

## **Utilization of Waste Types On The Quantity Of Fuel Oil Produced From The Pyrolysis Process**

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### **ABSTRACT**

*The use of plastic has become an important and inseparable part of people's daily lives, but rapid population growth and increasing human activities produce significant amounts of plastic waste. This research aims to reduce pollution caused by plastic waste, utilize plastic waste as a source of renewable energy in the form of Fuel Oil (BBM), and analyze the ratio of waste types to the quantity of fuel produced. In this research, data was collected from various commonly found waste, such as plastic bag waste, plastic bottle waste and styrofoam waste. Then, to produce fuel, a pyrolysis process is carried out with a waste mass of 1:1:1. Based on the results obtained, plastic bottle waste produces a product in the form of 0.019kg/30 ml kerosene. Furthermore, plastic bag waste produces 0.05kg/50 ml kerosene products, as well as 2.5 ml petrol oil. And styrofoam waste produces products similar to plastic bag waste, namely kerosene 0.171kg/98 ml, and petrol oil 2.5 ml. Based on the data obtained, Styrofoam waste produces more kerosene products compared to plastic bag and plastic bottle waste. With this research, we hope that society can maximize plastic waste into economic income and reduce environmental pollution caused by plastic waste.*

**Keywords:** Plastic Waste, Pyrolysis, Fuel oil

### **ABSTRAK**

*Penggunaan plastik telah menjadi bagian penting dan tidak dapat dipisahkan dari kehidupan sehari-hari masyarakat, namun pertumbuhan populasi yang cepat dan meningkatnya aktivitas manusia menghasilkan jumlah limbah plastik yang signifikan. Penelitian ini bertujuan untuk mengurangi pencemaran yang diakibatkan oleh sampah plastik, memanfaatkan limbah plastik sebagai sumber energi terbarukan dalam bentuk Bahan Bakar Minyak (BBM), dan menganalisis perbandingan jenis limbah terhadap kuantitas BBM yang dihasilkan. Dalam penelitian ini, dilakukan pengumpulan data dari berbagai limbah yang umum ditemui, seperti limbah kantong plastik, limbah botol plastik, dan limbah styrofoam. Kemudian, untuk menghasilkan BBM dilakukan proses pirolisis dengan massa limbah 1:1:1. Berdasarkan hasil yang diperoleh, untuk limbah botol plastik menghasilkan produk berupa minyak tanah 0,019kg/30 ml. Selanjutnya pada limbah kantong plastik menghasilkan produk minyak tanah 0,05kg/50 ml, serta minyak bensin sebesar 2,5 ml. Dan pada limbah styrofoam menghasilkan produk serupa dengan limbah kantong plastik, yakni minyak tanah 0,171kg/98 ml, serta minyak bensin 2,5 ml. Berdasarkan data yang diperoleh, bahwa limbah styrofoam menghasilkan produk minyak tanah yang lebih banyak dibandingkan dengan limbah kantong plastik dan botol plastik. Dengan adanya penelitian ini kami berharap agar masyarakat dapat memaksimalkan limbah plastik menjadi pemasukan ekonomi dan mengurangi pencemaran lingkungan yang disebabkan oleh limbah plastik.*

**Kata kunci:** Limbah Plastik, Pirolisis, Bahan Bakar Minyak

## **1. INTRODUCTION**

Indonesia is known for having a wealth of diverse natural resources, both biological and non-biological [1]. However, as time goes by, Indonesia is in second place as the largest waste producing country in the world [2]. According to Aryanto, plastic waste is an example of inorganic waste which takes up to 50-80 million years to decompose in the soil. [3]. One way to convert plastic waste into renewable energy or alternative fuel is to use the pyrolysis method [4].

Pyrolysis is a method of decomposition of organic and non-organic chemicals through a heating process with no or little oxygen or other reagents, where the raw material will experience a chemical structure breakdown into a gas phase [5]. Pyrolysis is carried out in the case of leaving only carbon compounds as residue, called carbonization. The pyrolysis method itself can be applied to produce a compound that can be used as a liquid fuel source [6]. With this method, plastic waste can be reduced by up to 90%. Then several studies related to the use of plastic waste which were converted into fuel were previously carried out and showed good results and were prospective for development [7].

The use of fuel continues to increase along with population growth in a country and the development of an industry. This is the main problem and idea for finding and developing potential renewable energy sources, especially as it is known that the world's oil reserves or fossil fuels are depleting (which only limited reserves) [8].

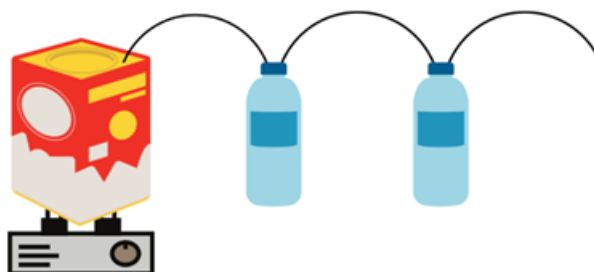
Apart from reducing plastic waste, we carried out this research because we realized that fuel oil (BBM) is an energy that can run out at any time because the role of fuel oil in this modern era is still quite large and it can be said that humans cannot escape from it [9]. So this research could be a contribution to overcoming the availability of fuel oil in the future which is increasingly running low. The research we carry out uses simple tools that are easy to find in everyday life so it doesn't cost a lot of money to carry out research. With this research, we hope that the public and the government will be aware of the urgency of fuel oil (BBM) availability. This is the background for us to conduct this research and with the aim of utilizing plastic waste as a source of renewable energy in the form of fuel oil (BBM) [10], Next, analyze the effect of the amount of plastic waste used on the fuel oil (BBM) produced, as well as reducing pollution caused by plastic waste in the environmental area where a community lives.

## **2. METHOD/RESEARCH DESIGN**

The materials used in this research were plastic bag waste, plastic bottles and styrofoam with a mass of each waste of 1:1:1, namely 1 kg. Making the tools used for the burning process is very simple, including a biscuit tin as a burning container, a handle to open the lid of the can, a ¾ cm screw, a wooden plate (length according to the handle), a screwdriver, a round file to make a hole in the top of the can, two bottles. measuring 550 ml as a container for the fuel produced, an aluminum pipe with a length of 70-90 cm (diameter 8 mm) and a hose to channel the steam from the can to the bottle, and a gas stove. Scissors and cutters are used to change the size of bottles and styrofoam to make them smaller. Then the tools used for the process after producing the fuel are filters, scales, measuring cups and plastic bottles (20 ml, 250 ml, 100 ml).

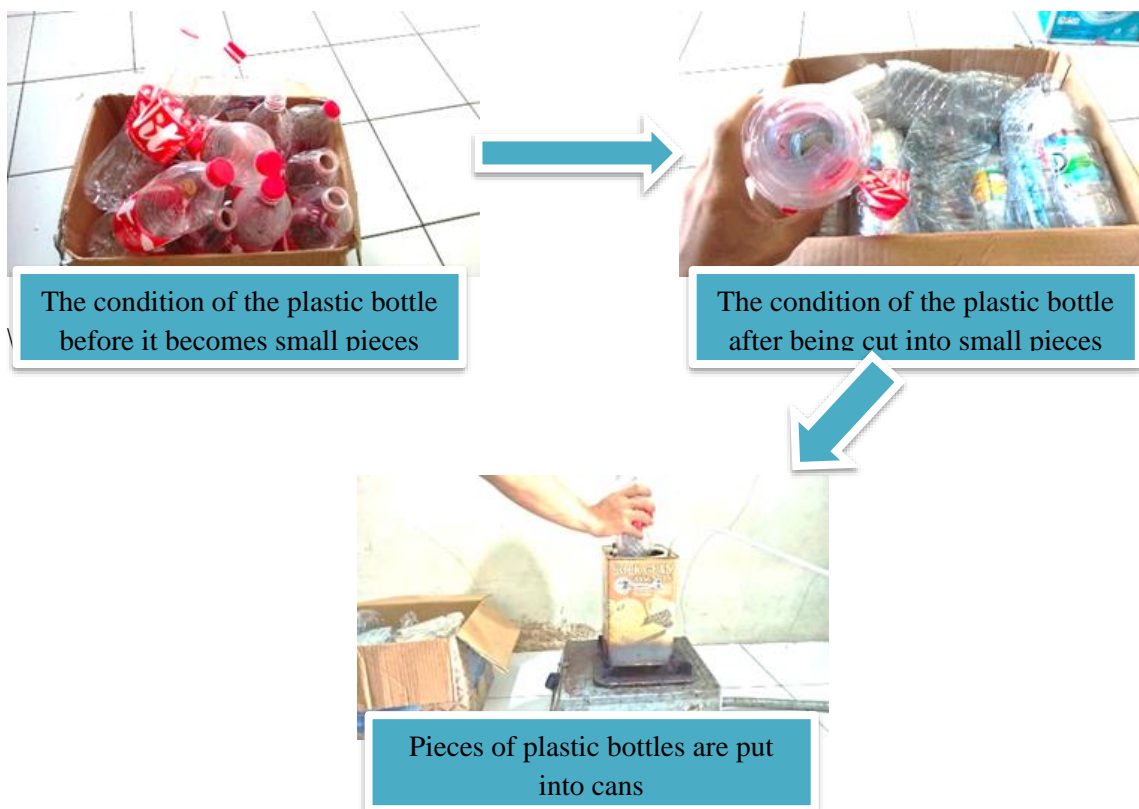
To make a pyrolysis tool, the first step is to attach the handle to the top of the can lid and put wood under the can lid according to the length of the handle and connect it using a ¾ cm screw. This is done to make it easier to open the lid of the can when you want to refill the burning waste because the size of the can is not too big so not all of the waste can be burned immediately. After that, make a hole in the top edge of the biscuit tin, then make two holes in the plastic bottle cap, where the two plastic bottles are bottle 1 as a kerosene container and bottle 2 as a petrol oil

container. The biscuit tin and bottle 1 are connected using an aluminum pipe in each hole that has been made, then bottle 1 is connected to bottle 2 using a hose, and in bottle 2 a hose is inserted as a gas outlet. The tools for the burning process can be seen in Figure 1

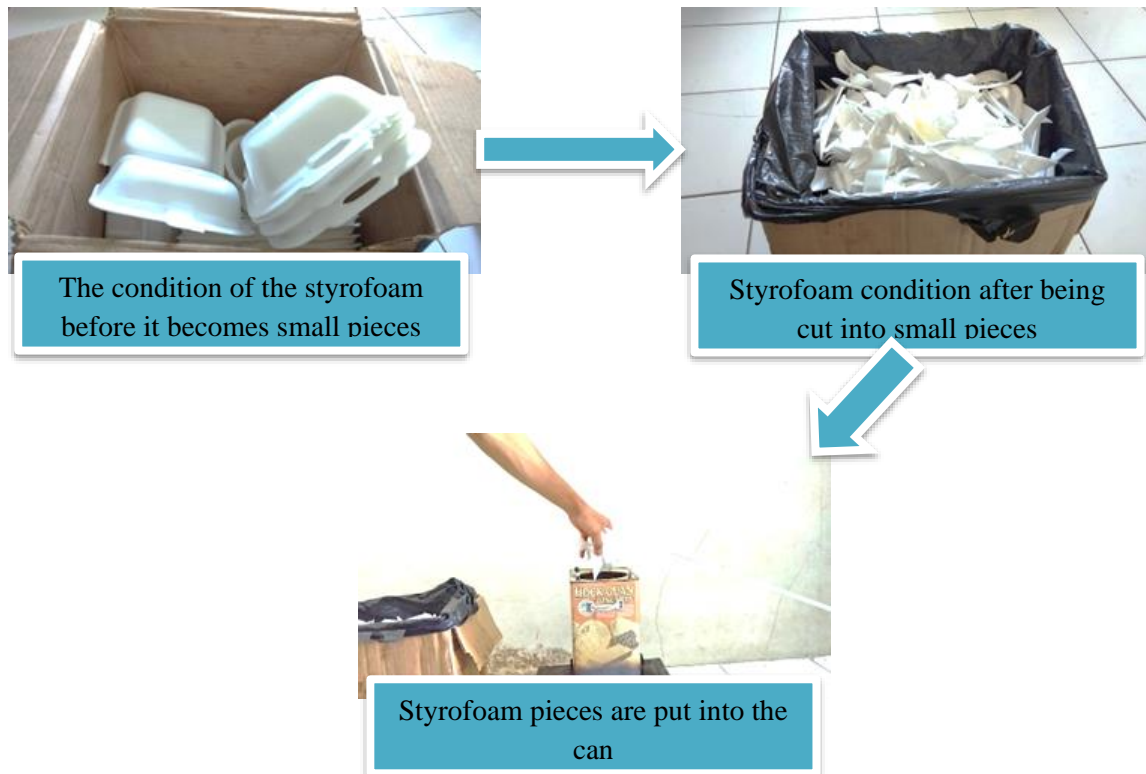


**Figure 1.** Schematic of the pyrolysis device circuit (source: personal document)

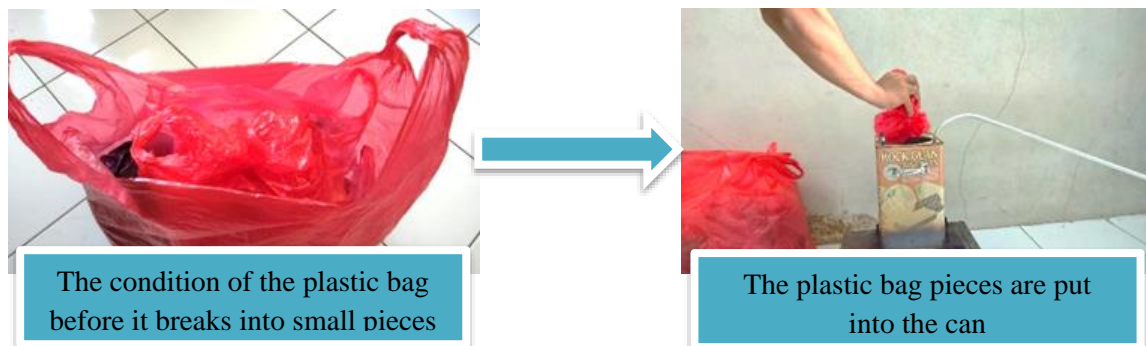
The first experiment was the pyrolysis process using plastic bottles. Before being placed in the pyrolysis equipment, the plastic bottle is cut into small pieces. Burning using a stove over high heat then the steam produced by the plastic bottle waste will go to bottle 1. If a lot of steam is produced, then the steam that has been channeled to bottle 1 will be channeled again to bottle 2. Thus, 2 fuel will be produced. . The steam in bottle 1 will become kerosene and the steam in bottle 2 will become gasoline. The resulting kerosene and gasoline are filtered first. Then the mass is measured using a scale and measuring cup. After that, do the same thing for Styrofoam waste and plastic bag waste, but don't cut the plastic bag waste into small pieces.



**Figure 2.** Pyrolysis process in plastic bottle



**Figure 3.** Pyrolysis process in styrofoam bottle



**Figure 4.** Pyrolysis process in plastic

### 3. RESULTS AND DISCUSSION

Based on the research that has been carried out, the products produced by each type of waste can be seen in the following table:

Table 1. Fuel products produced from each type of waste		
Waste type	The resulting fuel products	
	Kerosene	Gas
Plastic bottle	√	-
Plastic bag	√	√
Styrofoam	√	√

**Table 2.** Mass/volume of kerosene produced

Waste type	Mass/volume of kerosene (Kg)/(ml)
Plastic bottle	0,019 kg/30 ml
Plastic bag	0,05 kg/50 ml
Styrofoam	0,171 kg/198 ml

**Table 3.** Volume of gasoline produced

Waste type	Gasoline Volume (ml)
Plastic bottle	-
Plastic bag	2,5 ml
Styrofoam	2,5 ml

Based on **Table 1**, the only fuel product produced from plastic bottle waste is kerosene, in the experiment plastic bottles did not produce gasoline. The search results show that plastic bottles can be converted into fuel oil through a pyrolysis process, but the oil produced is not gasoline [11]. This happened because during the experiment there was an influence of environmental temperature, which caused the temperature to be unstable and this affected the yield of oil produced. This is in line with previous research that one of the factors that influences the pyrolysis process is temperature [12]. The fuel products produced from waste plastic bags and styrofoam are the same as producing kerosene and gasoline.

Based on **Table 2**, the mass of kerosene produced from waste. Plastic bottle waste produces 0.019 kg of kerosene or the equivalent of 30 ml. Plastic bag waste produces 0.05 kg of kerosene or the equivalent of 50 ml. Styrofoam waste produces 0.171 kg of kerosene or the equivalent of 198 ml.

Based on **Table 3**, namely the volume of gasoline produced by waste. The plastic bottle waste in the experiment did not produce gasoline. In plastic bag waste, the amount of gasoline obtained is around 2.5 ml and in styrofoam waste, the amount of gasoline obtained is the same as 2.5 ml.



**Figure 5.** Fuel yield

Based on research that has been carried out, Styrofoam waste is the type of waste that produces the most fuel, but the pyrolysis process takes quite a long time when compared to other types of waste. This can happen because differences in the chemical composition of these materials can affect the amount and quality of fuel oil produced through the pyrolysis process [13]. Styrofoam itself is a type of expanded polystyrene foam, which is a thermoplastic material consisting of long chains of styrene molecules. [14]. On the other hand, plastic bags and plastic

bottles are usually made from polyethylene, which is a different type of thermoplastic material [15]. On the other hand, plastic bags and plastic bottles are usually made from polyethylene, which is a different type of thermoplastic material.

In trials of kerosene produced from waste plastic bottles, plastic bags and styrofoam, it was been proven that the oil produced can be burned and is called fuel oil (BBM). The pyrolysis technique that has been carried out using a gas stove because if you use firewood it will produce combustion smoke which causes air pollution. This research utilized waste around the UIN Syarif Hidayatullah Jakarta campus and around residential areas where researchers collected plastic waste independently. So that the environment becomes cleaner and reduces plastic waste around the environment.

#### 4. CONCLUSIONS AND RECOMMENDATIONS

Based on the data obtained, it can be concluded that it is proven that the use of plastic waste as a renewable energy source produces fuel. The type of waste that produces the most fuel is a type of styrofoam waste. By using a simple distillation tool and the working principle of the pyrolysis method, 1 kg of Styrofoam waste can produce 0.171 kg 198 ml, this product is the largest producer of kerosene compared to kerosene products produced by waste plastic bags and plastic bottles. Then, with this research, we can reduce pollution caused by plastic waste in environmental areas, both the campus environment, specifically at the Faculty of Tarbiyah and Teacher Training (FITK) as well as residential areas around the campus.

For further research, it is hoped that: 1) Can develop safer burning tools and add tools so that the steam that comes out does not pollute the environment; 2) It is better to use larger burning cans so that more waste is burned and does not take a long time for the burning process.

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