

REGENERATION OF OIL FROM WASTE PLASTIC USING PYROLYSIS TECHNIQUE

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Abstract: Environmental concern and depletion of petroleum fuels have caused interests in the search for alternate fuels for combustion. Conversion of waste to energy is one of the recent trends in minimizing not only the waste disposal but also could be used as an alternate fuel for combustion. In the present paper, thermo chemical decomposition of plastics are attempted at high temperature in the absence of oxygen. For the purpose, pyrolysis reactor is designed and developed to produce liquid fuel. The properties of oil produced was tested and compared with fuel properties.

Keywords: pyrolysis , fuel oil, polymers, calorific value

INTRODUCTION

Plastics have become an indispensable part in today's world. Due to their light-weight durability, energy efficiency, coupled with a faster rate of production and design flexibility, these plastics are employed in entire industrial and commercial areas. Plastics are non-degradable polymers of mostly containing carbon, hydrogen and few other elements such as chlorine, nitrogen, etc. Due to its non-biodegradable nature the plastic waste contributes significantly to the problem of municipal waste management.

Over the past few decades scientists have discovered that in the absence of oxygen, plastic, which consists of long chain polymer chain, can be fragmented at high temperature to form oligomers. The term pyrolysis was used to refer to such process, although it normally refers to thermochemical decomposition of organic materials at high temperature in the absence of oxygen. Different methods of converting plastic waste to fuel with high calorific value have been reviewed with a view to solving the problem of conventional fossil fuel shortage and the environmental degradation effect of plastic waste. Pyrolysis of plastic waste is able to produce liquid products that can be used as fuel, there is a high potential for the process to be adopted in recycling industry. The related literature on this technology is discussed in next section.

LITERATURE SURVEY

Hydro-cracking of LDPE plastics into fuel over bi-functional catalysts systematically was done by **Wiwini Sriningsih (2014)**. It reduces the environmental pollution, supports the use of soil, and increases the energy storage. **Mochamad Syamsirao (2013)** shows fuel oil production from municipal plastic wastes by sequential pyrolysis and catalytic reforming processes. The results show that the feedstock types strongly affect the product yields and the quality of liquid and solid products.

A. López (2011) elaborated the recent technologies for recycling and recovery of Plastic Waste Management. Energy recovery was found to be an attainable solution to municipal solid waste. **Dezhen Chen (2014)** addressed the state-of-the-art of MSW pyrolysis in regards to its technologies and reactors, products and environmental impacts. In this review, first, the influence of important operating parameters such as final temperature, heating rate and residence time in the reaction zone on the pyrolysis behaviors and products is reviewed; then the pyrolysis technologies and reactors adopted in literatures and scale-up plants are evaluated. The research of

Chika Muhammad (2015) shows that pyrolysis of plastics produced from commercial waste electrical and electronic equipment produces a mainly oil product containing mostly styrene.

S.L. Wong (2015) presented an articulated summary (concise review) of the recent progress in production of fuels and chemicals from virgin and post-consumer plastic waste, with the main focus in pyrolysis, as well as co-pyrolysis of plastic waste with other materials. Performance and emission of plastic oil obtained by kaoline catalyzed pyrolysis of waste polypropylene in a diesel engine was studied by

Achyut K. Panda (2016). A laboratory prepared nickel–magnesium–aluminium catalyst and a commercial Ni catalyst were compared by **Chunfei Wu (2014)** in two stage pyrolysis reactors.

Thus plastic waste from mixed municipal and industrial waste fetch ample amount of energy, but very harmful environmental impact causing serious problems. Government of India has taken initiative by starting movement of 'Swachh Bharat' to see a cleaner future of India. Pyrolysis is best and promising method in deep research for better results producing less amount of residue and large amount of product. The development of this pyrolysis reactor is discussed in next section.

DEVELOPMENT OF REACTOR

Heating plastic waste in non-oxygen environment will melt it, but will not burn. After it has melted, it will start to boil and evaporate, vapors passes through a cooling pipe, and condense to a liquid and some of the vapors with shorter hydrocarbon lengths will remain as a gas. The exit of the cooling pipe is then going through a heat exchanger containing cold water to capture the last liquid forms of fuel and leave only gas that is then burned. The fuel is then collected into the storage container kept below the heat exchanger outlet. This device functions on a 3-phase electric coil with capacity of 2 KW/hour. You need to heat the plastic slowly to about 250-300 degrees as shown in fig 1.

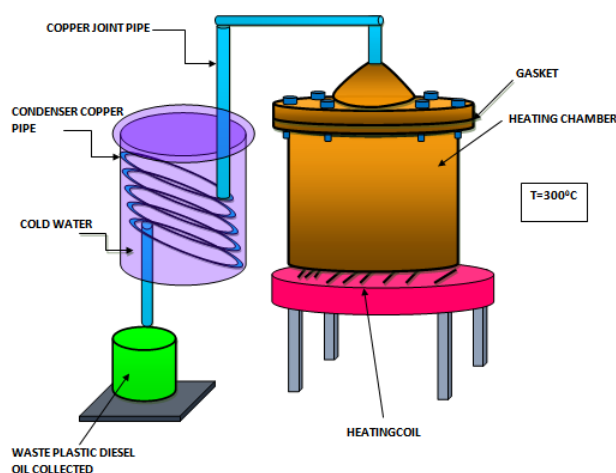


Fig 1. Schematic of reactor

The list of parts required for the reactor are shown in table 1.

Table 1. Part details

Sr no	Part name	Material	Qty
1	Frame	Ms	1
2	Heating coil(2 kw)	Std	1
3	Insulation	Glass wool	1 kg
4	Heating chamber	Ms	1
5	Condenser	Ms	1
6	Top cone	Ms	1
7	Wiring	Std	1
8	Nut bolt washer	Std	12
9	Copper pipe	Std	1
10	Miscellaneous	--	---

EXPERIMENTATION

The feed stocks used for these experiments were three kinds of municipal plastic wastes, i.e. polyethylene bag, high density polyethylene (HDPE) and low density polythene bags. They were obtained from the disposal site and small plastic recycling company. The feed stock thus obtained are cleaned and fed into

reactor. It was heated up to 350 degrees, and the heating process is continued for approx. 3 hours for one kg of feed stock. The actual setup is shown in fig 2.



Fig-2 Experimental Set Up

Results and Discussion:

The setup developed as shown in the fig. 2 is loaded with 0.5 kg of HDPE in 1st run and 0.5 kg of mixture of plastic in 2nd run. The plastic is heated up to 250-300 degree Celsius. The temperature measurement is recorded using temperature sensor gun. The oil obtained after 2.5 hours of heating is collected at the end of the condenser tube. It measured 300 ml of HDPE oil and 350 ml of plastic mixtures oil. The oil thus obtained is tested in chemical laboratory of BVCOE for specific gravity, flash and fire point and density. For calorific value, the sample was tested in SGS lab, Thane. The properties obtained are shown and compared with diesel in table 8.1

Table 2. Comparison of properties

Fuel Properties	Diesel	Plastic Mixture	HDPE
Specific gravity	0.81-0.96	0.655	0.74
Flash point (°C)	52-96	58	1
Fire point (°C)	70-82	72	7
Cloud point (°C)	2.5-4	Below 1	Below 2
Pour point(°C)	-2 to -12	-4 to -10	-4.5 to -5
Sulphur content (%)	0.05	0.028	0.019

Calorific value (kcal/kg)	10874	10409	10244
Color	Bluish yellow	Dark Yellow	Yellow,Light transparent

From above comparative analysis, it is clear that Specific Gravity of the plastic mixture and HDPE is nearly similar to that of diesel, also, Flash and Fire point and Pour Point of plastic mixture lies between the range of actual diesel. The Sulphur content of mixed plastic is more close to that of diesel while of HDPE is less. Calorific value when tested for mixed plastic displayed the value being very close to that of diesel. Thus from above results we can say that the oil obtained from pyrolysis of mixed plastic has the more properties similar to diesel and can be used as its alternative

CONCLUSIONS AND FUTURE SCOPE

Compared to traditional mechanical recycling, incineration and land filling, Plasma Pyrolysis is very sustainable having lesser harmful impact on environment and has potential to convert almost all waste plastics into useful products. After conducting multiple pyrolysis experiments on various types of plastics, it can be concluded that the product obtained from the process comprising of raw materials of a mixture of plastics have the general parameters like Calorific value, flash and fire point and specific gravity closer to that of the actual diesel oil. Current device is equipped with a stagnant cold water heat exchanger, but for faster cooling and hence increasing efficiency, we can create a continuous flow of coolant in heat exchanger. The efficiency can be increased by preventing leakages, proper insulation of condenser pipes, and increasing heating surface area.

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