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ANALYSIS OF POTENTIAL AND CONTRAINTS OF THE UTILIZATION OF PLASTIC WASTE AS FUEL OIL (BBM)

Cindy Ineke Ferdianti*, Sudarti
Universitas Jember
*E-mail: cindyinekeferdianti@gmail.com, sudarti.fkip@unej.ac.id

ABSTRACT

Indonesia is one of the countries that produces the highest plastic waste, but the management of plastic waste is still not optimal. Abundant plastic waste can be used as an alternative energy source for fuel oil (BBM) using the pyrolysis method. The purpose of this study is to examine the potential and constraints of using plastic waste as fuel oil by using the pyrolysis method. The method used in this research is a literature review conducted by collecting data from other studies that are still in line with the themes discussed in this article. The oil produced from the pyrolysis process of plastic waste can be used as a single fuel or as a substitute because of its relatively high thermal efficiency. Utilization of plastic waste into fuel oil has several obstacles, namely waste sorting takes a long time and is relatively inefficient in making reactors for large-scale processing, this is due to bubbling, chaneling, and still leaving residue. Plastic waste that is used as fuel oil by the pyrolysis method is one of the breakthroughs that can overcome the waste problem, although there are several obstacles in the application of the pyrolysis method.

***Keywords**: Platic waste; fuel oil; pyrolysis; potential; contraints*

INTRODUCTION

Garbage is all objects that are no longer needed, unwanted, and discarded by their owners. WHO (World Health Organization) defines waste as any object that is no longer needed, not liked, or any object that is thrown away. Garbage is a complex problem for the Indonesian people. The problem of waste continues to increase along with the development of the population. The problems caused by waste are closely related to human behavior which is the producer of waste. The lack of public understanding of waste management and the continued growth of population development causes the waste produced to be not commensurate with its management. This causes serious problems for the environment. Plastic waste cannot decompose by itself and if it is not handled properly it will also pollute the environment, so special efforts are needed to deal with the waste problem.

People who do not have an understanding of waste management usually burn plastic waste in order to reduce its quantity. This is not appropriate because burning plastic waste has the potential to produce toxic gas, namely Hydrogen Sulfide (H2S) (Endang et al., 2016). According to Nurdiansah, Purnomo and Kasiwi (2020) methane gas (CH4) which has the potential to affect climate change is mostly produced from waste. Improper management of plastic waste can add new problems to the environment.

(Lestari et al., 2021) stated that Indonesia is one of the countries that ranks among the highest contributors of plastic to the sea. Ordinary people who do not understand the characteristics of waste think that throwing plastic waste into the sea will solve the waste problem, even though this is certainly not true. The Indonesian Association of Aromatic Olefins and Plastics (Inaplas) and the Central Statistics Agency (BPS) state that Indonesia can produce up to 64 million tons, of which 3.2 million tons are dumped into the ocean.

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Disposal of plastic waste into the sea will actually cause other problems that are no less polluting the environment. Plastic waste management that is less than optimal is also caused because plastic waste is classified as waste that is difficult to decompose by itself, therefore handling the problem of plastic waste using the landfill or open dumping method is not correct (Wahyudi et al., 2018).

This study aims to examine the potential and constraints of using plastic waste as fuel oil. The energy in plastic waste is processed into oil which can be processed through various methods, one of which is the pyrolysis method. Pyrolysis is one of the methods of processing waste by breaking down material by temperature and producing gas, oil, and charcoal. Researchers hope that this research can enrich their knowledge and inspire the wider community regarding the potential constraints on the use of plastic waste as fuel oil.

MATERIALS AND METHODS

This research was conducted for one month, namely in April 2022. The research method used was a literature review. The literature review method is carried out by collecting data from previous studies that are still in accordance with the themes raised in this article. The collection of data from previous research aims to provide various kinds of information, theories, and factual ideas based on the existing literature. The steps that need to be taken to collect data are in the form of summarizing and recording the results, reviews, and conclusions from the literature sources, then analyzing and then describing the data that has been obtained.

The data analysis technique used is descriptive technique. The variables to be analyzed in this study are the potential and constraints of the use of plastic waste as fuel oil. The number of articles that are the source of information in this article are 20 articles from 2013 to 2021.

RESULTS AND DISCUSSION

Plastics are classified as petroleum derivative products, so plastics have energy properties similar to those contained in premium fuels such as gasoline, diesel, and kerosene. Plastic waste is also composed of polymers, carbon, and hydrogen. Plastic will decompose if heated to hundreds or even 1000 degrees Celsius. Processing of plastic waste by burning in the general public has the potential for incomplete combustion to occur and produce carcinogenic compounds. Firman, Maulana and Panjaitan (2019) stated that the key to the success of the pyrolysis process is the heating rate and the pyrolysis temperature.

Table 1. Code Number, Type of Plastic, and Use of Plastic

Code Number	Type of Plastic	Use of Plastic
1	PET (Polyethylene terephthalate)	Widely used in drinking water bottles, sauce bottles, and others
2	HDPE (High-density Polyethylene)	Widely used in jerry cans, medicine bottles, and others
3	PVC (Polyvinyl Chloride)	Widely used on hoses, protective plastic tablecloths to keep them clean, etc
4	LDPE (Low-density Polyethylene)	Widely used on objects in the form of thin plastic such as plastic ice lolly, shopping plastic, and others
5	PP (Polypropylene atau Polypropene)	Widely used in children's toys

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6	PS (Polystyrene)	Widely used in Styrofoam dining utensils, as well as other plastic cutlery
7	O (Other)	Various kinds of household appliances, electronic objects, and others

Source: Kurniawan in (Surono, 2013)

Currently, many efforts have been developed to convert plastic waste into fuel oil, one of which is the pyrolysis method (Savira & Hendriyanto, 2018). According to (Adoe et al., 2016) pyrolysis is a process of changing the form to a simpler form of a material that takes place involving heat and no oxygen. The results of the pyrolysis method are charcoal, gas, and oil. Pyrolysis methods can be categorized into 3, namely, fash pyrolysis (pyrolysis that occurs very quickly), fast pyrolysis (pyrolysis that occurs quickly), and slow pyrolysis (pyrolysis that occurs slowly). The success of the pyrolysis process is influenced by several factors, namely duration, degree of heat, particle size, and particle weight.

The conversion of plastic waste into fuel oil is a tertiary recycling process, in which plastic waste is processed into oil through a fracturing process. The fracturing process is the process of breaking polymer chains from previously intact ones into compounds of smaller molecular weight (Nofendri and Haryanto, 2021). In line with that, Salamah and Aktawan (2016) explained that the pyrolysis of plastic waste is a heating method of polymers contained in plastics in the absence of oxygen during the process. Syamsiro (2015) explained that the pyrolysis of plastic waste goes through several decomposition mechanisms, namely: randomly cutting polymer chains, causing the existing polymer chains to shorten. This causes small molecules and long polymer chains to form, and the polymer chains to separate, resulting in very small molecules being formed.

Plastic waste that is produced by the general public is usually destroyed in an inappropriate way, such as burning. Plastic waste that is not processed properly, will be very detrimental to the environment. Proper management of plastic waste can be used as fuel oil which is a solution to the problem of plastic waste as well as the problem of scarcity of fuel oil.

The pyrolysis process can be applied in the processing of plastic waste which can be used as a solution to the waste problem and as a source of commercial fuel oil one day (Ardianti et al., 2019). The pyrolysis process requires very high temperatures to produce oil. Based on research conducted by Purwanti in (Iswadi et al., 2017) 100 grams of plastic bags are heated at a temperature of up to 40000C for 2 hours, 75 grams of liquid oil is produced. This pyrolysis oil is flammable, emits smoke when used as fuel, and has a pungent aroma. Basically, the oil produced from the pyrolysis process is in the form of saturated oil, but it can be reprocessed to remove saturation and become more stable.

Research conducted by Cahyono, Liestiono and Widodo (2019) shows that the heating rate is proportional to the speed of the pyrolysis process. The high temperature causes the high yield of oil and the low yield of charcoal and gas. Plastic waste that is processed into oil has the potential as a single fuel or mixed fuel. The results of research conducted (Surono, 2013) show that power and thermal efficiency as well as mechanical efficiency in diesel motors increase due to mixing premium fuel with pyrolysis oil.

(Iswadi et al., 2017) in his research stated that the oil produced from the pyrolysis process of 1 kg of LDPE (Low Density Polyethylene) waste was 525 mL, while the produced 1 kg of PET (Polyethylene Terephthalate) plastic waste was 368.47 mL. oil. The resulting oil is then tested for its density value, the oil produced from LDPE waste has a density value of 0.7673 kg/L or almost the same as the density value of kerosene and PET waste oil with a density value of 0.7976 kg/L. (Sari, 2018) states that 81% of oil can be produced from the waste pyrolysis process and the rest is in the form of charcoal and gas. The content in the pyrolysis oil includes paraffins, isoparaffins, naphthene, aromatics, and olefins. Based on these contents, alternative fuels can be obtained from processing plastic waste into oil.

Santoso in (Sari, 2018) tested the oil from the pyrolysis process using a stove. Based on these tests, the results show that the pyrolysis oil has a maximum efficiency of 50%, whereas when compared to kerosene and gasoline the efficiency values are 24% and 68%. Tomilkolundu and Murugenesan (in Sari, 2018) tested the substitution of diesel fuel with pyrolysis oil on motorized vehicles with diesel engines. Based on these tests, it is known that diesel fuel mixed with pyrolysis oil drains fuel oil of 0.61 kg/hour and pure diesel fuel drains 0.69 kg/hour. The thermal efficiency of pyrolysis oil mixed with diesel fuel is 27.4% and the thermal efficiency of diesel is 22.5%. Based on these studies, it can be said that the oil from the pyrolysis process of plastic waste is suitable as a single fuel because it has a fairly high thermal efficiency value.

Testing of pyrolysis oil on motor vehicles has been tested (Nurdianto et al., 2016) with the result that PET waste pyrolysis oil is similar to gasoline. Based on these tests, no problems were found on the engine, so the engine could run properly. In addition, an emission test was also carried out which resulted in the number of CO, HC, CO2, and O2 produced which could still be said to be safe for use because they did not exceed the exhaust gas threshold for motorized vehicles. Research conducted (Sukadi & Novarini, 2019) also showed similar results, where the calorific value produced from the pyrolysis process meets Indonesian fuel quality standards so that it can be used in gasoline motor vehicles.

Yulianto, Nuryosuwito and Rhohman (2019) conducted a study on the comparison of the main fuel with the fuel from the pyrolysis of plastic waste. The results of this comparison show that the fuel from PET and PP plastics is 8.7 ml for a speed of 2000rpm for 2 minutes, while the average premium fuel consumed is 13 ml at the same time and speed. This shows that the waste pyrolysis fuel oil is more efficient than premium fuel.

Alternative fuels produced from the pyrolysis process have a very striking difference in aroma compared to ordinary fuels, but their function is the same as fuel oil in general (Diantanti et al., 2021). Many people do not have the awareness to separate waste independently. This causes waste sorting takes a long time. Another obstacle of the pyrolysis process is the inefficient manufacture of reactors in large-scale processing, this is due to the occurrence of bubbles, distribution, and still leaves residue so that it is less economical.

According to (Nuryosuwito et al., 2018) several researches on waste pyrolysis have been carried out, but still with limited operating conditions. Operational limitations cause the products from the pyrolysis of waste to have limited variations. This causes difficulties in optimizing the pyrolysis process and characterizing the pyrolysis products.

CONCLUSION

Plastic waste has the potential to be used as fuel oil using the pyrolysis method. The oil produced from this method can be used as a mixed fuel or single fuel because it has a relatively high thermal efficiency. Constraints faced from the use of plastic waste as fuel oil using the pyrolysis method, namely the oil resulting from the pyrolysis of waste has a more pungent aroma, waste sorting takes a long time, and is relatively inefficient in large-scale processing, still leaves residue, and is still limited. operating conditions that limit the variation of the pyrolysis yield.

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