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The Investigation on Physical Characteristics of Cracked Plastic Waste

The Investigation on Physical Characteristics of Cracked Plastic Waste

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Abstract. The consumption of plastic gives many benefits however, uncontrolled use can bring about negative impacts on the environment. Plastic waste is a material that is difficult to decompose by nature or referred to as non-biodegradable. The catalytic cracking process is one way to process plastic waste. This study was conducted to determine the effect of cracking temperature and cracking time on the volume and physical properties of the produced liquid. The catalyst used is Cu-Al_2O_3 with a ratio of 20% of 200 g of raw material. In this study, the most liquid produced is 142 mL at a cracking temperature of 300 ^oC within 150 minutes. The best physical properties (heating value, Octane Research Number, Octane Motor Number) produced from liquid condensate at 250 ^oC and 120 minutes.

1. Introduction

Plastic is widely used in households and industries. Plastic has many advantages instance, flexible, transparent, not easily damaged, varied in color, cheap, easy to obtain. In general, the plastic used as food permanent packaging material in the food industry, plastic bottles, or in the form of plastic bags crackle [1-2]. More than 70% of the mass of waste is household waste plastic such as LLDPE, HDPE, LDPE, PP, and PS [3-4].

Excessive use of plastic and the length of decomposition time will worsen environmental conditions. Plastic is more practical to use causing its use to continue to increase even though it is known for a long time for the degradation process. Needs are increasing, garbage is piling up and the environment is polluted and has an impact on health [5-7]. An alternative to handling plastic waste is to return plastic waste to the base material for making it. The technology f converting plastic waste into liquid fuel is by cracking. The process of thermal catalytic cracking is a process of breaking down hydrocarbon chains from long-chain compounds into hydrocarbons with smaller chains through the aid of heat and catalysts [8-11].

This research furthers the previou tudy [12-14]. The purpose of this research is to utilize plastic waste by adding Cu-Al_2O_3 catalyst and determine the effect of varied temperature and cracking time on the physical characteristics of produce liquid.

2. Experimental

The raw material used in this study was Expanded Polystyrene (EPS) plastic waste, or better known as styrofoam. Plastic waste was washed with water and then dried. Then the raw material was crushed to create a size of 1-3 mm. For each sample, 200 g of raw material was used.

Base on [15], Cu-Al_2O_3 catalyst was made by the impregnation of Cu metal on Al_2O_3 Dissolved 2 g of $CuSO_4$-$5H_2O$ into the distilled water while was stirring with a spatula. Added 25 g of Al_2O_3 with 99% purity to the $CuSO_4$-$5H_2O$ solution, while was continuing stirred. Then the mixture was heated to a temperature of 90 °C while was continuing stirred using a heating stirrer for 3 hours. The impregnation of Cu-Al_2O_3 was filtered then washed with distilled water. Then, dried it in the oven for 3 hours at 90 °C. The resulting Cu-Al_2O_3 was stored in a dry and closed container.

200 g of raw material was put into the fixed bed reactor then add 20% Cu-Al_2O_3 catalyst of the raw material mass. Temperature variations of 150 °C-300 °C with a range of 50 °C. The time variation was 30 minutes until 150 minutes with a range of 30 minutes. After the processing time reached, measured the yield of the produced liquid. After finishing all treatments, analyzed the physical characteristics of each sample.

3. Results and discussions

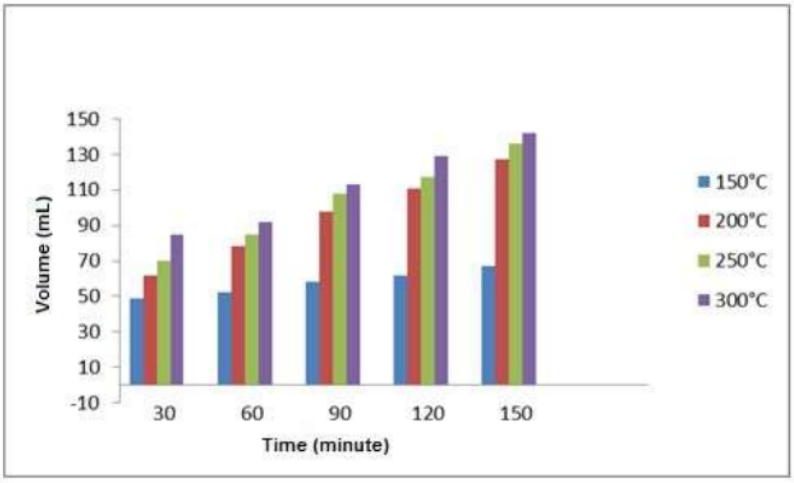

Figure 1. The Effect of Time and Temperature to Yield

Figure 1 shows that in general the produced yield has the same tendency for temperature and time variations. Yield will continue to increase with increasing temperature and length of cracking. Polystyrene degradation will begin to occur at a temperature of 150 °C but only a small yield produced because the decomposition temperature has not reached yet [16]. While starting at 200 °C the yield produced tends to be large and increasing at various time variations. The highest yield of 142 mL was obtained from the sample with a temperature variation of 300 °C for 150 minutes because the raw material had experienced perfect cracking characterized by the absence of liquid droplets after that time.

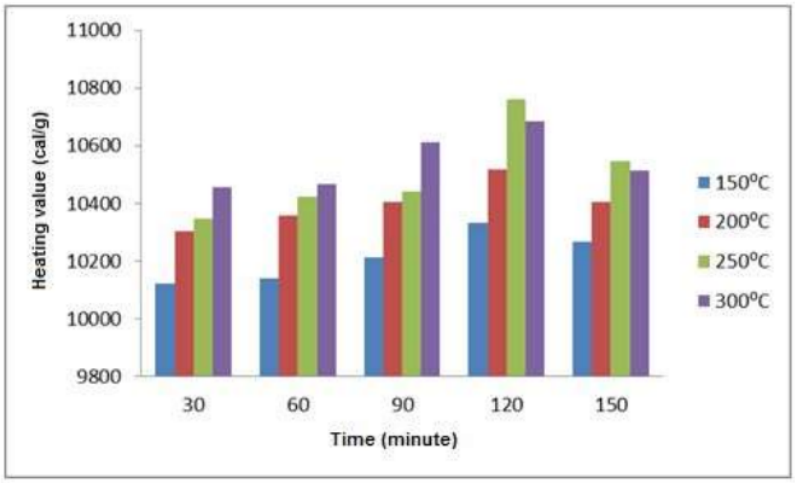

Figure 2. The Effect of Time and Temperature on the Heating Value

Figure 2 shows that the higher the temperature and the length of cracking are, the higher the heating value will be because there are paraffin, olefin, naphtha, and aromatic contents which cause an increase in heat value [10-11]. The dominant cracking of styrofoam contains Styrene, ethylbenzene, and 2-phenyl-propene. These three compounds have a high heating value. For Styrene, ethylbenzene and 2-phenyl-propene compounds the calorific values are 10,085.45 cal/g, 10,276.26 cal/g and 9,836.44 cal/g [13]. Results The heating value at a temperature of 250°C with various time variations has a tendency to good results, which is between 10,350 cal/g-10,760 cal/g. The highest heating value is 10,760 cal/g obtained at operating conditions of 250 °C and 120 minutes. However, the time variation of 150 minutes for all temperature variations was obtained as the calorific value tends to decrease because in these conditions more long-chain compounds produced more residues.

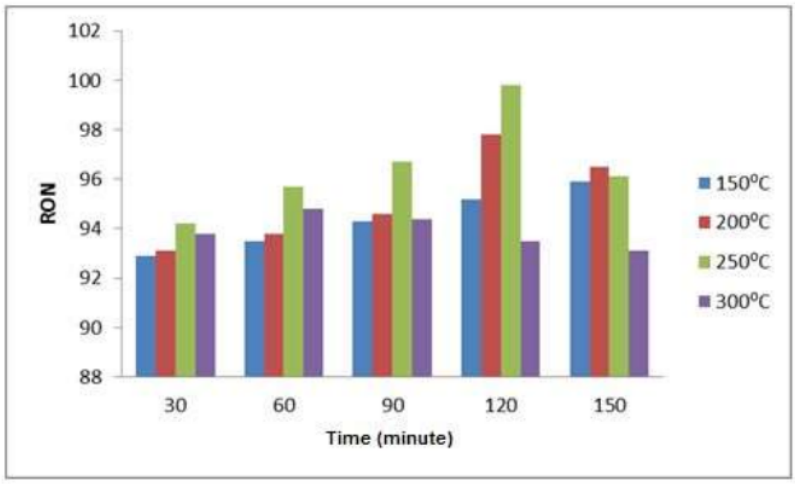

Figure 3. The Effect of Time and Temperature Reaserch Octane Number (RON)

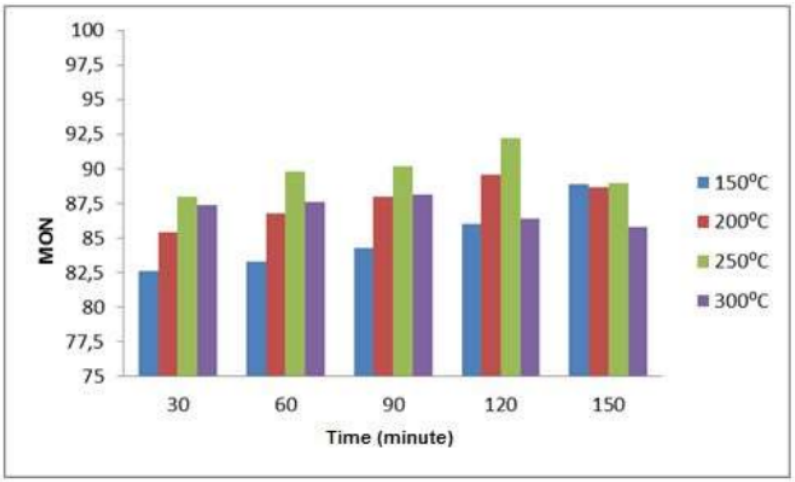

Figure 4. The Effect of Time and Temperature on Motor Octane Number (MON)

To determine the quality of gasoline can be determined through the effectiveness of combustion in the engine. The octane number is a comparison of n-heptane and iso tan compound which is used as a gasoline quality standard. The better the quality of gasoline, the higher the octane number. Gasoline content consists of paraffin, olefin, naphthalene, aromatic, and other organic compounds and contaminants. When burning, good gasoline does not cause knocking because it can interfere with the movement of the piston on the engine. Besides RON, Motor Octane Number (MON) is another way to determine octane numbers. This method is done with the same engine test as RON but uses a higher rotation per minute (rpm). RON uses 600 rpm while MON 900 rpm. Also, MON uses pre-heated fuel and variations of ignition timing [14].

Figure 3 shows that the RON at a temperature of 250 °C and various time variations show better results than the octane number produced under other operating conditions. At temperatures of 250 °C and various time variations, the octane number obtained ranged from 94 - 99. For the best octane number obtained at 250 °C and a time of 120 minutes. The RON value based on the standard and quality (specification) of gasoline fuel 90 listed in the decision document of the General Oil and Gas of the Republic of Indonesia Number 313. K / 10 / DJM.T / 2013 is equal to 90. The results of this study indicate that the range of RON values following quality standards, which amounted to 92-99. Figure 4 shows the MON reaching 90 obtained at temperatures of 250 °C with 90 minutes and 120 minutes time variations, namely 90 and 92.

4. Conclusion

From the results of the study, it can conclude that temperature and time variations are more dominant in the results of the analysis of the physical properties of the calorific value, Research Octane Number and Motor Octane Number is a temperature of 250 °C and a time of 120 minutes.

Acknowledgment

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