A Review on Fuel from Waste Plastic and Assessment of its Potential as an Alternative Fuel for Diesel Engines

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Abstract— The aim of this research fuel oil production from municipal plastic wastes by sequential pyrolysis and catalytic reforming processes. The demand for diesel fuel is higher than that of petrol throughout the world hence seeking alternative to mineral diesel is a natural choice. Alternative fuels should be easily available at lower cost, environment friendly and fulfil energy needs without modifying engine's operational parameters. The characteristics of fuel obtained from plastic such as density, viscosity, octane-cetane number, ash content and calorific value have similar properties with those of fossil fuels. Plastics are an integral part of our modern life and are used in almost all daily activities. Since plastics are synthesized from non-renewable sources and are generally not biodegradable, waste plastics are the cause of many of the serious environmental problems the world faces today. Due to depletion of fossil fuel reserves and increasing cost of the petroleum products are the big troubles of today's world.

Keywords: Solid, liquid and Gaseous Fuel Production, Pyrolysis, Catalytic, Synthesis gas

I. INTRODUCTION

The purpose of this review is the existing literature about chemical recycling of plastic waste and its potential as fuel for diesel engines. Disposal and recycling of waste plastics have become an incremental problem and environmental threat with increasing demand for plastics. One of the effective measures is by converting waste plastic into combustible hydrocarbon liquid as an alternative fuel for running diesel engines. Converting waste plastics into fuel oil by different catalysts in catalytic pyrolysis process. Important point is the fuel is extracted using plastic which is not degradable and not environmental friendly.

Plastic is the general common term for a wide range of synthetic or semi synthetic organic amorphous solid materials used in the manufacture of industrial products. Plastics are typically polymers of high molecular mass, and may contain other substances to improve performance and/or reduce costs.

II. PRINCIPLES INVOLVED

Fig. 1: Waste recycle production

All plastics are polymers mostly containing carbon and hydrogen and few other elements like chlorine, nitrogen, etc. Polymers are made up of small molecules, called monomers, which combine together and form large molecules, called polymers. When this long chains of polymers break at certain points, or when lower molecular weight fractions are formed, this is termed as degradation of polymers. This is reverse of polymerization or de-polymerization.

A. Types of Waste Plastic Fuel Production

1) Solid Plastic Fuel

Solid fuel, as referred in this compendium, is prepared from both municipal and industrial non-hazardous waste. Additionally, the solid fuel unlined here excludes coal and coal derived fuels as well as solid bio fuels such as firewood and ride manure but it may contain bio fuels as a component. This compendium differentiates two types of old fuel: refuse derived fuel (RDF), also called solid recovered fuel (SRF) and refuse-derived paper and plastic densities 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. Solid recovered fuel (SRF) is defined in the European Committee for Standardization technical specification. On the other hand RPF is prepared from used paper, waste plastics and other dry Feed stocks. Within the plastics, the thermoplastics play a key role as a binder for the other components such as thermosetting plastics and other combustible wastes, which cannot form pellets or briquettes without a binding component.

	Moisture	Ash	Combustibles	total
Yield (wt %)	1.04	2.19	96.77	100

Table. 1: Yield against various parameters

2) Liquid Fuel Production

The burner or the engine performance. The fuel properties such as viscosity and ash content should conform to the specifications of the fuel user’s burners or engines. No additives would be needed for fuel used Liquid fuel within this compendium is defined as plastic derived liquid hydrocarbons at a normal temperature and pressure. Only several types of thermoplastics undergo thermal decomposition to yield liquid hydrocarbons used as liquid fuel. PE, PP, and PS, are preferred for the feedstock of the production of liquid hydrocarbons. The addition of thermosetting plastics, wood, and paper to feedstock leads to the formation of carbon us substance. It lowers the rate and yields of liquid products. Depending on the components of the waste plastic being used as feedstock for fuel production, the resulting liquid fuel may contain other contaminants such as amines, alcohols, waxy hydrocarbons and some inorganic substances. Contamination of nitrogen, sulphur and halogens gives flu gas pollution. Un expect contamination and high water contents may lower the product yields and shorten the lifetime of a reactor for pyrolysis Liquid fuel users require petroleum substitutes such as gasoline, diesel fuel and heavy oil. In these fuels, various additives are often mixed with the liquid hydrocarbons to improve in a boiler.

3) Gaseous Fuel Production

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:

a) Gaseous hydrocarbon:

Hydrocarbons that are in a gaseous state under normal Temperature and pressure (0 °C, 1atm) (fig. 1).

b) 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 feed stocks for the production of gaseous fuel like methane and hydrogen.

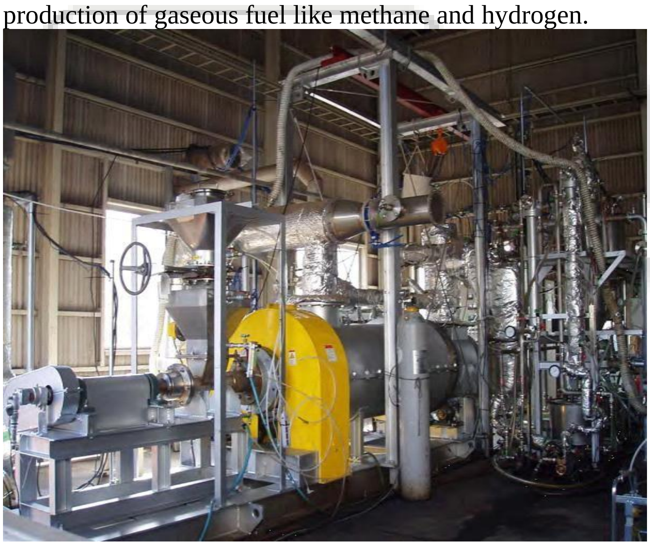

Fig. 1: Liquid Fuel Production

III. PYROLYSIS

Pyrolysis is the thermal decomposition of materials at elevated temperatures in an inter atmosphere. It involves a change of chemical composition. The word is coined from the Greek derived elements pyro "fire" and lysis "separating".

Pyrolysis is most commonly used in the treatment of organic materials. It is one of the processes involved in charring wood. In general, pyrolysis of organic substances produces volatile products and leaves mostly carbon as the residue, is called carbonization (fig. 2).

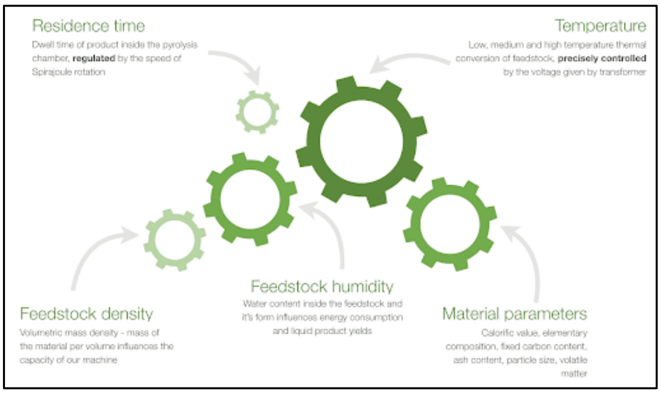

Fig. 2: Steps involved in Pyrolysis

IV. CATALYTIC

Catalytic reforming is a chemical process used to convert petroleum refinery naphthas distilled from crude oil (typically having low octane ratings) into high-octane liquid products called reformates, which are premium blending stocks for high-octane gasoline. The process converts low-octane linear hydrocarbons (paraffin) into branched alkanes (isoparaffins) and cyclic naphthenes, which are then partially dehydrogenated to produce high-octane aromatic hydrocarbons. The dehydrogenation (fig. 3) also produces significant amounts of byproduct hydrogen gas, which is fed into other refinery processes such as hydrocracking.

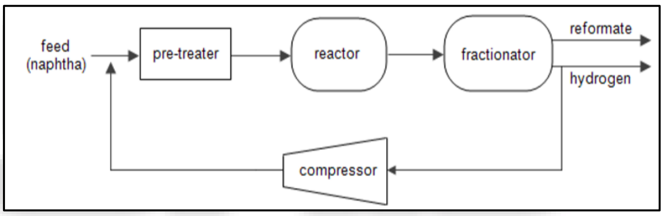

Fig. 3: dehydrogenation

A side reaction is hydrogenolysis, which produces light hydrocarbons of lower value, such as methane, ethane, propane and butanes. Catalytic reforming uses a catalyst, usually platinum, to produce a similar result. Mixed with hydrogen, naphtha is heated and passed over pellets of catalyst in a series of reactors, under high pressure, producing high-octane gasoline. Hydrocarbon is rearranged to alter its properties. The process is frequently applied to low-quality gasoline stocks to improve their combustion characteristics. Thermal reforming alters the properties of low-grade naphthas by converting the molecules into those of higher octane number by exposing the materials to high temperatures and pressures. Catalytic reforming uses a catalyst, usually platinum, to produce a similar result. Mixed with hydrogen, naphtha is heated and passed over pellets of catalyst in a series of reactors, under high pressure, producing high-octane gasoline.

V. WASTE TO FUEL

Waste-to-energy or energy-from-waste is the process of generating energy in the form of electricity, heat or fuel from waste. WtE is a form of energy recovery. Most WtE processes produce energy directly through combustion, or produce a combustible fuel commodity, such as methane, methanol, ethanol or synthetic fuels.

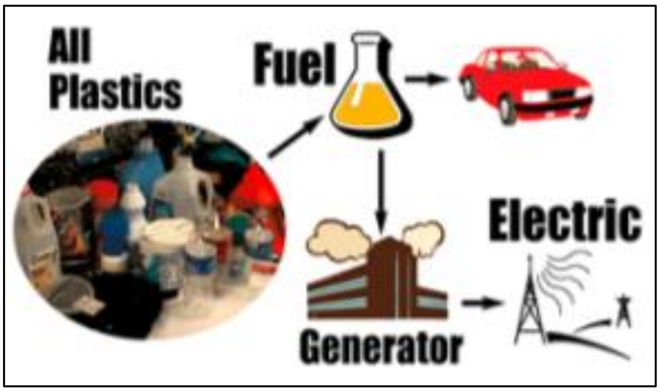

Fig. 4: Waste to Fuel

VI. APPLICATIONS

- *Fuel oil:* widely used ad fuel oil in industries such as steel and iron factories, ceramics or chemical industries or hotels, restaurant etc. or used for generators to get electricity.
- *Carbon black:* Used form construction brick with clay, also can be used as fuel.
- *Combustible gas:* It can be recycled and used during process as fuel.
- *Steel wire:* sold or reprocessing.

VII. CONCLUSION

A plausible alternative could be to revise the Packaging Ordinance, such that ecologically favourable packaging systems would be included in a deposit without being discriminated when compared to refillable packaging. It cannot be explained to consumers that they should return the empty bottles to the store if they are subsequently transported to the other side of the world for recycling. This way we are losing environmental gain that is the prime reason behind bottles collection. This study has shown that it does not matter whether collected PET is recycled into polyester fibre, sheet, strapping or back into PET bottles: they all offer equal benefits to the ecological profile of PET. Mandatory or semi mandatory requirements to recycle PET bottles into PET bottles would be ridiculous. Public perception does not always match reality. Not many people comprehend that PET bottles, even for single use, are as good as their glass counterparts. This calls for further improvements in balanced, reputable education, and independent.

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REFERENCES

[1] L. Léal, M. Miscevic, P. Lavieille, M. Amokrane, F. Pigache, F. Topin, B. Nogarède and L. Tadrist, An overview of heat transfer enhancement methods and new perspectives: Focus on active methods using electro active materials, International Journal of Heat and Mass Transfer, 61, 2013, pp. 505-524.
[2] Wael I. A. Aly, Numerical study on turbulent heat transfer and pressure drop of Nano fluid in coiled tube in-tube heat exchangers, Energy Conversion and Management, Volume 79, March 2014, Pages 304316.
[3] A. Rabienataj Darzi, Mousa Farhadi and Kurosh Sedighi, Heat transfer and flow characteristics of AL2O3–water Nano fluid in a double tube heat exchanger, International Communications in Heat and Mass Transfer, Volume 47, October 2013, Pages 105112.
[4] Anup T. J. & Vilas Watwe, International Journal of Innovative Research in Science, Engineering and Technology. Vol. 3, Issue 7, July 2014.

