# Comparison of Plastic Derived Fuel Production Methods and Its Effect on Fuel Quality

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***ABSTRACT***

*Plastics play an important role in day-today life, for certain application they have an edge over conventional materials due to their light weight, durability, energy efficiency, coupled with a faster rate of production and more design flexibility, they are allowing breakthroughs in fields ranging from non-conventional energy, to horticulture and irrigation, also water-purification systems and even space flight. However one has to accept that virtues and vices co-exist. Plastics are relatively cheaper and are easily available which brought the use and throwaway culture. Due to their non-degradable property plastics waste management has become a problem world over. A majority of landfills, allotted for plastic waste disposal, are approaching their full capacity. Thus recycling is becoming increasingly necessary. This paper emphasizes the typical methods for converting waste plastics into solid, liquid and gaseous fuels as well as the comparison of qualities of these three different fuels with its production method.*

## INTRODUCTION

Economic growth and changing patterns of consumption and production are resulting into rapid increase in generation of waste plastics in the world. The world's yearly consumption of plastic materials has increased from around 5 million tonnes to nearly 100 million tonnes; thus, 20 times more plastic is produced today than 50 years ago. This implies that on the one hand, more resources are used to meet the increasing demand of plastic, and on the other hand, more plastic waste is being generated. This increase has turned into a major challenge for local authorities, which are responsible for the solid waste management and sanitation. Due to absence of integrated solid waste management, most of the plastic waste is neither collected properly nor disposed in an appropriate manner to avoid negative impacts on environment and public health and also cause littering and chocking of sewage system. Plastic waste recycling can provide an opportunity for collection and disposal of plastic waste in a higher environmental friendly way and it can be converted into a resource. In most of such situations, plastic waste recycling could also be economically viable, as it generates resources, which are in higher demands. Plastic waste recycling also has a huge potential for resource conservation and greenhouse gas emissions reduction. This resource conservation is a very important goal for most of the national and local governments, where sudden industrialization and economic development is putting a huge amount of pressure on natural resources. Some of the most developed countries have been previously established commercial level resource recovery products from waste plastics.

## LITERATURE REVIEW

### Plastics

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

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reduce costs. These polymers can be moulded 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.

- **Thermosetting plastics** 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.

**Solid Fuel Production**

**1.2.1. Production Method**

The solid fuel production process usually involves two steps, pre-treatment and pellet production:

- Pre-treatment includes coarse shredding and removal of non-combustible materials.
- Pellet production comprises secondary shredding and pelletization (<200°C).

A fuel production facility consists of a waste unloading area, stockyard, pre-treatment equipment, pelletizing equipment and solid fuel storage. The pre-treatment process includes crushing and sorting for the removal of unsuitable materials from incoming wastes. After pre-treatment, a suitable mixture of paper and plastics are further processed in a Secondary crusher and sorting process (conveyor and magnetic separator) and the resulting mixture is pelletized to produce solid fuel. The resulting solid fuel is cooled in an air-cooling system to prevent natural ignition during storage and it is further stored for shipping.

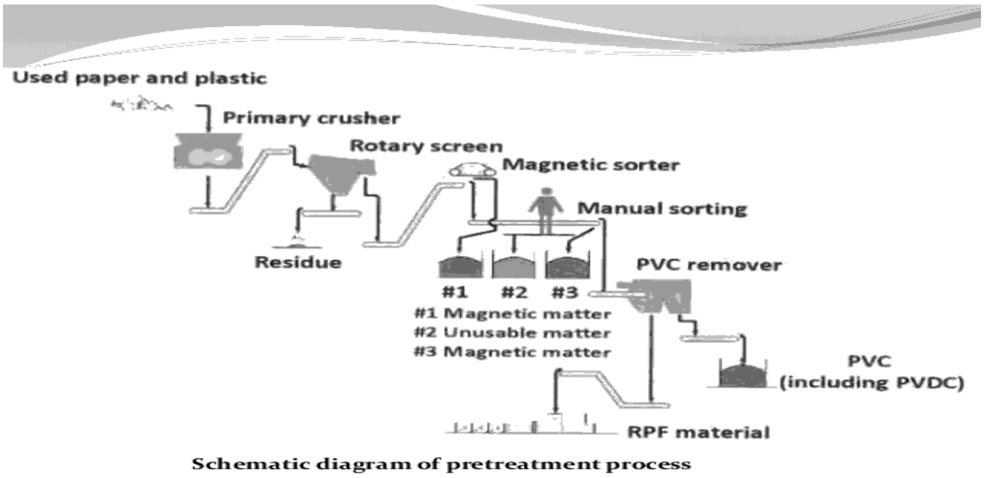


**Fig.(1) Schematic Diagram of Pretreatment Process**

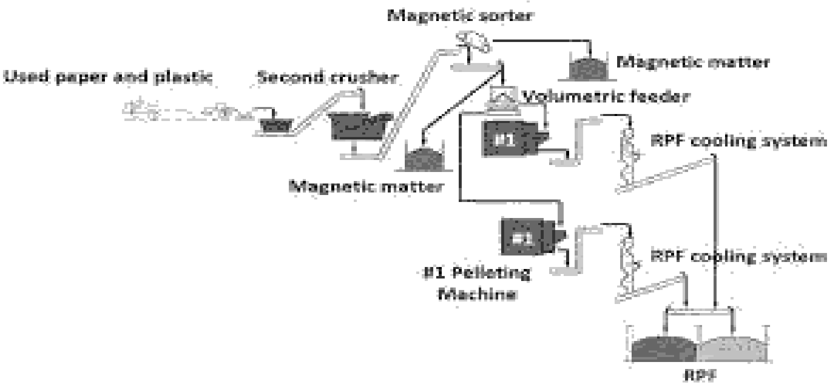


**Fig.(2)Schematic Diagram Of Pelletizing Process**

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## LIQUID FUEL PRODUCTION

### 1.3.1. Production Method

The production method for the conversion of plastics to liquid fuel is based on the pyrolysis of the plastics and the condensation of the resulting hydrocarbons. Pyrolysis refers to the thermal decomposition of the matter under an inert gas like nitrogen. For the production process of liquid fuel, the plastics that are suitable for the conversion are introduced into a reactor where they will decompose at 450 to 550 □ C. Depending on the pyrolysis conditions and the type of plastic used, carbonous matter gradually develops as a deposit on the inner surface of the reactor. After pyrolysis, this deposit should be removed from the reactor in order to maintain the heat conduction efficiency of the reactor. The resulting oil (mixture of liquid hydrocarbons) is continuously distilled once the waste plastics inside the reactor are decomposed enough to evaporate upon reaching the reaction temperature. The evaporated oil is further cracked with a catalyst. The boiling point of the produced oil is controlled by the operation conditions of the reactor, the cracker and the condenser. In some cases, distillation equipment is installed to perform fractional distillation to meet the user's requirements. After the resulting hydrocarbons are distilled from the reactor, some hydrocarbons with high boiling points such as petrol, kerosene and gasoline are condensed in a water-cooled condenser. The liquid hydrocarbons are then collected in a storage tank through a receiver tank. Gaseous hydrocarbons such as methane, ethane, propylene and butanes cannot be condensed and are therefore incinerated in a flare stack. This flare stack is required when the volume of the exhaust gas emitted from the reactor is expected to be large. Due to the formation of carbonous matter in the reactor, which acts as a heat insulator, in some tank reactors the stirrer is used to remove the carbonous matter rather than for stirring. After the liquid product of the pyrolysis is distilled, the carbonous matter is taken out either with a vacuum cleaner or in some cases reactors are equipped with a screw conveyor at the bottom of the tank reactor to remove the carbonous matter.

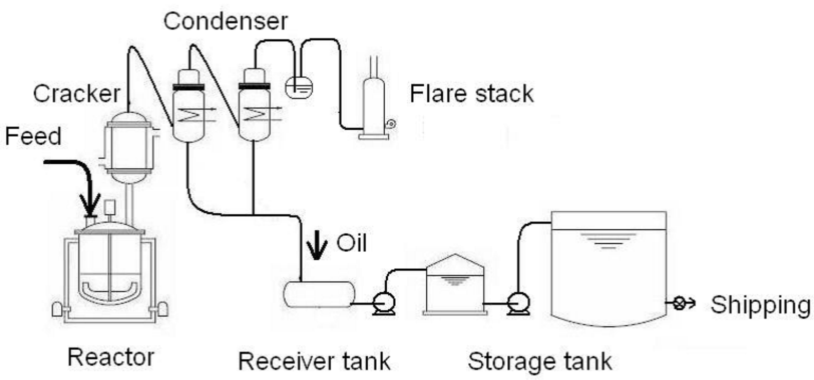


**Fig.(3) Schematic Diagram of a Production Plant of Plastics-Derived Fuel**

## GASEOUS FUEL PRODUCTION

### 1.4.1.Production Method

Polyethylene and polypropylene thermally decompose at temperatures up to about 700 °C and under a inert atmosphere to form a mixture of gaseous hydrocarbons, methane, ethane, ethylene, propane, propylene, and various isomers of butane and butane. On the other hand, most of the organic substances undergo gasification yielding syngas. Gasification proceeds at elevated temperatures, higher than 800 and practically 1000 °C. Depending on the types of reactors and reaction conditions, carbonous matter and carbon dioxide are formed, and nitrogen from the air is contained in the product gas. The gasification reactors to be used are moving-bed, fluidized-bed and entrain-bed reactors. If the

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product is to be stored, a large gas holder is to be required. The gasification technique is already used commercially for coal and there are several examples of commercial operations using biomass and waste plastics to produce low- and medium-BTU gas.

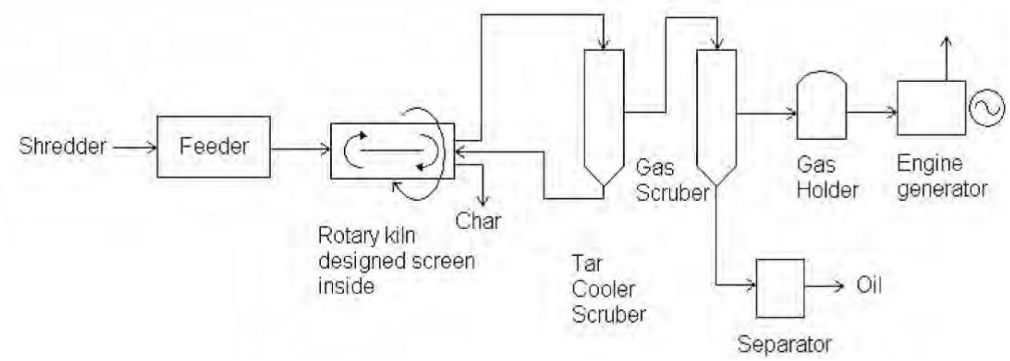


**Fig.(4) Schematic Diagram of a Production Plant of Plastics-Derived Gaseous Fuel**

## COMPARISON OF QUALITY OF FUEL PRODUCED

| | Normal petrol | Petrol produced by solid fuel production method | Petrol produced by Liquid fuel production method | Petrol produced by gaseous fuel production method |
|---|---|---|---|---|
| Specific gravity at 28 °C | 0.7254 | 0.7135 | 0.7423 | 0.7156 |
| Specific gravity at 15 °C | 0.7365 | 0.7268 | 0.7528 | 0.7305 |
| Flash Point | 22 | 20 | 23 | 21 |
| Octane rating | 95 | 75 | 83 | 78 |
| Mileage | 44.0 | 43.12 | 44.4 | 43.25 |
| Gross calorific value | 11262 | 11192 | 11210 | 11135 |

**Fig.(5) Comparison of Quality of Fuel Produced**

fig(5) shows the comparison between the fuels produced from different fuel production methods and its quality with the normal petrol. In this work we are comparing the properties such as Specific gravity (at 28 °C) , Specific gravity (at 15 °C) , Flash Point , Octane rating , Mileage of the fuel produced, Gross calorific value , Net calorific value of petrol produced from 3 different methods such as solid fuel production method , Liquid fuel production method , gaseous fuel production method with normal petrol and tabulated the values of these properties. The amount of plastic we have taken for fuel production from these methods are the same and is equal to 1 tonne. From the tabulated values of the properties of fuel ,we found that petrol produced from plastic by Liquid fuel production method is more similar with normal petrol and it has more calorific value compared to the fuel production by other methods.

## ADVANTAGES OF PETROL PRODUCED BY LIQUID FUEL PRODUCTION METHOD OVER OTHER 2 METHODS

- It is cheaper among all methods.
- The fuel produced is qualitatively similar to normal petrol.
- The fuel produced by Liquid fuel production method has more points of similarity with normal petrol.

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## CONCLUSION

Comparison of plastic derived fuel production methods and its effect on fuel quality has been analysed. Also the fuel produced from various methods such as liquid fuel production method, solid fuel production method, and gaseous fuel production method is compared with the normal petrol produced by the distillation of crude oil from oil rigs. Liquid fuel production method is found to be cheaper and advantageous compared to the other methods. It is economical and has more no. of similarities with normal petrol. Mileage of the fuel produced by the liquid fuel production method is also better. The heating value is also found to be comparable with the normal petrol.

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