) Polyvinylidene chloride (PVDC)	Not allowed. Not allowed.

Gaseous Fuel Production:

Scope of gaseous fuel in this compendium"

The gaseous fuel described in this report refers to the flammable gas obtained from the thermal treatment of waste plastics. There are two types of gaseous fuel: Gaseous hydrocarbon: hydrocarbons that are in a gaseous state under normaltemperature and pressure (0 °C, 1 atm). Synthesis gas or syngas: mixture of hydrogen and carbon monoxide. In the conversion of plastics to gaseous fuel, the waste plastics undergo thermal decomposition in a tank reactor, resulting in the formation of liquid fuel as the main product and gaseous fuel up to about 20 wt%, as the minor product. Gaseous hydrocarbons become the main product after residing in the reactor for an extended time at a reaction temperature under controlled decomposition conditions and the use of a specific reactor. Under specific conditions, carbon and carbohydrates can be used as feedstocks for the production of gaseous fuel like methane and hydrogen.

Table: List of various gasification methods

Type of gasification	Conditions	Typical products
Pyrolysis	>700 °C under inert atmosphere	Gaseous hydrocarbons from aliphatic hydrocarbons including polyethylene and polypropylene.
Partial oxidation	>1000 °C under oxygen or air	Carbon monoxide from carbon, hydrocarbons and carbohydrates including wood. Hydrogen also forms from hydrocarbons and carbohydrates.
Steam gasification	>800 °C under oxygen or air	Methane, carbon monoxide and hydrogen
Hydrogasification	Around 500 – 600 °C under hydrogen	Methane, carbon monoxide and water

Solid Fuel Production:

Table: Heating values of various fuels and wastes

Fuel or waste	Typical heating value (kcal/kg)
RDF	**4000 – 5000*[1]**
RPF	**6000 – 8000*[2]**
Coal	6000 – 8000*[3]
Heavy oil	9500
Wood/paper	4300
Plastics (polyethylene)	11000
Typical municipal wastes	1000 – 1500*[1]

The heating values of solid RDFs and RPFs may vary depending on the composition of the materials they contain. Especially in RDF, fluctuations in the heating values are often observed due to changes in the composition of the municipal waste (which is difficult to control) and according to the degree of drying of the municipal waste used in the production process.

Scope of solid fuel in this compendium

Solid fuel, as referred in this compendium, is prepared from both municipal and industrial non-hazardous waste. Additionally, the solid fuel outlined here excludes coal and coal-derived fuels as well as solid biofuels such as firewood and dried manure but it may contain biofuels as a component. This compendium differentiates two types of solid fuel: refuse derived fuel (RDF), also called solid recovered fuel (SRF) and refuse-derived paper and plastic densified fuel (RPF). RDF is mainly produced from municipal kitchen waste, used paper, waste wood and waste plastics. Due to the presence of kitchen waste, prior to the conversion to a fuel, a drying process is required to remove the moisture from such waste to allow the solidification of the waste in suitable shapes and densities. This process is seen as a disadvantage due to the large amount of energy that the process requires.

Figure: Example of RPF

Table: Polymer as feedstock for fuel production

Types of polymer	Descriptions	Examples
Polymers consisting of carbon and hydrogen	Typical feedstock for fuel production due to high heat value and clean exhaust gas.	Polyethylene, polypropylene, polystyrene. Thermoplastics melt to form solid fuel mixed with other combustible wastes and decompose to produce liquid fuel.
Polymers containing oxygen	Lower heat value than above plastics	PET, phenolic resin, polyvinyl alcohol, polyoxymethylene
Polymers containing nitrogen or sulfur	Fuel from this type of plastic is a source of hazardous components such as NO_x or SO_x in flue gas. Flue gas cleaning is required to avoid emission of hazardous components in exhaust gas.	Nitrogen: polyamide, polyurethane Sulfur: polyphenylene sulfide
Polymers containing halogens of chlorine, bromine and fluorine.	Source of hazardous and corrosive flue gas upon thermal treatment and combustion.	Polyvinyl chloride, polyvinylidene chloride, bromine-containing flame retardants and fluorocarbon polymers.

PROJECT PLAN

C	**June**	**July**	**august**	**Sept**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**
Search for project topic										
Literature Review										
Background Study										
Mathematical calculations										
Software design										
Fabrication										
Publication										

CHAPTER 4
ADVANTAGES AND APPLICATION

ADVANTAGES

- Corrosion is less.
- Residue can be used as paraffin wax.
- Less amount of residue and large amount of product.
- Plastic wastes can be reduced
- A proper solution for energy crisis
- Can reduce the problems due to plastic wastes.

DISADVANTAGES

- Large amount of the fuel cannot be produced,
- Large amount of the input is needed.

APPLICATIONS

- It can be used in the industrial fuel production and consumption,
- It can also be used for the domestic purposes also.

CONCLUSION

We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work.

We are proud that we have completed the work with the limited time successfully. The "FABRICATION OF EXTRACTION OF BIO-DIESEL FROM PLASTIC WASTE MATERIAL" is working with satisfactory conditions. We are able to understand the difficulties in maintaining the tolerances and also quality.

We have done to our ability and skill making maximum use of available facilities. Thus we have developed an "design and fabrication of biodiesel by using plastic waste" which helps to know how to achieve extraction of bio fuel from plastics. By using more techniques, they can be modified and developed according to the applications.

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