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A Review on Plastic Pyrolysis

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ABSTRACT: *Plastic usage has increased, and there is no effective system in place to manage its non-biodegradable nature, which has become a severe issue that concerns humanity. Growing consumption of fossil fuels, on the other hand, has resulted in their loss, necessitating the hunt for a substitute that can replace traditional fuels while also reducing emissions. By recycling waste plastic to useful energy, both the non-biodegradability of plastic and the demand for an alternative fuel can be resolved. To obtain fuel, waste plastic undergoes depolymerization, pyrolysis, thermal cracking, and distillation. Pyrolysis is the thermal decomposition of plastic into fuel in three forms: gas, crude oil, and solid residue. As a result, this article describes a literature review on plastic pyrolysis process for conversion into liquid oil and gasoline.*
Keywords: *Plastic, Pyrolysis, Fuel, Literature review.*

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I. INTRODUCTION:

Plastics are an essential element of our lives today, and they are employed in practically every area of daily life. Plastic waste is the source of many of the world's significant environmental problems since they are made from non-renewable resources and are often not disposable. Massive amounts of discarded plastic have recently been available in municipal solid waste (MSW) and other locations. Plastic pollution is a global problem. Humans have manufactured about 8 billion tonnes of plastic since 1950. More than half of it landed up in the landfill, with only approximately 9% being recycled. The majority of plastic that hasn't been recycled or dumped enters the oceans. Annually, it is estimated that between 4.8 and 12.7 million metric tonnes of plastic ends up in the ocean. In 1950, the world's annual plastic production was only 2 million tonnes. Average yearly production has nearly doubled since then, hitting 381 million tonnes in 2015.[1]

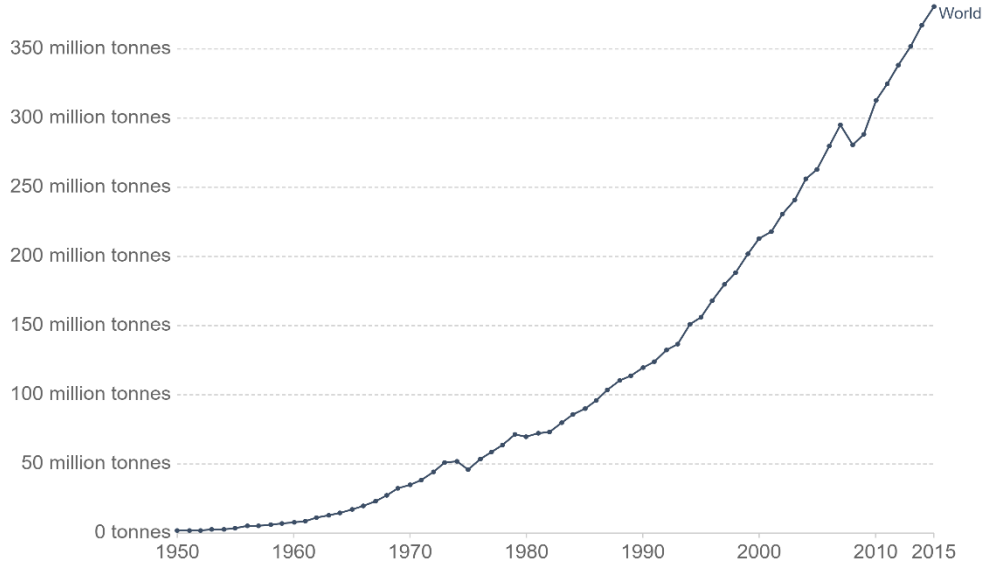

Figure 1: Global plastic production from 1950 to 2015.[1]

severe economic and environmental concerns. Plastic garbage generation per person is higher in high-income countries. Plastic garbage still finds its way into waterways, despite well-managed waste systems. Plastic in the waters has a harmful effect on the environment because marine animals may mistake it for food or become

caught or harmed as a result of it. Plastic pollution statistics of some major countries are present below in figure 2. China accounts for the huge majority of the World's plastic pollution and being on top by generating nearly 6 crore tonnes of plastic waste in 2021. Whereas, the USA stays the 2nd largest plastic pollution country. North Korea is one of the least plastic pollution-producing countries, only producing about 4.8 lakh tonnes.

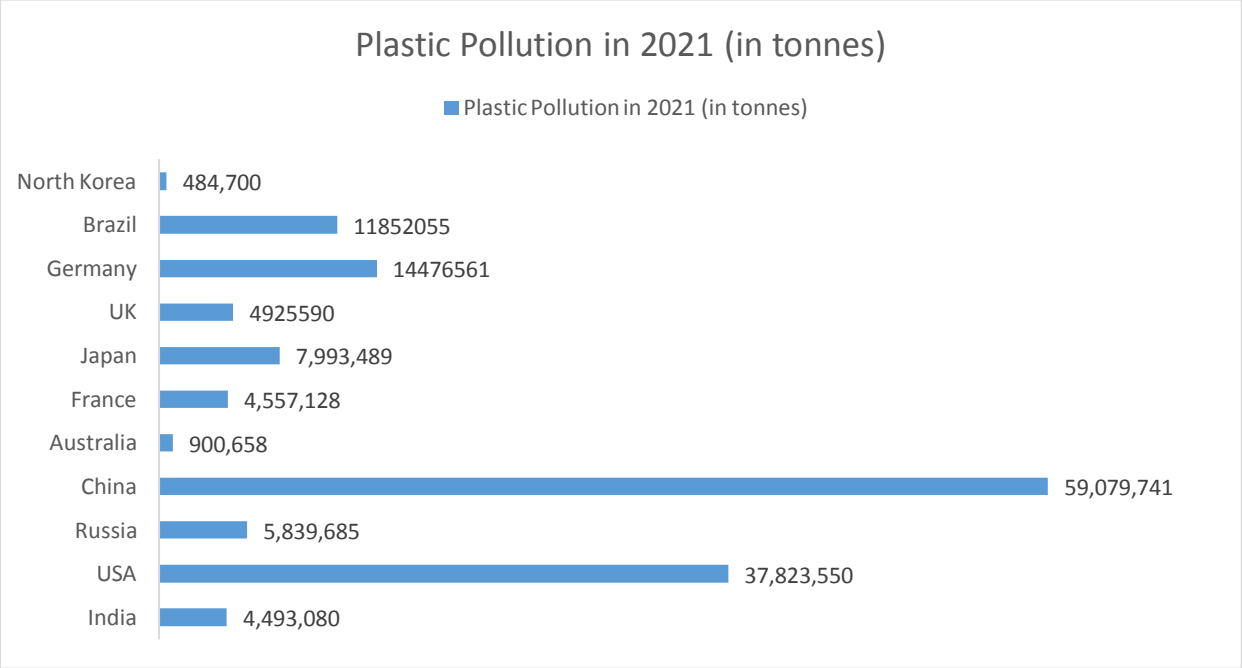

Figure 2: Plastic pollution in 2021.[2]

However, with the right treatment, waste plastics can become a huge source of energy. As a result of this issue, a method of transforming waste plastic into fuel has been proposed as a remedy. Because plastics are a component of petroleum, the pyrolysis oil has a high caloric value and can be utilised as a substitute fuel. Because natural resources are finite, the most sustainable alternative is to minimize crude oil utilization so that waste plastics can be reprocessed and used again to the maximum extent.[3] Pyrolysis is the heating-induced chemical breakdown of organic compounds. Pyro "fire" and lysis "decomposition" is Greek-derived elements that were used to create the word. Pyrolysis is the decomposition of long-chain hydrocarbon (polymer) molecules into smaller sizes (monomer) using higher temperatures (450–800°C) for a short time and in the anaerobic condition generating products in the form of carbon, residues, and volatile hydrocarbons that can be condensate as liquid oil or non-condensable as gasoline.[4]

II. LITERATURE REVIEW:

Tiwari D.C et.al (2009): In this work pyrolysis of LLDPE is studied. Two industrial cracking catalysts are used with the provision of pressure, a temperature measurement.[5]

Arun Joshi, Rambir and Rakesh Punia (2013): Addressed the study in India 3.6 million tons of plastic waste produced in 2007. Because of air pollution, economic unfairness compared to the waste plastics fuel system, incineration, gasification, the blast furnace is another method that does not effectively tackle this issue. A catalytic cracking method in which waste plastic is fractured at a high temperature and the gases produced are condensed to extract liquid fuels.[6]

Mochamad Syamsiro et.al (2013): Focused on developing and manufacturing the plastic waste shredding machine to supply the Municipal waste plastic for the waste pyrolysis process. The machine's output capability depends on the thickness of the plastic waste. Operational experience reveals that as a knife mover, the diesel engine emits fuel smoke and more noise compared to that of an electric motor. Catalyst presence increases gaseous fraction and reduces liquid fuel fraction.[7]

Neha Patni et.al. (2013): Presented the paper showing experimental results of working temperature, heating intensity, particle size, and solid dwelling parameters. The catalysts used are USY, ZSM5, MOR, ASA, etc the pyrolysis reactor must be built to be ideal for the processing of mixed waste plastics and small and mid-scale

plastics.[8]

Brajendra K. Sharma et.al. (2014): Made a detailed study on pyrolysis of HDPE waste plastic grocery bags followed by distillation, a major liquid hydrocarbon product (PPEH-L) with an average structure consisting mainly of saturated aliphatic paraffinic hydrogens (94.0 percent) and smaller quantities of aliphatic olefinic hydrogens (5.4 percent) and aromatic hydrogens (1.0 percent) corresponding to the boiling range typical of traditional hydrogens was obtained.[9]

Gaurav, Madhukar M. et.al. (2014): Presented the paper showing catalytic pyrolysis offers an efficient, safe, and very effective means of removing the debris that we are studying this we can infer from the studies carried out that the characteristics of the fuel obtained from plastics are close to that of petrol and better results can be obtained from further studies in this area.[10]

P. Senthil Kumar et.al (2014): GC-characterization FID's studies show that when linear thermoplastic polymers are used as feed, the depolymerization product is straight-chain hydrocarbons. Furthermore, the GCFID study reveals that the percentage of petrol in pyrolyzed oil is higher. For different types of machinery, residues obtained from the distillation process can be oils.[11]

Wega Trisunaryanti et.al (2014): Intended in the study to experimentally investigate pyrolysis of LDPE. The type of natural zeolite mineral obtained from Sukabumi, Indonesia consisted of the crystalline type of mordenite which has high thermal stability, was found from the results. Hydrocracking of LDPE plastic waste at 350°C effectively produced 14.91% of liquid yield, 1.39% of solid yield, and 83.71% of gas yield. 71.49% of the gasoline range and 28.52% of the diesel range were determined from the liquid yield. The liquid yield was composed of hydrocarbon compounds with an atomic chain between C6 and C19, such as isoparaffins, olefins, and naphthene.[12]

Vijaykumar B. Canashetty et.al. (2015): Examined the catalytic pyrolysis, which provides an inexpensive, clean, and very efficient way to remove the contaminants. studies were carried out that the properties of the fuel obtained from plastics are close to that of petrol and better results can be obtained from further studies in this area.[13]

R. Boopathy Pradeep. et.al (2016): The author made an attempt to investigate the polymer degradation used for the conversion of waste plastic into liquid hydrocarbon. It is done by catalytic degradation of waste plastic into hydrocarbons such as i.e., petrol, diesel, and kerosene, etc and plastic waste occurrences are significantly reduced. The conversion of waste plastic into fuel would decrease reliance on fossil fuels. Pelletizing process is used to minimize pollution that is caused by plastic waste.[14]

Achyut K. Panda et.al (2018): Made an attempt to make comparative study on the pyrolysis of various plastics into liquid fuel using calcium bentonite as a catalyst in a batch reactor, an optimized condition for temperature and catalyst concentration was experimentally developed. By improving the quality and quantity of oil and reaction time, calcium bentonite is shown to be the efficient catalyst for the pyrolysis of different plastics. Experiments can be done on all types of plastic the optimum conditions for high oil yield were at 500°C with a 1:3 catalyst to plastic ratio. For different plastic samples there were optimum pyrolysis conditions, the oil yield was around 80-90% by weight. The oil comprised only a hydrocarbon mixture.[15]

Kiran Raj Bukkarapu et.al (2018): Examined the recent study conducted by the Environmental Protection Agency(PA), the globe generates around billions of tonnes of waste plastic each year. According to statistics, about 10% of this plastic is reused, 25% is burned (destroyed by fire), and the rest 65% is released to the environment. Incineration is a viable alternative to dumping plastic trash in landfills, however it may result in unacceptable emissions of gases such as nitrous oxide, sulphur oxides, dusts, dioxins, and other poisons substances.[16]

Achyut K. Panda et.al (2019): Experimentally investigated the thermo-catalytic pyrolysis process used by sulphated zirconium hydroxide as a catalyst in a batch reactor for conversion of different plastics to liquid fuel. The maximum yield for all plastics was obtained using a 10% catalyst at 500°C. The oil yield obtained was over 79% and included hydrocarbons from C10 to C24. In the petro fuel (gasoline, kerosene, and diesel) category, the stated gravity of the oil is. The plastic oil's viscosity is within the range of kerosene and gasoline. In short, the fuel properties are sufficient to be used as a fossil fuel replacement. In short, the fuel can be used as a fossil fuel.[17]

A.Pakiya Pradeep,S. Gowthaman (2019): Investigated the process of pyrolysis is the conversion of waste plastic into hydrocarbon fuel which yields is 75% of usable liquid fuels without releasing any contaminants. Hazardous plastic waste will also be taken care of and the import of crude oil minimized. The properties of liquid plastic fuel are almost identical to diesel fuel, so plastic fuel is a good substitute fuel for diesel engines.[18]

Ramli Thahir, Ali Altway (2019): Experimented pyrolysis followed by bubble cap, tray column distillation. It was found that depending on the pyrolysis temperature, there are variations in the characterization of liquid fuel yielded on each tray.[19]

Samuel Kofi Tulashie et.al. (2019): This paper critically reviewed the advantage of plastic waste mixture pyrolysis (energy recycling and environmental problems) will only remain as long as the waste plastics stay, it will certainly provide a strong foundation for us to create a safe, clean and green future. Plastic waste is not the whole problem, but how we treat it counts as well. We therefore must be intelligent on how we treat plastics as a contaminant or as an economic resource is a great potential for plastic pyrolysis to turn plastics into oil to achieve full economic and environmental benefits. The best way to tackle the problems of great alternative fuel and waste plastic management is the recycling of plastic pyrolysis.[20]

Kundan Kumar Jha et.al. (2020): Examined the various field assessment of fuel development using the catalytic pyrolysis method from plastic waste (polypropylene), and parameters like temperature, the quantity of catalyst, and residence time were optimized. It was observed that by varying quantities of catalyst high-grade fuel can be obtained.[21]

Ram Jatan Yadav et.al (2020): Focused on process of waste plastics into hydrocarbon fuels and is a better alternative to petroleum. It decreases the number of imports of crude oil from other countries. Review of the various methods listed shows that in many countries, mechanical recycling is the most commonly used method. The technique of fuelling plastic waste through the pyrolysis process.[22]

Roman Krzywda et.al (2020): Aimed to study the condensation and fractionation unit with the rectification column allows the composition of both oil fractions to be regulated by changing the parameters of the process. Compared to the heat exchanger the system, the TOWR configuration is more complex, and periodic cleaning is required. The yield and composition of the oil do not depend on the feed stream temperature.[23]

III. CONCLUSION:

- According to review papers, fuel from plastic waste is a viable approach for gaining new energy resources while also addressing the larger issue of plastic waste management.
- Converting waste plastic into liquid fuel will lessen reliance on fossil fuels.
- The oil can be further fractionated and used as acceptable gasoline or aviation fuel, according to the analysis of physical, chemical, and gas chromatograms.
- For all of the plastic types, the best temperature for higher plastic oil yield was 500 °C with a catalyst to the plastic ratio of 1:3.
- At the optimum pyrolysis conditions, the oil output was around 80–90% by weight for several plastic samples.
- The method is completely eco-friendly and plastic waste is eliminated.
- Sulfur content in the fuel generated is less than 0.002%.

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