



Clean Energy from Plastic: Production of Pyrolysis Oil from Plastic Waste

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Abstract

Plastic materials' applications are expanding on a daily basis due to their unique properties, which enable them to replace other materials in their applications while still meeting customer needs thanks to advanced technology. In Sultanate of Oman 20.9% of the solid waste are plastics. As a result, more plastic produced, which leads to an increase in plastic waste. Since it is produced from an unsustainable crude oil source using a high-energy consuming method, plastic waste contributes significantly to soil, water, and even air pollution. As a result, they are non-biodegradable, resulting in high greenhouse gas emissions, a plastic waste crisis, and the non-renewable fossil fuel petroleum being depleted. One of the methods for handling plastic waste that has been developed is the energy recovery process. Given that petroleum was the primary source of plastic, converting it to liquid oil via pyrolysis had enormous potential, as the resulting oil had a calorific value comparable to commercial fuel. Pyrolysis of plastics is a chemical reaction in which larger molecules are broken down into smaller molecules using heat. As a result, the aim of this study is to catalytically pyrolyze most commonly plastic waste (PET, HDPE) into a liquid oil using a spent FCC catalyst. This will contribute to the plastic waste management program while also providing a renewable energy source which can be used in boilers combustion and engines fueling, reducing plastic waste. Pyrolysis has been found to be an excellent solution for transforming Petroplastics into different functional products, with liquid oil production reaching up to 80%, according to previous studies. This study conduct Pyrolysis of PET and HDPE plastic waste the poly fuel produced was analyzed by Gas Chromatography (GC) instrument and compared with commercial diesel properties.

1. Introduction

Plastic is a type of synthetic material structured of a high-molecular-weight polymer (20000 to 500000 kg/Kmole) added with other ingredients to enhance performance or reduced the costs. This mate-

rial was discovered more than a century ago and derives from the etymological term "moulded sample." According to the structure of the polymers that make up plastic, there are three types of plastics: elastomers (high Young's modulus viscoelastic materials created by short-chain polymers

linked by a weak force of attraction), thermoset-plastics, and thermoset-plastics (S. Kumar and Singh). The molecular structure of thermoplastics is basic, consisting of chemically independent macromolecules (Miandad et al., “Catalytic Pyrolysis of Plastic Waste: Moving Toward Pyrolysis Based Biorefineries”). They are softened or melted when heated, then moulded, formed, welded, and solidified after cooling (Miandad et al., “Catalytic pyrolysis of plastic waste: A review”). This property allows the thermoplastic to be used in a variety of consumer applications such as eyeglass lenses, shampoo bottles, food storage containers, drinking bottles, and other products, resulting in its high presence in landfills (Sarker et al., “Waste Polyethylene Terephthalate (PETE-1) Conversion into Liquid Fuel”). For these reasons, researchers are interested in using the thermoplastic in the pyrolysis process (Yuliansyah et al.). Plastic materials have recently become unavoidable in the world, and they can be used to replace a wide range of materials, including metal, wood, bone, and leather, depending on the application for the most efficient process and standard life (Jha and Kannan). Plastics are suitable for a wide variety of applications because they are versatile, electrically and thermally resistant, mouldable, chemically resistant, and lightweight by nature. According to 2015 global plastic production figures, the amount of plastic produced increased to over 360 million metric tons, with plastic wastes estimated to surpass the number of fish in the sea by 2050, and plastic-micro-particles trapping more than 80% of total available water (Miandad et al., “Plastic waste to liquid oil through catalytic pyrolysis using natural and synthetic zeolite catalysts”). Saudi Arabia, the United Arab Emirates, and Oman are the world’s largest plastic manufacturers, according to 2016 statistics, with Saudi Arabia, the United Arab Emirates, and Oman leading the pack. (Sharuddin et al., “A review on pyrolysis of plastic wastes”). This work explains the issue of plastic material’s widespread use and demand in a variety of applications due to its resilience, thermal, electrical, and resistance to chemical attack, machinability, and lighter weight properties, as well as other properties that enable it to be used in place of other materials such as metals, wood, and leather. (Claudio and Ariza). However, the majority of the plastics used are made from

finite petroleum products that emit a lot of greenhouse gases, produce toxic monomers, and are non-biodegradable (Al-Salem et al.). As a result, plastics have become extremely hazardous materials that have a wide range of effects on living things and the environment, even though they are still needed and manufactured. To mitigate the harmful effects of petroleum-based plastics, a high-quality liquid oil can be made from waste as part of waste management to minimize landfill waste and meet high energy demand (Jha, Kannan, and Senthilvelan). Furthermore, most waste management systems are costlier due to high labour costs for the separation process, as well as water pollution, which reduces the process’s sustainability (Khan et al.). As a result, various studies on the pyrolysis process technology have been carried out, including the processing of liquid oil, gaseous, and char as useful materials for industries and other utilities. This study focuses on making liquid oil from plastic waste, which is an environmentally friendly oil that does not release radioactive particles when degraded (Sharuddin et al., “Pyrolysis of plastic waste for liquid fuel production as prospective energy resource”). As a result, the paper will demonstrate how different parameters affect liquid yield efficiency and purity while using less energy. Because of its simple parameter control, high oil output yield, and energy conversion, the pyrolysis process is favoured.

2. Methodologies

The methodologies used in this experiment was to collect plastic waste from people’s homes initially. PET waste came from any brand of water bottle, while HDPE waste came from bottle caps. The waste plastics were then cleaned to remove any contaminants. The plastic wastes were segregated and cut into little pieces to enhance the material’s contact surface area during the pyrolysis process. The experimental setup, shown in Figure 1, illustrates the apparatus used to conduct the experiments. After that, 90 grams of clean PET and 10 grams of FCC catalyst were added to the reactor, which was then heated to 350 degrees Celsius, and the process was repeated for HDPE (Syamsiro et al.). A condenser was connected to the reactor and sealed once the catalyst was added, ensuring that no air enters the reactor during the process, as oxygen will cause the plastic waste to burn rather than thermally crack.

The reactor was then heated to between 300 and 350 degrees Celsius. Following that, the heating process began, during which the thermal degradation techniques were used, and the vapours formed by the thermal cracking of hydrocarbons were condensed. The vapour was collected after it had been transformed to liquid oil (poly fuel). After roughly 1.5 hours, the reactor's heating came to an end. Finally, after producing poly fuel through the pyrolysis process, the poly fuel was analysed and placed inside the Gas Chromatography apparatus to be compared to commercial fuel. The percentage yield of the pyrolysis liquid collected at the end of the reaction and gas was calculated by the Equations (1)–(3):

$$Y_{liquid} = \frac{M_2}{M_1} 100\% \quad (1)$$

$$Y_{residue} = \frac{M_3}{M_1} 100\% \quad (2)$$

$$Y_{gas} = 100\% - (Y_{liquid} - Y_{residue}) \quad (3)$$

Here,

M_1 : Mass of the sample, M_2 : Mass of liquid product, M_3 : Mass of residue.

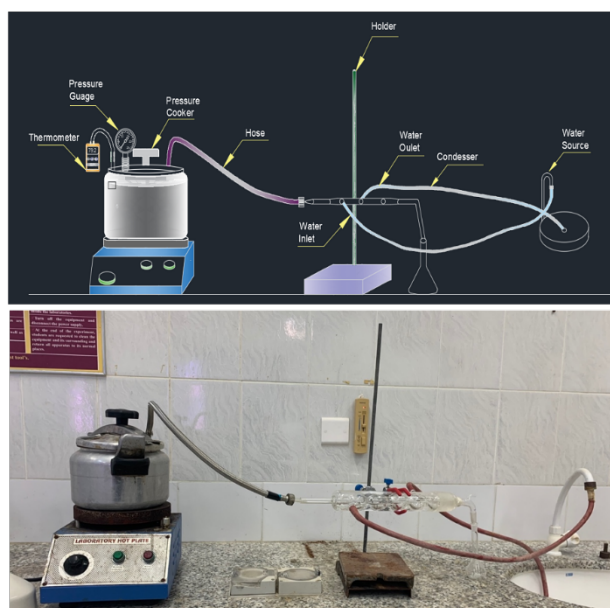


FIGURE 1. Experimental Setup

3. PET GC Results

With the exception of hexane, which was used as a solvent, the poly fuel generated from PET waste was fed into a GC instrument, and the GC graph exhibited tiny peaks. Figure 2. According to the GC data, there are 18 peaks in the PET GC results. The first peak revealed hexane with a retention duration of 1.541 minutes and an area percent of 74.85. (C₆H₁₄). With a retention time of 7.393 minutes, an area percent of 0.57, and a raw quantity of 0.0451, cyclodecane (C₁₀H₂₀) was the second peak. During retention time 8.797 minutes, there was an unknown peak with an area percent of 0.23 and a raw amount of 0.0184. Undecane (CH₃(CH₂)₉CH₃) at a retention time of 9.625 minutes with an area percent of 0.26 and a raw amount of 0.0208. At a retention time of 11.346 minutes, 3-dodecene (C₁₂H₂₄) had an area percent of 0.62 and a raw amount of 0.0490. 6-Tridecene (C₁₃H₂₆) was held for 13.093 minutes with an area percent of 0.52 and a raw amount of 0.0407. At retention time 14.262 minutes, tetradecane (CH₃(CH₂)₁₂CH₃) had an area percent of 0.47 and a raw amount of 0.0373. During the retention period of 15.370 minutes, 1-Pentadecene (C₁₅H₃₀) had an area percent of 0.26 and a raw amount of 0.0201. For 16.539 minutes, hexadecane (C₁₆H₃₄) with an area percent of 4.99 and a raw amount of 0.3921 was kept. During the retention time of 18.391 minutes, there was an unknown peak with an area percent of 0.59 and a raw quantity of 0.0464. 1-Nonadecane (C₁₉H₄₀) was kept for 20.896 minutes with an area percent of 7.19 and a raw amount of 0.5654. Heneicosane (C₂₁H₄₄) was held for 23.128 minutes with an area percent of 4.79 and a raw amount of 0.3767. With an area percent of 2.57 and a raw amount of 0.2023, nonadecane (C₁₉H₄₀) has a retention duration of 24.349 minutes. For 25.902 minutes, heptacosane (C₂₇H₅₆) with an area percent of 1.28 and a raw amount of 0.1010 was kept. Finally, Heptadecane (C₁₇H₃₆) was held for 27.036 minutes with an area percent of 0.80 and a raw amount of 0.0631. Components with a lower retention period are more volatile than those with a longer retention time, according to GC data.

The largest peak on the GC graph was hexadecane, with hexane being omitted because it was utilized as a solvent. 1-Nonadecane, Heneicosane, and Nonadecane were the other minor peaks. The GC results revealed that the PET plastic-based poly fuel

liquid comprises a range of hydrocarbons. PET poly fuel contains hydrocarbons ranging from C10 to C27. Because hexadecane (C₁₆H₃₄) is found in crude oil and is utilized as an ingredient in diesel, gasoline, and jet fuels, it can be used as a fuel. Hexadecane, which has a retention time of 17.80 minutes and an area percent of 3.09, is also found in light diesel. Furthermore, because the same component is present in the light diesel section as paraffin, the existence of nonadecane (C₁₉H₄₀) in poly fuel means that it can be used as a fuel (n or iso alkane group). Whereas Nonadecane has a retention duration of 25.36 minutes and an area percent of 1.57 in light diesel. Heneicosane (C₂₁H₄₄) is also present in diesel, and it is used for a variety of purposes, such as a feed for cracking into a gasoline blend stock material. Heneicosane is found in diesel with a retention time of 33.03 minutes and an area percent of 0.44 (Anene et al.). As a result, the components with the largest peak in PET poly fuel have been proved to be present in diesel fuel, which is utilized as gasoline and jet fuel.

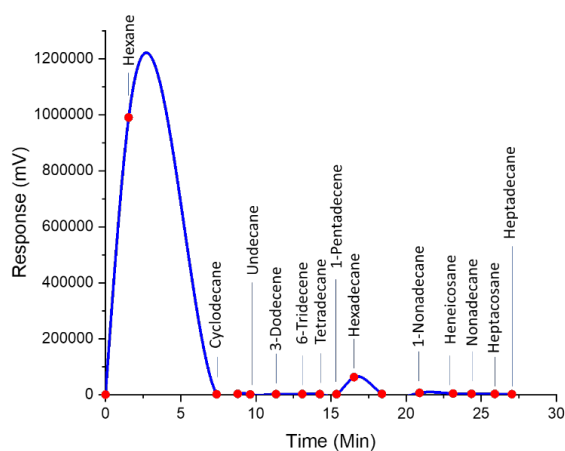


FIGURE 2. PET GC Results

4. HDPE GC Results

A GC instrument was used to inject poly fuel made from HDPE plastic waste, and the GC graph revealed considerably more peaks than the PET GC result. Figure 3. There are 24 peaks in HDPE, according to GC data. Hexane (C₆H₁₄) was discovered in the first peak with a retention duration of 1.571 minutes, an area percent of 3.44, and a raw amount of 0.3571. Heptane (C₇H₁₆), with a retention duration of 2.883 minutes, an area percent of 0.81, and a raw amount of 2.1909, was the

second peak. Octane (C₈H₁₈) had an area percent of 0.26 and a raw amount of 0.0838 at a retention duration of 4.303 minutes. The retention time of cyclopentane (C₅H₁₀) is 5.290 minutes, with an area percent of 0.70 and a raw amount of 0.0732. 1-nonene (C₉H₁₈) had an area percent of 0.84 and a raw amount of 0.0877 at a retention time of 5.995 minutes. Cyclohexane (C₆H₁₂) with an area percent of 1.84 and a raw amount of 0.1907 was kept for 6.866 minutes. Decane (C₁₀H₂₂) had an area percent of 0.83 and a raw amount of 0.0858 with a retention duration of 7.978 minutes. Peak 9 had an area percent of 3.88 and a raw amount of 0.4027 at retention time 8.986 minutes. With an area percent of 1.24 and a raw amount of 0.1287, dodecane (C₁₂H₂₆) was held for 11.676 minutes. 6-Tridecene (C₁₃H₂₆) had an area percent of 3.38 and a raw amount of 0.3510 at retention time 13.110 minutes. Tetradecane (C₁₄H₃₀) had an area percent of 1.78 and a raw amount of 0.1847 at retention time 14.662 minutes. The raw quantity of 1-hexadecanol (C₁₆H₃₄O) is 0.2249 percent, while the area percent is 2.16. 1-Hexadecanol (C₁₆H₃₄O) has a raw quantity of 0.2249% and an area percent of 2.16. 1-Hexadecanol (C₁₆H₃₄O) with area percent 2.16 and raw quantity 0.2249. At retention time 16.002 minutes, 1-Hexadecanol (C₁₆H₃₄O) with area percent 2.16 and raw amount 0.2249. Heptadecane (C₁₇H₃₆) with an area percent of 0.54 and a raw amount of 0.0566 was kept for 17.519 minutes. Peak 15 had an area percent of 0.67 and a raw quantity of 0.0701 at retention time 19.072 minutes. Nonadecane (C₁₉H₄₀) with an area percent of 2.35 and a raw amount of 0.2441 was maintained for 19.979 minutes. After 20.846 minutes of retention, 1-nonadecane (C₁₉H₄₀) had an area percent of 1.06 and a raw amount of 0.1100. Peak 18 had an area percent of 1.73 and a raw amount of 0.1795 at retention time 21.255 minutes. 10 heneicosane (C₂₁H₄₄) with an area percent of 19.86 and a raw amount of 2.0626 was discovered after a retention period of 21.882 minutes. 1-Docosane (C₂₂H₄₆) had an area percent of 4.62 and a raw amount of 0.4795 at a retention duration of 22.423 minutes. With an area percent of 6.72 and a raw amount of 0.6978, heneicosane (C₂₁H₄₄) was kept for 24.173 minutes. Tetracosane (C₂₄H₅₀), with an area percent of 19.98 and a raw amount of 2.0753, was kept for 24.688 minutes. Heptacosane (C₂₇H₅₆)

has a 0.50 minute retention duration, a 0.50 area percent, and a raw amount of 0.0517. Tetradecane is a kind of tetradecane (C₁₄H₃₀). According to GC data, components with a shorter retention duration are more volatile than those with a longer retention period. There are 24 peaks in HDPE, according to GC data. Hexane (C₆H₁₄) was discovered in the first peak with a retention duration of 1.571 minutes, an area percent of 3.44, and a raw amount of 0.3571. Heptane (C₇H₁₆), with a retention duration of 2.883 minutes, an area percent of 0.81, and a raw amount of 2.1909, was the second peak. Octane (C₈H₁₈) had an area percent of 0.26 and a raw amount of 0.0838 at a retention duration of 4.303 minutes. The retention time of cyclopentane (C₅H₁₀) is 5.290 minutes, with an area percent of 0.70 and a raw amount of 0.0732. 1-nonene (C₉H₁₈) had an area percent of 0.84 and a raw amount of 0.0877 at a retention time of 5.995 minutes. Cyclohexane (C₆H₁₂) with an area percent of 1.84 and a raw amount of 0.1907 was kept for 6.866 minutes. Decane (C₁₀H₂₂) had an area percent of 0.83 and a raw amount of 0.0858 with a retention duration of 7.978 minutes. Peak 9 had an area percent of 3.88 and a raw amount of 0.4027 at retention time 8.986 minutes. With an area percent of 1.24 and a raw amount of 0.1287, dodecane (C₁₂H₂₆) was held for 11.676 minutes. 6-Tridecene (C₁₃H₂₆) had an area percent of 3.38 and a raw amount of 0.3510 at retention time 13.110 minutes. Tetradecane (C₁₄H₃₀) had an area percent of 1.78 and a raw amount of 0.1847 at retention time 14.662 minutes. The raw quantity of 1-hexadecanol (C₁₆H₃₄O) is 0.2249 percent, while the area percent is 2.16. 1-Hexadecanol (C₁₆H₃₄O) has a raw quantity of 0.2249% and an area percent of 2.16. 1-Hexadecanol (C₁₆H₃₄O) with area percent 2.16 and raw quantity 0.2249. At retention time 16.002 minutes, 1-Hexadecanol (C₁₆H₃₄O) with area percent 2.16 and raw amount 0.2249. Heptadecane (C₁₇H₃₆) with an area percent of 0.54 and a raw amount of 0.0566 was kept for 17.519 minutes. Peak 15 had an area percent of 0.67 and a raw quantity of 0.0701 at retention time 19.072 minutes. Nonadecane (C₁₉H₄₀) with an area percent of 2.35 and a raw amount of 0.2441 was maintained for 19.979 minutes. After 20.846 minutes of retention, 1-nonadecane (C₁₉H₄₀) had an area percent of 1.06 and a raw amount of 0.1100. Peak 18 had

an area percent of 1.73 and a raw amount of 0.1795 at retention time 21.255 minutes. 10 heneicosane (C₂₁H₄₄) with an area percent of 19.86 and a raw amount of 2.0626 was discovered after a retention period of 21.882 minutes. 1-Docosane (C₂₂H₄₆) had an area percent of 4.62 and a raw amount of 0.4795 at a retention duration of 22.423 minutes. With an area percent of 6.72 and a raw amount of 0.6978, heneicosane (C₂₁H₄₄) was kept for 24.173 minutes. Tetracosane (C₂₄H₅₀), with an area percent of 19.98 and a raw amount of 2.0753, was kept for 24.688 minutes. Heptacosane (C₂₇H₅₆) has a 0.50 minute retention duration, a 0.50 area percent, and a raw amount of 0.0517. Tetradecane is a kind of tetradecane (C₁₄H₃₀). According to GC data, components with a shorter retention duration are more volatile than those with a longer retention period. The high peaks on the HDPE poly fuel GC graph include Heptane, Octane, Cyclopentane, Dodecane, 6-Tridecene, Tetradecane, Heptadecane, Nonadecane, 10 Heneicosane, 1-Docosane, Heneicosane, and Tetracosane. The poly fuel liquid generated from HDPE plastic contained a range of hydrocarbons, according to the GC data. HDPE poly fuel contains hydrocarbons ranging from C₅ to C₂₇. The industry standard for octane ratings, such as those found on gas stations, is Heptane (C₇H₁₆). Octane (C₈H₁₈), a component found in gasoline that is particularly important in establishing the quality of the fuel, was also observed in the poly fuel. The higher the octane number, the higher the quality of the fuel. Cyclopentane (C₅H₁₀) is present in natural gas, motor fuel, diesel, petroleum gas, kerosene, and a range of other heavy oils, and is classified as a cycloalkane. Decane (C₁₀H₂₂) is a paraffin petroleum component that is used in jet fuel research and is found in poly fuel. Decane, which has a retention time of 4.87 minutes and an area percent of 0.43, is also found in light diesel. Tetradecane (C₁₄H₃₀) is a component of jet fuel that was identified in crude oil. In light diesel, tetradecane has a retention time of 12.39 minutes and an area percent of 1.74. Heptadecane (C₁₇H₃₆), which has a retention time of 20.13 minutes and an area percent of 4.04 in light diesel, is also found in petroleum products. Nonadecane (C₁₉H₄₀) in poly fuel shows that it can be used as a fuel because it is the same component found in light diesel fraction as paraffin (n or iso alkane group). In mild diesel, Nonadecane has

a retention time of 25.36 minutes and an area percent of 1.57. Heneicosane (C₂₁H₄₄), which is also found in diesel, is used in a variety of applications, including feed, where it is broken down into a gasoline mix stock material. In diesel, heneicosane has a retention time of 33.03 minutes and an area percent of 0.44. Additionally, docosane (C₂₂H₄₆) and tetracosane (C₂₄H₅₀) are two components found in diesel. The largest peak in the GC result for HDPE poly fuel was discovered to be for 10 Heneicosane. As a result, the HDPE poly fuel components with the largest peak have been found in diesel fuel, as well as gasoline, jet fuel, and petroleum products. Furthermore, the GC data show that the poly fuel produced HDPE plastic is better than the PET poly fuel; this is due to the presence of more hydrocarbons in diesel, and the GC results of HDPE poly fuel show more peaks than the GC results of PET poly fuel; this is due to the presence of more hydrocarbons in diesel, and the GC results of HDPE poly fuel show more peaks than the GC results of PET poly fuel. (Vijayakumar and Sebastian).

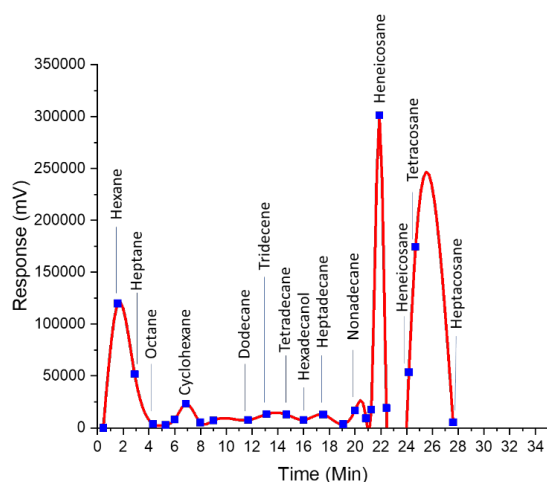


FIGURE 3. HDPE GC Results

5. Comparison of Poly Fuel

Both poly fuels comprised hydrocarbons, a component found in diesel and used in automobile and jet fuels, and were produced from PET and HDPE plastics. The PET poly fuel GC graph revealed tiny peaks, revealing that only 18 peaks existed in the PET poly fuel. The GC graph for HDPE poly fuel, on the other hand, exhibited numerous peaks, more than the PET GC result, and it revealed that the HDPE poly fuel had 24 peaks, which is more

than the PET poly fuel. More components found in HDPE poly fuel that are found in diesel and petroleum products and can be used in car and jet fuel have been discovered. According to previous study, PET poly fuel has a density of roughly 900 kg/m³, whereas HDPE poly fuel has a density of 747.7 kg/m³, which is closest to the density of gasoline and diesel, which are 780 kg/m³ and 807 kg/m³ respectively. As a result, PET poly fuel has a higher density than HDPE poly fuel. (P. S. Kumar et al.).

In the HDPE poly fuel GC result, the peak for 10 Heneicosane was observed at retention time 21.882 minutes with area percent 19.86 and raw quantity 2.0626, and 10 Heneicosane was found to be present in diesel and petroleum products. Hexadecane, on the other hand, had the highest peak on the GC graph, with the exception of hexane, which was used as a solvent. The peak was found at 16.539 minutes retention time, with an area percent of 4.99 and a raw amount of 0.3921. Because it is found in crude oil and is utilized as an ingredient in diesel, gasoline, and jet fuel, hexadecane has been confirmed to be a fuel. Heneicosane was found in PET poly fuel with a retention period of 23.128 minutes, an area percent of 4.79, and a raw amount of 0.3767, all of which are low. Hexadecane was not present in HDPE poly fuel. The majority of peaks in HDPE poly fuel and PET poly fuel GC data indicate that they contain hydrocarbons found in diesel and petroleum products. HDPE poly fuel, on the other hand, had more and higher peaks, as well as more components, than PET plastics; hence, both can be used as a diesel substitute, but HDPE poly fuel is more suited than PET poly fuel. According to prior tests, when a calcium hydroxide (Ca(OH)₂) catalyst was used for PET plastic pyrolysis at temperatures ranging from 405 to 500°C, the amount of fuel obtained was 6.3ml. For example, using 40 grams of PET plastic and 80 grams of Ca(OH)₂ catalyst, the catalyst to PET waste ratio was 2:1. Furthermore, using a zeolite type catalyst (CAT-2) on HDPE plastic helped lower the temperature of polymer degradation, meaning less energy consumption during the pyrolysis process. The pyrolysis temperature of HDPE plastic was 452–489 degrees Celsius. For HDPE plastic, the zeolite type catalyst (CAT-2) was found to be superior to the LDPE/PP plastic mixture. Thus, instead of using an FCC catalyst, a calcium hydroxide (Ca(OH)₂) catalyst for PET pyrolysis and

a zeolite type catalyst (CAT-2) for HDPE pyrolysis is preferable (Sarker et al., “Method of Converting Municipal Proportional Waste Plastics into Liquid Hydrocarbon Fuel by Using Activated Carbon”).

6. Conclusion

Plastics are one of the most widely utilized materials in a growing number of applications. Plastic materials can now be found almost wherever. Humans use plastic products to make their lives easier, safer, and cleaner. Plastics are highly versatile materials that are ideal for a wide range of industrial and consumer applications. However, as the world's population grows, so does the creation of plastic, which is disposed of in landfills, oceans, and other places. The majority of waste plastic in the world ends up in the ocean. Plastic waste accumulates in the center of the ocean over time due to the flow of the water, forming “a patch of wastes,” resulting in a vast amount of floating collected waste in the oceans. Plastic pollution disrupts the food chain, pollutes groundwater, pollutes land, and pollutes the air. Plastics account up 20.9 percent of solid waste in the Sultanate of Oman. Pyrolysis of plastics is a method for reducing pollution produced by plastic waste and converting it into a useful energy source. Pyrolysis is a chemical reaction in which heat is used to break down bigger molecules into smaller molecules. PET and HDPE plastic waste were pyrolyzed at a temperature of 300-350°C. The project's goal of performing pyrolysis on the most regularly used plastic type was achieved. In addition, the project's goals of producing poly fuel (bio-fuel) from waste PET (Polyethylene Terephthalate) and HDPE (High-Density Polyethylene) plastics, reducing plastic waste by recycling, and analyzing the poly fuel created from the pyrolysis of PET and HDPE plastics were met. Due to very small feedstock volume and insufficient temperature, approximately 1 ml of poly fuel from PET and HDPE poly fuel was generated, according to the results. The poly fuel produced by the pyrolysis process from PET and HDPE plastic waste was evaluated using a gas chromatography analyzer. Hexadecane was the largest peak in the GC graph for PET poly fuel, omitting hexane because it was used as a solvent. The hydrocarbons in PET poly fuel range from C10 to C27. PET poly fuel contains components found in diesel fuel and is utilized as gasoline and jet fuel

due to the presence of hexadecane, nonadecane, and heneicosane. The HDPE poly fuel GC graph, on the other hand, has a lot of high peaks. The hydrocarbons in HDPE poly fuel range from C5 to C27. The presence of Heptane, Octane, Cyclopentane, Dodecane, Tridecene, Tetradecane, Heptadecane, Nonadecane, Heneicosane, and Tetracosane in HDPE poly fuel demonstrates that the poly fuel contains components found in diesel fuel, gasoline, jet fuel, and petroleum products. Furthermore, the GC data demonstrate that the poly fuel created from HDPE poly fuel is superior to that produced from PET poly fuel; this is owing to the presence of more hydrocarbons contained in diesel, and the HDPE poly fuel GC results show more and higher peaks than the PET poly fuel GC results. As a result, both HDPE and PET poly fuels can be utilized as a diesel substitute, however HDPE poly fuel is preferable to PET poly fuel.

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References

- Anene, Azubuikwe, et al. “Experimental Study of Thermal and Catalytic Pyrolysis of Plastic Waste Components”. *Sustainability* 10.11 (2018): 3979–3979. [10.3390/su10113979](https://doi.org/10.3390/su10113979).
- Claudio, J E M and O J C Ariza. “A study on thermo - Catalytic degradation of PET (polyethylene terephthalate) waste for fuel production and chemical products”. *Chem. Eng. Trans* 57 (2017): 259–264. [10.3303/CET1757044](https://doi.org/10.3303/CET1757044).
- Jha, Kundan Kumar and T. T. M. Kannan. “Recycling of plastic waste into fuel by pyrolysis - a review”. *Materials Today: Proceedings* 37 (2021): 3718–3720. [10.1016/j.matpr.2020.10.181](https://doi.org/10.1016/j.matpr.2020.10.181).
- Jha, Kundan Kumar, T. T. M. Kannan, and N. Senthilvelan. “Optimization of catalytic pyrolysis process for change of plastic waste into fuel”. *Materials Today: Proceedings* 39 (2021): 708–711. [10.1016/j.matpr.2020.09.263](https://doi.org/10.1016/j.matpr.2020.09.263).
- Khan, M. Z. H., et al. “Pyrolytic Waste Plastic Oil and Its Diesel Blend: Fuel Characterization”. *Journal of Environmental and Public Health* 2016 (2016): 1–6. [10.1155/2016/7869080](https://doi.org/10.1155/2016/7869080).

- Kumar, P. Senthil, et al. "Conversion of waste plastics into low-emissive hydrocarbon fuels through catalytic depolymerization in a new laboratory scale batch reactor". *International Journal of Energy and Environmental Engineering* 8.2 (2017): 167–173. [10.1007/s40095-015-0167-z](https://doi.org/10.1007/s40095-015-0167-z).
- Kumar, Sachin and R. K. Singh. "Thermolysis of High-Density Polyethylene to Petroleum Products". *Journal of Petroleum Engineering* 2013 (2013): 1–7. [10.1155/2013/987568](https://doi.org/10.1155/2013/987568).
- Miandad, Rashid, et al. "Catalytic Pyrolysis of Plastic Waste: Moving Toward Pyrolysis Based Biorefineries". *Frontiers in Energy Research* 7 (2019). [10.3389/fenrg.2019.00027](https://doi.org/10.3389/fenrg.2019.00027).
- Miandad, R., et al. "Catalytic pyrolysis of plastic waste: A review". *Process Safety and Environmental Protection* 102 (2016): 822–838. [10.1016/j.psep.2016.06.022](https://doi.org/10.1016/j.psep.2016.06.022).
- Miandad, R., et al. "Plastic waste to liquid oil through catalytic pyrolysis using natural and synthetic zeolite catalysts". *Waste Management* 69 (2017): 66–78. [10.1016/j.wasman.2017.08.032](https://doi.org/10.1016/j.wasman.2017.08.032).
- Al-Salem, S. M., et al. "A review on thermal and catalytic pyrolysis of plastic solid waste (PSW)". *Journal of Environmental Management* 197 (2017): 177–198. [10.1016/j.jenvman.2017.03.084](https://doi.org/10.1016/j.jenvman.2017.03.084).
- Sarker, Moinuddin, et al. "Method of Converting Municipal Proportional Waste Plastics into Liquid Hydrocarbon Fuel by Using Activated Carbon". *International Journal of Materials and Chemistry* 2.5 (2013): 208–217. [10.5923/j.ijmc.20120205.05](https://doi.org/10.5923/j.ijmc.20120205.05).
- Sarker, Moinuddin, et al. "Waste Polyethylene Terephthalate (PETE-1) Conversion into Liquid Fuel". *Journal of Fundamentals of Renewable Energy and Applications* 1 (2011): 1–5. [10.4303/jfrea/r101202](https://doi.org/10.4303/jfrea/r101202).
- Sharuddin, S D A, et al. "Pyrolysis of plastic waste for liquid fuel production as prospective energy resource". *IOP Conference Series: Materials Science and Engineering* 334 (2018): 012001–012001. [10.1088/1757-899x/334/1/012001](https://doi.org/10.1088/1757-899x/334/1/012001).
- Sharuddin, Shafferina Dayana Anuar, et al. "A review on pyrolysis of plastic wastes". *Energy Conversion and Management* 115 (2016): 308–326. [10.1016/j.enconman.2016.02.037](https://doi.org/10.1016/j.enconman.2016.02.037).
- Syamsiro, Mochamad, et al. "Fuel Oil Production from Municipal Plastic Wastes in Sequential Pyrolysis and Catalytic Reforming Reactors". *Energy Procedia* 47 (2014): 180–188. [10.1016/j.egypro.2014.01.212](https://doi.org/10.1016/j.egypro.2014.01.212).
- Vijayakumar, Anandhu and Jilse Sebastian. "Pyrolysis process to produce fuel from different types of plastic – a review". *IOP Conference Series: Materials Science and Engineering* 396 (2018): 012062–012062. [10.1088/1757-899x/396/1/012062](https://doi.org/10.1088/1757-899x/396/1/012062).
- Yuliansyah, Ahmad Tawfiequrrahman, et al. "Pyrolysis of Plastic Waste to Produce Pyrolytic Oil as an Alternative Fuel". *International Journal of Technology* 6.7 (2015): 1076–1076. [10.14716/ijtech.v6i7.1241](https://doi.org/10.14716/ijtech.v6i7.1241).



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