Quantity and Composition of Liquid Products from Used Motorcycle Tire Pyrolysis

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Abstract: Used tires are very difficult to degrade naturally. So far, the handling of used motorcycle tires has only been hoarding or burning directly in the open air. This is less able to reduce used tires because it will cause problems with pollutant gases resulting from burning used materials that can pollute the environment. The pyrolysis process is one way to minimize waste restrictions. The purpose of this study is to determine the effect of the temperature of the pyrolysis of used motor vehicle tires on the yield of liquid products and to determine the composition of the liquid product at the highest yield. The pyrolysis process of used tires was carried out for 2 hours and 1000 grams of raw material. Pyrolysis was carried out at various operating temperatures, namely 450 ° C, 500 ° C, 550 ° C, 600 ° C, and 650 ° C without using a catalyst. The yield of liquid products produced at operating temperatures were 450 ° C, 500 ° C, 550 ° C, 600 ° C, and 650 ° C respectively 41.31%, 55.07%, 51.49%, 41 , 99%, and 36.89%. The liquid product composition test for used motor vehicle tires at a temperature of 550 ° C was analyzed using GC-MS (Gas Chromathography-Mass Spectrometer), the hydrocarbon chains were obtained as follows: (C5-C12) as much as 95.12% and (C13-C20) as much as 4, 88%.

1 INTRODUCTION

Used tires are very difficult to degrade naturally by nature. So far, the handling of used motorcycle tires has only been carried out by hoarding or burning directly in the open air. This is less able to reduce used tires, because it will cause problems with pollutant gases resulting from burning used tires that can pollute the environment. Another way to process used tires is by processing them into handicraft products. Handling used tires is usually done using the already popular method, namely 3R (Reuse, Reduce, Recycle), but that method has weaknesses. A better alternative for dealing with waste or used tires is to convert them into other forms, namely liquid fuels as alternative energy. Rubber-based tires are one of the synthetic polymers (polystyrene). Polystyrene is derived from petroleum so the best solution at this time is to return to the form of oil.

Polystyrine cracking is a way of reducing this waste. Cracking is the process of breaking polymer chains into compounds with lower molecular weights. Although this method is included in recycling, the results of recycling do not return to the form of tires or rubber. This used tire cracking uses the pyrolysis method (Handono, M. R. T., 2017). The tire composition consists of Styrene-butadiene rubber (SBR) 62.1%, Carbon black 31%, Extender Oil 1.9%, Zinc Oxide 1.9%, Stearic Acid 1.2%, Sulfur 1.1%, Accelerator 0 ,7% (Williams & Besler, 1995). Where Styrene-butadiene rubber (SBR) is a synthetic rubber that will be converted into another form, namely liquid fuel as an alternative energy. Based on the results of research conducted by (Muis et al., 2019) it was found that the compounds contained in the pyrolysis oil of used tires have the following hydrocarbon chains: (C1- C5) as much as 0.33%, (C5-C12) as much as 88.96% and (C10-C28) 10.71%. The hydrocarbon compounds found in the oil from the pyrolysis of used tires contain a lot of aromatic compounds, wherein the aromatic compounds are derivatives of petroleum hydrocarbon compounds which function as fuel components. Many researches on pyrolysis using used motor vehicle tires have been carried out, one of which was conducted by Muis et al., (2019) This researcher used used tires as raw materials with variations in catalyst mass. Pyrolysis was carried out at a temperature of 400^0C within 3 hours, the oil conversion obtained increased with increasing

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catalyst mass. The highest yield was found in the 180 gram catalyst weight of 41.073%. Dumilah & Kholidah, (2019) conducted a study using used two-wheeled motorcycle tires as raw materials with a temperature variation of 200^{0}C – 300^{0}C in an operating time of 3 hours and using a zeolite catalyst. The best results obtained were 58.6030% at a temperature of 300^{0}C. To get maximum and efficient results, the pyrolysis process is carried out without the use of a catalyst, this aims to avoid the activation of the catalyst which is quite long so that it can shorten the time used for the pyrolysis process. Research on the effect of pyrolysis temperature without a catalyst using bicycle tire waste raw materials with temperature variations of 450 C, 500 C, 550 C, 550 C, and 650 C. The percent yield of the liquid product produced was 49.6% with the optimum temperature of 600 C with a reaction time of 39 minutes.

The percent yield generated on research Debalaxmi is higher as many as 49.5% compared to the research conducted by Muis., Et al (2019), which is only about 41.07%, this is because the higher the temperature the more more liquid product is produced and can reduce the reaction time required. Therefore, the pyrolysis process of used motorcycle tires without using a catalyst in temperature variations is carried out at medium to high temperatures, it is hoped that it can produce a maximum and faster percent. The purpose of this study was to determine the effect of the pyrolysis temperature of used motor vehicle tires on the yield of liquid products and to determine the composition contained in the liquid products at the highest yields.

2 METODHOLOGY

This study uses quantitative and qualitative analysis. used motorcycle tires are pyrolyzed in a reactor with variations in temperature. Quantitative analysis is carried out by weighing the resulting product. Used motorcycle tires are cleaned and dried and then reduced in size by 2 cm. A total of 1000 grams were put into the pyrolysis apparatus and the process was run for 2 hours with variations in pyrolysis time (450, 500, 550, 600, 650) °C. The resulting liquid product is then weighed and its composition analyzed using GC-MS

3 RESULT AND DISCUSSION

The relationship between temperature and the yield of liquid products can be seen in Figure 1

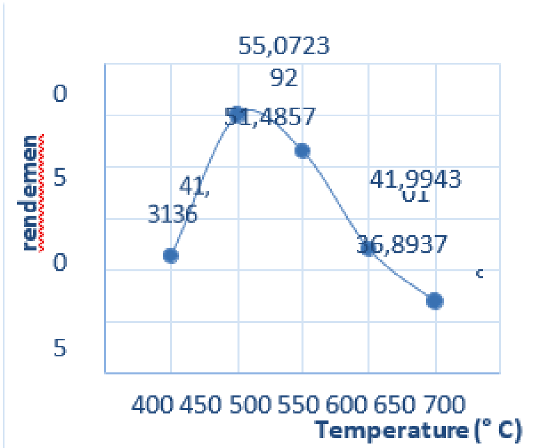

Figure 1: The Effect of Temperature Relationship on the Yield of Liquid Products.

Figure 1. shows that when the pyrolysis process is carried out, the percent yield increases from a temperature of 450 °C to 500 °C, this is because at high temperatures the carbon chain will be more easily cracked than at low temperatures so that the yield of liquid products produced will be more and more (Kholidah , 2018). The yield percentage increased with the initial increase in temperature and after the temperature of 550oC the percentage yield decreased. Jung et al., (2013) explained this phenomenon that after reaching the optimal temperature, several secondary reactions such as polyaromatic formation reactions are initiated during the pyrolysis of used tires which reduce the yield of liquid products. This is also in accordance with research conducted by Udyani et al (2018), where the yield produced will decrease with increasing temperature from pyrolysis. This is because the higher the temperature, the more used tires break down into non-condensable gases (CO, CO2, CH4, etc.) so that less liquid is produced. Based on Figure 1 shows that the temperature of 500 °C is the optimal temperature because it reaches the highest yield of 55.07% which when the temperature is increased to 550 °C the liquid product decreases to 51.49% with a pyrolysis process time of 2 hours, while in the research conducted by Dumilah and Kholidah (2019), using temperature variations where at the highest temperature of 300 °C added using a 400 gram catalyst produced a liquid product of 58.60%, and in the research conducted by Muis et al.,

(2019) using The variation of the weight of the catalyst which had previously been activated for 10 hours and the pyrolysis process for 3 hours at a temperature of 400°C resulted in the highest percentage yield, which was around 41.07%.

From the yield obtained, it shows that the percent yield obtained between the pyrolysis of used tires using a catalyst and the pyrolysis of used tires without the use of a catalyst is only a difference of about 3.53% when compared to the results of research conducted by Dumilah and Kholidah (2019), and higher when compared to with research conducted by Muis et al., (2019). The results of the pyrolysis of used motor vehicle tires without using a catalyst obtained a higher percent yield because during the process it uses a higher temperature so that the cracking process of used tires becomes faster and at the optimum temperature produces more liquid products.

The results of the pyrolysis of used motor vehicle tires which have the highest percent yield at a temperature of 500 °C were analyzed using GC-MS (Gas Chromatoghraphy-Mass Spectrometry). Based on Table 4.2, it shows that the characteristics of the liquid fuel obtained have the following hydrocarbon chains: (C5 - C12) as much as 95.12% and (C13 - C20¬) as much as 4.88%. This is similar to the experiment conducted by Andry et al., (2020) where the results of the GC-MS analysis showed the highest hydrocarbon compounds (C5 - C12) and included the gasoline fraction.

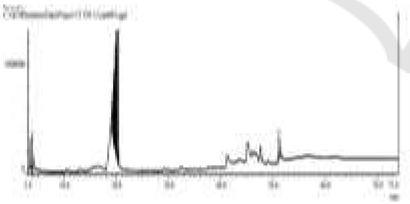

Figure 2: Spectra of GC-MS Pyrolysis Oil of Used Tires.

Table 1: GC-MS analysis at a temperature of 500 °C.

No	% Area	Molecular Formula	Compound
1.	95,12 %	C_5 - C_{12}	1H-Azepine, hexahydro; 2H-Azepine-2-One, hexahydro; cyclobutene, 1,2,3,4- tetramethyl; Hexanoic acid, 6- amino
2.	4,88 %	C_{13} - C_{20}	9-Octadecenal, (Z)

Based on research conducted by Muis., et al (2019), the results of pyrolysis analyzed using GC-MS are the results of pyrolysis that have the highest conversion, namely 41.073% at a temperature of 400 °C. The analysis results obtained have the highest hydrocarbon chain (C5 - C12) as much as 88.96%. This shows that the pyrolysis process using a catalyst carried out by Muis., et al (2019) produced the same fraction as the study without using a catalyst but the operating temperature used was lower at 400 °C compared to the pyrolysis experiment without using a catalyst, which was 500 °C. . This is due to the presence of a catalyst so that in the Muis., et al. (2019) experiment, the process of breaking or breaking long chain hydrocarbons is faster.

4 CONCLUSIONS

1. The higher the temperature, the lower the liquid product yield and the percent yield obtained. The temperature of 500 °C is the optimal temperature where the highest yield percentage is 55.07%.
2. The results of the GC-MS analysis show that the composition of the liquid product at a temperature of 500 °C has the most hydrocarbon chains (C5 - C12) as much as 95.12% which is included in the gasoline fraction (gasoline).

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