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HYDROCARBON FRACTIONS FROM THERMOLYSIS OF WASTE PLASTICS AS COMPONENTS OF ENGINE FUELS

Berdiyeva Ayjemal

Supervisor: Lecturer of Oguz han Engineering and Technology University of Turkmenistan
Ashgabat, Turkmenistan

Ekayev Mukam

Supervisor: Lecturer of Oguz han Engineering and Technology University of Turkmenistan
Ashgabat, Turkmenistan

Gurbangeldiyeva Suray

Student of Oguz han Engineering and Technology University of Turkmenistan
Ashgabat, Turkmenistan

Abstract

The increasing accumulation of waste plastics poses a significant environmental challenge. However, the thermolysis of these waste plastics has emerged as a promising method for transforming them into valuable hydrocarbon products, which can potentially be used as components of engine fuels. The thermolysis process involves the thermal decomposition of plastics at high temperatures in the absence of oxygen, resulting in a range of hydrocarbon fractions that can be further processed into usable fuel. This article explores the potential of using hydrocarbon fractions obtained from the thermolysis of waste plastics in engine fuels. It discusses the chemical composition, properties, and the impact of these hydrocarbon fractions on fuel performance and engine operation.

1. Introduction

The global plastic waste crisis continues to grow, with millions of tons of plastic being discarded each year. Conventional methods of plastic waste disposal, such as landfilling or incineration, are not sustainable and pose environmental risks. In response to these concerns, researchers have been exploring alternative methods to convert waste plastics into valuable products, including fuels. One such method is the thermolysis of plastics, which involves heating plastic waste in the absence of oxygen to break down the polymer chains into smaller hydrocarbon molecules.

Thermolysis of plastics has gained attention due to its ability to produce liquid fuels, gases, and solid residues, which can be used as components of engine fuels. These hydrocarbon fractions can be processed and upgraded to meet the specifications of commercial fuels.

This paper focuses on the use of the hydrocarbon fractions derived from the thermolysis of waste plastics as potential components for engine fuels, analyzing their chemical composition, fuel properties, and the potential benefits of incorporating them into existing fuel systems.

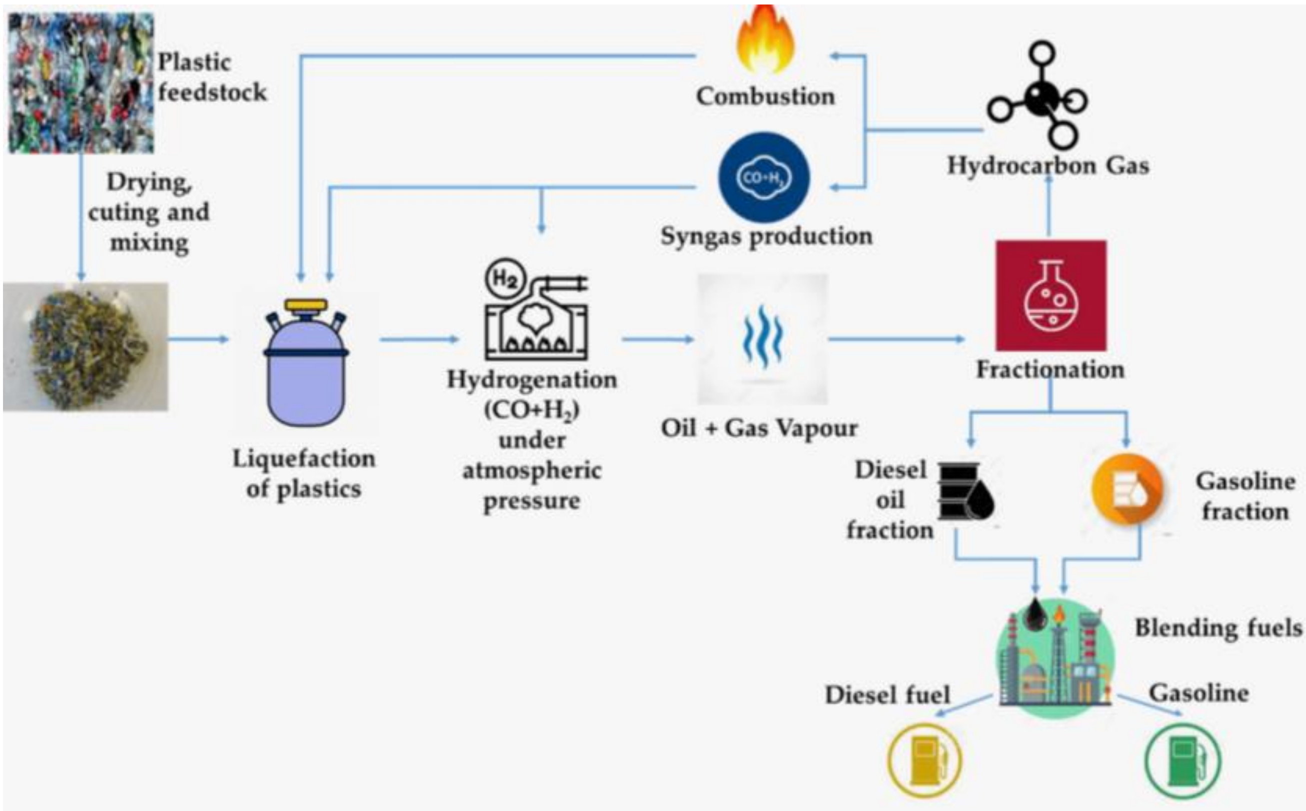

Figure 1. The process diagram from raw material to fuel products ***("Plastic Waste and Recycling: Environmental Impact, Current Practices, and Technological Advances"Authors****: Robert K. Gupta, Shashi Bhushan, and Vikas Kumar)*

2. Thermolysis Process of Waste Plastics

Thermolysis, or pyrolysis, is a thermal degradation process that occurs in the absence of oxygen. This process breaks down waste plastics into smaller molecules, typically producing a mixture of gaseous hydrocarbons, liquid oils, and solid char. The key steps in the thermolysis of plastics include:

- **Pre-treatment of Plastics**: Waste plastics are first sorted, cleaned, and shredded into smaller pieces to ensure uniformity and improve the efficiency of the thermolysis process.
- **Heating and Decomposition**: The plastics are heated to temperatures typically ranging from 350°C to 500°C.

At these temperatures, the long polymer chains in plastics break down into smaller hydrocarbon molecules, such as alkanes, alkenes, aromatics, and other organic compounds.

- **Product Separation**: The products of thermolysis include gaseous hydrocarbons, liquid oil, and solid residues (char). The gaseous hydrocarbons are typically composed of lighter compounds such as methane, ethane, propane, and butane.

  The liquid fraction contains a range of hydrocarbons, including aliphatic and aromatic compounds, and can be used as a potential fuel component. The solid char is usually rich in carbon and can be further processed or used in other applications.

The composition of the hydrocarbon fractions depends on the type of plastic being thermolyzed, the process conditions (such as temperature and pressure), and the presence of catalysts. Common plastics, such as polyethylene (PE), polypropylene (PP), and polystyrene (PS), yield different distributions of hydrocarbons during thermolysis.

3. Hydrocarbon Fractions from Thermolysis of Waste Plastics

The liquid products obtained from the thermolysis of waste plastics consist of a complex mixture of hydrocarbons, which can be classified into several fractions based on their boiling points and chemical properties. These hydrocarbon fractions can be categorized as follows:

- **Light Hydrocarbons (C1–C4)**: These are low molecular weight compounds, such as methane, ethane, propane, and butane, which are typically produced in the gaseous phase during thermolysis. These light hydrocarbons can be used as a source of natural gas or further processed into high-value products like ethylene and propylene, which are key feedstocks in the petrochemical industry.
- **Mid-range Hydrocarbons (C5–C12)**: These hydrocarbons are typically found in the liquid phase and consist of a mix of alkanes, alkenes, and aromatic compounds. These fractions are particularly relevant for engine fuels and can be used as gasoline or diesel-like fuels after proper refinement and upgrading.
- **Heavy Hydrocarbons (C13 and above)**: These are higher molecular weight compounds that can be used as diesel fuel or further processed into lubricants or other high-viscosity fuels. However, their presence in the product stream may require further treatment, such as distillation or hydrocracking, to improve their fuel properties.

The chemical composition of these fractions largely depends on the type of plastic used and the thermolysis conditions. For example, polyethylene (PE) typically yields a higher proportion of light hydrocarbons, while polystyrene (PS) tends to produce a greater share of aromatic compounds, which can have beneficial properties for fuel performance.

4. Fuel Properties of Hydrocarbon Fractions from Waste Plastics

The hydrocarbon fractions derived from the thermolysis of waste plastics can exhibit a range of properties that make them suitable for use as engine fuel components. Key fuel properties that are affected by the type of plastic and the thermolysis process include:

- **Energy Content**: The energy content of the hydrocarbon fractions depends on their chemical composition and molecular weight. In general, lighter hydrocarbons such as methane, ethane, and propane have higher energy densities compared to heavier fractions like the heavier alkanes or aromatics. The overall energy content of the product depends on the distribution of these fractions in the final product.
- **Octane Rating (for Gasoline)**: Hydrocarbons with a high proportion of alkanes and aromatics tend to have higher octane ratings, making them suitable for use in gasoline engines. The presence of aromatic compounds, such as benzene, toluene, and xylene, can improve the octane rating of the fuel. Therefore, the liquid hydrocarbons obtained from thermolysis of plastics like PS and PET can be blended into gasoline formulations.
- **Cetane Rating (for Diesel)**: The cetane rating of a fuel is an important factor for diesel engines. Hydrocarbons that are more saturated (alkanes) generally have higher cetane numbers, which means they ignite more easily and burn more efficiently in diesel engines. The heavier hydrocarbons obtained from thermolysis of plastics like PE and PP can be suitable candidates for blending into diesel fuels after proper treatment.
- **Viscosity**: Viscosity is a critical parameter for engine fuels, particularly in cold weather conditions. The viscosity of the hydrocarbon fractions from waste plastics can vary depending on their molecular weight and chemical structure. Generally, liquid hydrocarbons with higher molecular weights have higher viscosities. Therefore, some heavier fractions may require blending or refining to meet the viscosity specifications for commercial engine fuels.

5. Challenges and Considerations

While the thermolysis of waste plastics offers promising opportunities for producing alternative fuel components, several challenges need to be addressed:

- **Process Efficiency**: The efficiency of the thermolysis process depends on various factors such as temperature, pressure, and plastic type. Optimizing these parameters is crucial to maximize the yield of usable hydrocarbon fractions and minimize the production of unwanted by-products, such as char and gas.
- **Contamination and Impurities**: Waste plastics often contain contaminants such as additives, dyes, and fillers that can affect the quality of the resulting hydrocarbons. These impurities need to be removed or minimized to ensure that the fuel fractions meet the required specifications.

- **Upgrading and Refining**: The hydrocarbon fractions from thermolysis may require additional refining processes, such as distillation, hydrotreatment, or cracking, to improve their fuel properties and make them suitable for use in modern engines. This adds to the complexity and cost of the process.
- **Environmental Impact**: While the thermolysis of waste plastics reduces plastic waste and produces valuable fuels, the environmental impact of the process should be carefully assessed. Emissions from the process, as well as the sustainability of the plastic feedstock, must be considered in the broader context of waste management and fuel production.

6. Conclusion

The thermolysis of waste plastics offers a promising method for converting plastic waste into valuable hydrocarbon fractions that can be used as components of engine fuels. These hydrocarbon fractions, depending on their chemical composition, can be used in gasoline or diesel engines after appropriate refining and upgrading. The use of waste plastics as a feedstock for fuel production not only addresses the growing environmental issue of plastic waste but also provides an alternative source of energy. However, further research and development are needed to optimize the thermolysis process, improve the quality of the fuel products, and address economic and environmental challenges.

References

1. Wang, H., & Xu, C. (2019). *Thermolysis of Plastic Waste to Liquid Fuels*. Journal of Environmental Management, 238, 217-228.
2. Pötsch, J., & Kühl, J. (2018). *Upgrading Plastic Waste to Engine Fuels by Pyrolysis*. Fuel Processing Technology, 172, 85-94.
3. Sadhukhan, J., & Thomas, T. (2020). *Conversion of Plastic Waste to Energy via Thermochemical Processes*. Renewable and Sustainable Energy Reviews, 116, 109-119.
4. Rahim, F., & Muda, M. (2021). *Conversion of Waste Plastics to Fuel by Pyrolysis and its Effect on Engine Performance*. Energy Reports, 7, 845-853.