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A PROJECT REPORT ON

"RECYCLING OF WASTE PLASTIC INTO USEFULL PRODUCT -FUEL"

Submitted in the partial fulfillment for the award of the degree of

BACHELOR OF
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CIVIL ENGINEERING BY

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CERTIFICATE

This is certified that **"Recycling of waste plastic into useful product-fuel".** is a bonafide work carried out by "PAVAN KUMAR K(1EW18CV061), RAJASHEKARA REDDY (1EW18CV071), RAVI KUMAR D R(1EW18CV076), SHASHANK C S (1EW18CV080)", in the partial fulfillment of BACHELOR OF CIVIL ENGINEERING, VTU, BELGAUM. during the year 2022. It is certified that all the corrections, suggestions indicated for internal assessment have been incorporated in the report deposited in the department library. This project report deposited in the department library. This project report has been approved as it satisfies the academic requirements in respect of project work prescribed for BACHELOR OF ENGINEERING DEGREE.

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ABSTRACT

In order to control the various problems including, reduction of groundwater due to wide spread of plastic, many solutions have been suggested which have not proven to be effective enough. Dumping all the plastic wastes makes the landfill nothing but a carbon sink. The process of incineration also releases toxic gases. Hence, to prevail over all this, reusingplastic in an effective way is required, one of which is pyrolysis. A laboratory scale pyrolysis model consisting of three main parts such as reactor, condenser, and collector. Pyrolysis will be conducted in an inert atmosphere. A completely closed system is required conduct this project. This work has provided effective and convenient way of producing fuel and successfully managing plastic waste.

INTRODUCTION

GENERAL

Plastics play an important role in day- today life. It is a unique material because of their toughness, lowed weight, resistance to water and chemicals, resistant to heat and cold, low electrical and thermal conductivity, ease of fabrication, remarkable color range, more design flexibility, durability and energy efficiency. Plastics are of two main categories thermoplastics and thermoset plastics. Thermoplastics can re-melt or re-mould and therefore it is recyclable, but thermoset plastics cannot re-melt or reshape and therefore it is difficult to recycle. Plastic waste management is biggest problem now, due to their non-biodegradability nature. Plastics are managed by plastics recycling technologies. Reusing plastic wastes to produce biofuel by disintegrating the long chain hydrocarbons of the plastics has proven way effective and also as a sustainable solution. Pyrolysis is a thermal degradation process, in the absence of oxygen. It prevents the formation of COx, NOx, SOx due to absence of oxygen. It breaks large hydrocarbon chain into smaller ones, but this type of pyrolysis requires higher temperature and high reaction time. Also, the resulting fluid have low higher pour point of diesel and highresidue content.

TYPES OF PLASTICS

The types of the waste plastics are LDPE, HDPE, PP, PS, and PVC. The problems of waste plastics can't be solved by landfilling or incineration, because the safety deposits are expensive and incineration stimulates the growing emission of harmful greenhouse gases like COx, NOx, SOx and etc. These types of disposals of the waste plastics release toxic gas which has negative impact on environment. Plastic wastes can also classify 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

correspond to thermoplastics and the remaining to thermosets. Thermoplastics are composed of polyolefins such as polyethylene, polypropylene, polystyrene and polyvinyl chloride and can be recycled. On the other hand, thermosets mainly include epoxyresins and polyurethanes and cannot be recycled.

COLLECTION OF PLASTIC

Polypropylene plastic has been used for this project. PP was collected at BBMP dry waste collection and solid waste management processing plant, Jayanagar. After collecting the required raw material, plastic was cleaned and then taken to shredding industry. Using shredding machine, the collected waste PP plastic was shredded. Shredding of plastic is cutting plastic into smaller pieces for granulation. These shredded plastics were then processed to granulation. The machine used to make granules from shredding is called Gatta machine. Shredded granules were taken to Shakti mono- filaments in Peenya to convert the same into granules using Gatta machine. The granules then produced were directly used for pyrolysis. Shakti mono-filaments collects 6000 kgs of plastic every 15 days from waste. They segregate only one type of plastic called PP plastic. And make PP granules by that.

Figure 1.1 Gatta machine

Figure 1.2 Granules

ADVANTAGES AND DISADVANTAGES

Advantages

Plastics are Durable: There are some plastics that last more than the life of a human. Not all plastics are the disposable type. PVC piping has a life span of more than a hundred years. Household products that are made of plastics have a normal lifespan of more than 25 years. Made Our Life a Whole Lot Easier: Like mentioned earlier, imagine some of the items that you use on a daily basis made of anything else but plastic. How would you drink water or store food? Every aspect of life from transportation to medical facilities, from fitness tools to study materials, is connected with plastics. It is because ofthe plastics we are able to stuff much easier and faster than we would do otherwise. TheCost is Less Than Half: Life without plastics would cost us more than twice the currentamount. The manufacturing cost of plastic products is much less than other materials. In the kitchen, the less expensive plastic cutleries take up less space and weigh much less than glass or ceramic. Food stored in plastic containers preserves the freshness and flavor for a longer period of time.

Disadvantages

Non-Renewable Nature: Plastics are made of non-renewable resources making it less desirable than its alternatives. It takes millions of years to degrade and end up on landfills disturbing the ecosystem and making way to the food chain of different organisms including humans. Burning of Plastics Releases Toxic Chemicals: Burning them is not the right solution to go for. When burnt, they release some of the most toxic chemicals that severely impair the lives of different plants and animals. Environmental Pollution 100 billion plastic bags are thrown away in America each year. This garbage ends up on the ocean polluting and disturbing the marine ecosystem. The packaging materials are mostly made of plastics and the presence of microplastics in those packaging materials can very possibly end up on the food we eat on a daily basis.Moreover, they contain harmful components .

CHARACTERISTICS OF PLASTIC AS ENGINEERING MATERIAL

Low density, ease of fabrication, low thermal conductivity, available transparency, and low unit cost for mass-production items are characteristics of organic plastic materials that make them attractive to the designer and the engineer. Plastics are generally low cost, easy to manufacture, durable, strong for their weight, electrically and thermally insulative, and resistant to shock, corrosion, chemicals, and water. Polypropylene (PP) is a thermoplastic polymer that is rugged as well as unusually resistant to many chemical solvents, bases and acids. It is resistant to fatigue and tolerates high heat—66°C (150°F). It can be extruded or molded. Many physical finishing techniques can also be used on polypropylene, such as machining. Surface treatments can be applied to PP parts in order to encourage adhesion of inks and paints.

PYROLYSIS

Pyrolysis is a process of thermal Degradation of plastics in the Absence of oxygen.

ADVANTAGES AND DISADVANTAGES OF PYROLYSIS

Advantages

- It is a simple, inexpensive technology for processing a wide variety of feedstocks.
- It reduces waste going to landfill and greenhouse gas emissions.
- It reduces the risk of water pollution.
- It has the potential to reduce the country's dependence on imported energy resources by generating energy from domestic resources.
- Waste management with the help of modern pyrolysis technology is inexpensive than disposal to landfills.
- The construction of a pyrolysis power plant is a relatively rapid process.
- It creates several new jobs for low-income people based on the quantities of waste generated in the region, which in turn provides public health benefits through waste clean-up.

Disadvantages

- The product stream is more complex than for many of the alternative treatments.
- The product gases cannot be vented directly in the cabin without further treatment because of the high CO concentrations.

Objectives:–

- ✓ To reduce the amount of plastic waste reaching landfills by converting it to usable fuel with the helpof Pyrolysis Method.
- ✓ To check the quality of the fuel

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LITERATURE SURVEY

1] “Pyrolysis of Waste Plastic into Fuel”, Ram Jatan Yadav etal, [2020]

From this review paper the experiment conducted could be concluded that burning 1 kg of plastic could easily yield 600 to 750 ml of diesel fuel. By turning plastic into fuel, theywere able to reduce atmospheric CO2 emissions by 80% and burn 1 kg of plastic in theopen atmosphere to produce up to 3 kg of CO2, thus solving both problems. Waste plastic conversion oil released unbalanced hydrocarbons less than diesel fuel. An important point of this experiment was that the obtained waste plastic fuel had a higher efficiency than the available fuel in the market and the cost of production was 30% to 40% lower than Other fuel production methods. The brake thermal efficiency of the performance features ensured that the compression ignition engine had a thermal efficiency of 27.5% at full load. Other fuel production methods. The brake thermal efficiency of the performance features ensured that the compression ignition engine had a thermal efficiency of 27.5% at full load.

[2] “Production Of Liquid Fuel From Plastic Waste Using Integrated Pyrolysis Method With Refinery Distillation Bubble Cap Plate Column”, RamliThahiretal.,[2019].

The objective of this paper was to optimize the liquid product of pyrolysis from as muchas 500 g of polypropylene (PP) plastic waste, using a fixed bed type reactor in a vacuum condition to minimize the oxygen entering the reactor. The vapor flows through the 4-tray distillation bubble cap plate column for fractionation by utilizing heat from thereactor. Process conditions at 500– 650 ◦C and of 580 ◦C optimum liquid oil yield was 88 wt.%, comprising of kerosene in tray 1 with a volume 0f 350 ml, gasoline in tray 2 and 3 with a volume of 228 ml, and tray 4 had no condensate. Gas yield was 5wt.% and therest was char.At the conditions between 500 ◦C and 560 ◦C, gasoline yield in 6– 67 wt.% comprises of kerosene and gasoline. However, at process conditions between 600 ◦Cand 650 ◦C yielded at 64-83 wt% which was comprising of diesel oil and was obtained in tray 1 and 2 while kerosene and gasoline were obtained in the next tray.

The characteristics of fuel obtained from such as density, viscosity, octane – cetane number, ash content and calorific value had similar properties with those of fossil fuels.

[3] "Experimental characterization of a diesel engine running on polypropylene oils produced at different pyrolysis temperatures", Ioannis Kalargaris etal., [2018].

An experimental investigation was conducted to analyze and understand the combustion performance and emission characteristics of a diesel engine running on oils derived from the pyrolysis of polypropylene plastic at two temperatures (700°C and 900°C). The tests were performed on a diesel engine generator using oil-diesel blends of 75% and 100%. The PP900 oil exhibited better emission and performance characteristics compared to PP700. The conclusions could be drawn from the experimental results, that the engine was able to operate stably on polypropylene oils and blend with diesel, PP700 and PP900 had slightly longer ignition delay periods, lower cylinder peak pressures, and longer combustion periods due to the lower cetane number and engine brake thermal efficiency decreased by 1– 2% when polypropylene oils were used in comparison to diesel. The polypropylene oils produced higher NOX, UHC, and CO emissions than diesel, but lower CO2 emissions. The results suggest that all polypropylene blends would be suitable for long-term use in a diesel engine at elevated engine loads. However, the most promising blend is considered to be the PP900.

SUMMARY OF LITERATURE REVIEW

• Different types of plastics have different sublimation point, HDPE and LDPE havehigh thermal yielding point compared to Polypropylene.
• Thermal pyrolysis can be used for polypropylene due to its low thermal yielding point.

• It was heated to an optimum temperature between 300-500°C. The product of heating was then transferred to the condenser and stored in a container.

• These byproducts obtained from pyrolysis of polypropylene (PP) consists of Pyrolysis Oil(60-70%), Gas (15-20%) and lamp black (20-30).

• Pyrolysis oil after distillation can be used in engines as fuel, enabling stable operation and performance.

• The processes used in the above papers were in large scale and it did not prove to be effective in small scale production.

• Usage of catalysts have made the pyrolysis process more effective than withoutcatalyst.

MATERIALS AND METHODOLOGY

MATERIALS

Municipal plastics wastes included different types of plastics like PP, PE, HDPE, LDPE and PVC etc. In this project, pyrolysis method is used to convert the pp plastics collected by various methods such as

- Drop off
- Curbside
- Buy back

We had chosen with 2 of the above methods: drop off and curbside

Next to collection is cleaning and segregation. Manually segregating the plastic wastes, as it is going to be conducted in lab scale. Segregation helps in finding out various typesof plastics and also let's to you use desirable Thermos plastic. Segregated waste plastics are then subjected to pyrolysis.

PP plastics: Polypropylene (PP): Polypropene is a hard but flexible thermoplastic produced, it is used in a wide variety of applications. It is produced via chain-growth polymerization from the monomer propylene, it belongs to the group of polyolefins andis partially crystalline and non-polar.

PP is 100% recyclable. Automobile battery cases, signal lights, battery cables, brooms, brushes, ice scrapers, etc., are few examples which can be made from recycled polypropylene (PP). The PP recycling process mainly includes melting of waste plastic to 250°C to get rid of contaminants followed by removal of residual molecules under vacuum and solidification at nearly 140°C. This recycled PP can be blended with virgin PP at a rate up to 50%. The main challenge in PP recycling is related to its amount consumed – currently nearly 1% PP bottles are recycled as compared to 98% recycl*ing rate of PET & HDPE bottles together.*

Source: From bottles, bottle caps, plastic cups, bottles

Figure 3.1 collecting plastic bottles

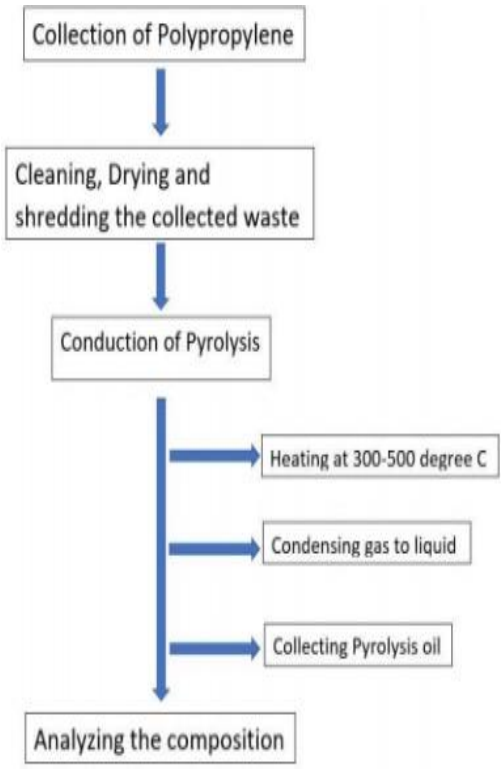
Figure 3.2 Shredding plastic

Collection: BBMP dry waste collection and solid waste management processing plant, Jayanagar.

Figure 3.3 plastic bottles

Figure 3.4 Shredded plastic bottles

Setup for the experiment



• Identification of materials for the pyrolysis instrument and raw materials for the pyrolysis process.

• Collection of PP plastic waste and cleaning, drying and shredding them.

• Design of the reactor unit, condenser unit and collection unit

• Acquiring the required materials for setting the pyrolysis instrument and assembling.

• Conducting the experiment, Heating of plastic at 300-500°C, condensing the emitted vapors into liquid and collecting.

• Analyzing the collected pyrolysis oil to determine its carbon chain and concluding with the result.

Pyrolysis unit developed from Mild Steel materials with 2mm thickness. By using laser technology, we fabricated the above pyrolysis unit. The experiments carry out with high temperature, so unit must withstand to high temperature. Safety valves are provided to the reactor. Reactor welded by using laser welding to prevent the leakage of vapors. The safe and efficient pyrolysis unit is shown below. Pyrolysis in simple words mean, thermal decomposition of materials at elevated temperatures in an inert atmosphere. Pyrolysis of plastic involves a reactor, condenser and a collecting chamber. The set-up must be inert – without any air molecules.
Reactor is made of mild steel, which can withstand a temperature of about 400-500 degree C, which is maintained during combustion of plastic. Reactor consisting of one-way valve or check valve, which acted as boththe inlet to dump the plastic and as the connection of condensing pipe. Condensing pipe is made of copper which can also withhold the heat produced during the process. The condensed liquid fuel is collected ina water container. The separated liquid fuel will be sent to fuel testing lab to analyze the composition of fuel.

RESULTS AND DISCUSSION

EXPEREMENTATION WORK CONDUCTED

Table- Result obtained of experimentation work

Sl No.	Total time of heating(hrs.)	Quantity ofPP added(g)	Quantity of residue obtained (g)	Quantity of pyrolysis oil(ml)	Average quantity of pyrolysis oil obtained(ml)
1	1.5	200	170	8	8.66
2	1.5	200	165	10	
3	1.5	200	173	8	

- The above table gives details regarding the quantity of the plastic added and also theaverage quantity of the oil obtained.
- The total time of conducting experiment for one trial was 1hr30mint for 200 gms of Initial PPplastic added.
- In first trial, pyrolysis oil obtained was 8ml for 200gms of initial plastic, which makes ita 4% conversion rate.
- Second trial gives a solid 10ml of oil along with 165gms of residue making it a 5%conversion rate.
- In third trial, oil obtained was 8ml for 200gms of plastic added, making it a 4%conversion.

Table - Percentage of pyrolysis oil obtained

Sl No.	Quantity of PP added in percentage (%)	Quantity of residue obtained (%)	Quantity of pyrolysis oil (%)	Average quantity of pyrolysis oilobtains (%)
1	100	85	15	15.33
2	100	82.5	17.5	
3	100	86.5	13.5	

- The total average percentage of pyrolysis oil obtained for heating the polypropylene (PP) plastic for 1 hour time at a temperature of 300◦C was about 26.67% of the total quantity
- of plastic taken for testing.
- The total quantity of plastic taken for testing was 200gms in first trial; where we obtained at 52ml of pyrolyzed oil.
- During second trial, we got 50ml as a conversion rate for 200gms of plastic taken at start of the second trial.
- During third trial, we were able to collect 58ml of plastic for again 200gms of plastic taken.
- Average of all three trials gave us a net 53.34gms of Pyrolyzed oil, which sums up to anaverage of 26.67% of oil

Figure Obtained Pyrolysis oil

CONCLUSION

In this work an attempt has been made to convert waste plastic into reusable fuel with thehelp of pyrolysis, the collection of the plastic waste was done from BBMP dry waste collection and solid waste management processing plant, the obtained plastic waste was segregated based on their various properties and PP plastic was separated, the obtained PPplastic waste was cleaned and shredded into smaller pieces for feeding it to the reactor,the design of the instrumental setup was done for feeding the PP plastic and for the extraction of requires quantity of pyrolysis oil.

- With increasing temperature, plastic will go through glassy state, liquid state anddecomposition. Decomposition of plastic in an inert atmosphere is called pyrolysis.
- Thermal pyrolysis can be used for polypropylene due to its low thermal yieldingpoint.
- It is heated to an optimum temperature between 300-500°C. The product ofheating is then transferred to the condenser and stored in a container.
- These by-products obtained from pyrolysis of polypropylene (PP) consists ofPyrolysis Oil (20-30%), Gas (5-10%) and lamp black (70-80%).
- Pyrolysis oil exhibited characters of a diesel.
- When PP alone is pyrolyzed at 300 to 500 degree C, it produced Diesel oil. It isused as a fuel for four-cylinder diesel engine.

FUTURE SCOPE OF WORK

- conducted with different plastics and note down their conversion rates.
- Measurement of pressure can be done using a pressure-gauge attached to the pyrolysis unit. In the lab-scale pyrolysis that we conducted, we have used only PP plastics, whose conversion rate has been noted as 26.67% as average. This Process can also be

References

1. Aishwarya K N and N Sindhu, Microwave Assisted Pyrolysis of PlasticWaste, India,2016, Procedia Technology 25 (2016) 990 – 997.

2. N. D. L. Rao, J. L. Jayanthi and D. Kamalakar, Conversion of waste plastics into alternative fuel, India, 2015, international journal of engineeringsciences & research technology, pp. 195-201.

3. Mochamad Syamsiro, Fuel Oil Production from Municipal Plastic Wastesin Sequential Pyrolysis and Catalytic Reforming Reactors, Japan, 2014, Energy Procedia 47 (2014) 180 – 188.

4. Pallab Das and Pankaj Tiwari, The effect of slow pyrolysis on the conversion of packaging waste plastics (PE and PP) into fuel, India, 2018,Waste Management 79 (2018) 615–624.

5. S.M. Al-Salem, Thermal pyrolysis of high-density polyethylene (HDPE) ina novel fixed bed reactor system for the production of high value gasoline range hydrocarbons, Kuwait, 2019, Process Safety and Environmental Protection 127 (2019)171–179.

6. B. S. S. Phanisankar, N. Vasudeva Rao and J. E. Manikanta, Conversionof waste plastic to fuel products, India, 2020.

7. Pawel J. Donaj and W. Kaminsky,

8. Pyrolysis of polyolefins for increasing the yield of monomers' recovery,Brazil, 2012, Waste Management 32 (2012) 840–846.

9. Young-Hwa Seo and Kyong Lee, Investigation of catalytic degradation of high density polyethylene by hydrocarbon group type analysis, South Korea, 2002, J.AnalAppl. Pyrolysis 70 (2003) 383-398.