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# Identification of Cetane Number in Solar Fuel from Pyrolysis of Plastic Waste

**T Towijaya[1*], K Anam[1], W D Lestari[2]**

[1]Department of Mechanical Engineering, Faculty of Engineering University of Muhammadiyah Pekajangan, Pahlawan No.10 Gejlig, Kajen, Pekalongan.

[2] Department of Mechancial Engineering, Faculty of Engineering, University of Pembangunan Nasional Veteran Jawa Timur, 60294, Indonesia

*Corresponding e-mail: towijaya@gmail.com

**Abstract.** The use of fuel is currently increasing, as well as the increasing number of plastic waste that comes from household and industrial waste. The need for processing plastic waste to reduce the volume of waste is very necessary. One type of plastic waste is the type of polypropylene. This type of polypropylene plastic waste is a type of waste that can be used as a basic material to produce alternative fuels in the types of diesel, gasoline, and kerosene. In this research work, a test will be carried out to determine the cetane number of this type of diesel fuel produced by the pyrolysis process, to the treatment of temperature and time variables so that a high cetane number is produced. Plastic waste processing uses pyrolysis and distillation methods to produce alternative fuels with processing temperatures of 190ºC, 200ºC, and 225ºC in 3 hours, 4 hours, and 5 hours. From testing the cetane number on the pyrolysis fuel, the cetane number from the process of making this alternative fuel itself reached the highest number, namely 64.1 at a processing time of 5 hours at a temperature of 200ºC.

**Keywords:** Plastic Waste, Pyrolysis, Solar, Cetane Number

## 1. Introduction

Plastic is a type of polymer that has a common base material, namely Polyethylene terephthalate (PET), High-Density Polyethylene (HDPE), Polypropylene (PP), Poly Vinylchloride (PVC), Low-Density Polyethylene (LDPE), Polystyrene (PS) and others (OTHER). . Until now, plastic is widely used by industry and homes to meet needs, this can cause problems due to the large use of plastic waste that is not recycled properly. The term plastic covers synthetic or semi-synthetic polymerized products. They are formed from organic condensation or polymer addition and may also consist of other substances to improve performance or economy. Several natural polymers include plastics. Plastics can be formed into films or synthetic fibers. The name comes from the fact that many of them are malleable, possessing the property of plasticity. Plastics are designed with a great variety of properties that can tolerate heat, hardness, advantage, and so on. Combined with their adaptability, general composition, and light weight ensure plastics are used in almost all industrial fields [1]. The PP or polypropylene that we use for this test is hard but flexible, strong, waxy surface, not clear but translucent, chemical resistant, heat resistant, and oil resistant. The characteristics of Polypropylene are like ordinary transparent bottles that are not clear. Polypropylene is stronger and lighter with low vapor penetration, good resistance to grease, stable to high temperatures, and quite shiny. This type of PP is the best choice of plastic material, especially for food and beverage containers such as places to store food, drinking bottles, and most importantly drinking bottles that are safe from harmful chemicals [2]. From the nature of the polymer, it can be concluded that thermoplastic polymer is a type of polymer that can be recycled by pyrolysis, while the type of polymer that can be recycled is given a code in the form of a number and abbreviation for the type of polymer to facilitate the identification and use [3]. Pyrolysis is the process of decomposition of a material at high temperatures in the absence of air or the presence of free air. The decomposition process in pyrolysis is also often referred to as devolatilization. The main products of pyrolysis that can be produced are charcoal (char), oil, and gas. Charcoal formed can be used for fuel or used as activated carbon. The oil produced from the pyrolysis of polypropylene in the form of diesel, gasoline, and kerosene can be used as an addictive substance or fuel. While the gas formed can be burned directly [4].

According to the theory of the formation of petroleum, especially Engler's animal theory and the theory of plants, the organic compounds that makeup petroleum are the natural product of the decomposition process of plants over millions of years. Therefore, petroleum is also known as a fossil fuel other than coal and natural gas [5]. Fuel is any material that can be converted into energy. Usually, the fuel contains heat energy that can be released and manipulated. Most of the fuel is used by humans through a combustion process (redox reaction) where the fuel will release heat after being reacted with oxygen in the air [6]. Diesel oil is one of the fuels from the clear yellow-brown petroleum fraction which boils at about 175-370°C. Generally, diesel fuel contains sulfur at a fairly high level. The use of diesel, in general, is for fuel in all types of diesel engines. It can also be used as a fuel for direct combustion in small kitchens where clean combustion is especially desired. The measured quality of diesel fuel is indicated by the cetane number. The cetane number is a number ranging from 0 (zero) to 100 which indicates the quality of diesel fuel based on the relative combustion. This cetane number is one of several measurable factors to show the overall characteristics and quality of diesel fuel. The cetane number in diesel is inversely proportional to the octane number found in gasoline, if the gasoline fuel, the higher the octane value, the gasoline will be difficult to burn. Whereas in diesel fuel it is the opposite, the higher the cetane value in diesel, the easier it is for the diesel to burn [7].

## 2. Research Methodology

In this study, the dependent variable will be determined, namely the cetane number, as the number from the laboratory test results of diesel fuel produced from the plastic heating process through the pyrolysis process. The independent variables are temperature (T) and time (t) treatments on different heating processes. The variables of temperature (T) and time (t) of the heating process can be seen in Table 1. The detailed steps of this research can be seen through the flow chart in Figure 1. Cetane number testing was carried out at the Integrated Laboratory of Diponegoro University, Semarang.

**Table 1.** Variabel Temperature (*T*ºC) dan Time (*t* jam)

| Variable | Condition | | |
|---|---|---|---|
| *T* ( ºC) | 190<br>200<br>225 | 190<br>200<br>225 | 190<br>200<br>225 |
| *t* (hours) | 3 | 4 | 5 |

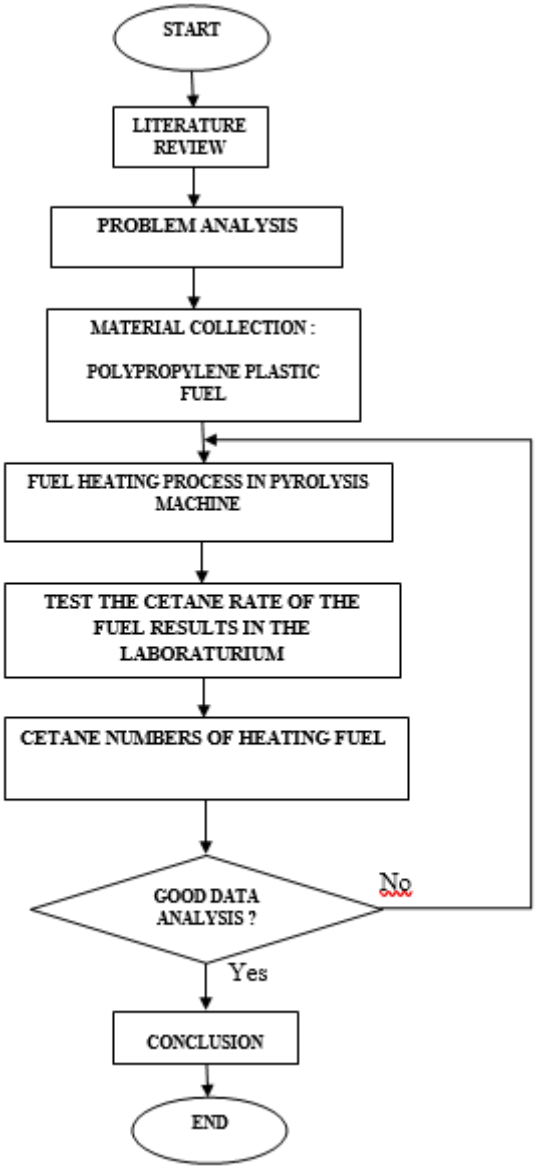


**Figure 1.** Experimental Flow

The samples to be tested are 9 types of plastic heating results, which can be seen in Figure 2, according to the heating process variables.


**Figure 2.** Sample

## 3. Results and Discussions

Based on the data obtained from the results of laboratory tests carried out, to find out the cetane number was measured using the Cetane Number Analyzer. The testing process is shown in Figure 3.

**Figure 3.** Testing using *Cetane NumberAnalyzer*

The data obtained from the test results can be seen in Figure 4. In this figure, the test results show that the largest cetane number is obtained in the heating process which is carried out for 5 hours and at temperatures of 190$^{o}$C and 200$^{o}$C. However, at temperatures above 225$^{o}$C, the cetane number tends to decrease again. Meanwhile, in the heating process with a duration of 4 hours, at temperatures of 190$^{o}$C, 200$^{o}$C, and 225$^{o}$C, the cetane number tends to increase linearly, but the cetane number obtained is lower than when the heating process is carried out with a longer duration of 5 hours. Likewise, in the heating process with a duration of 3 hours, at temperatures of 190$^{o}$C, 200$^{o}$C, and 225$^{o}$C, the cetane number tends to increase linearly, but the cetane number obtained is even lower than the heating duration of 5 hours. From the evidence of the tests that have been carried out, the longer the duration of the process tends to produce the higher the cetane numbe

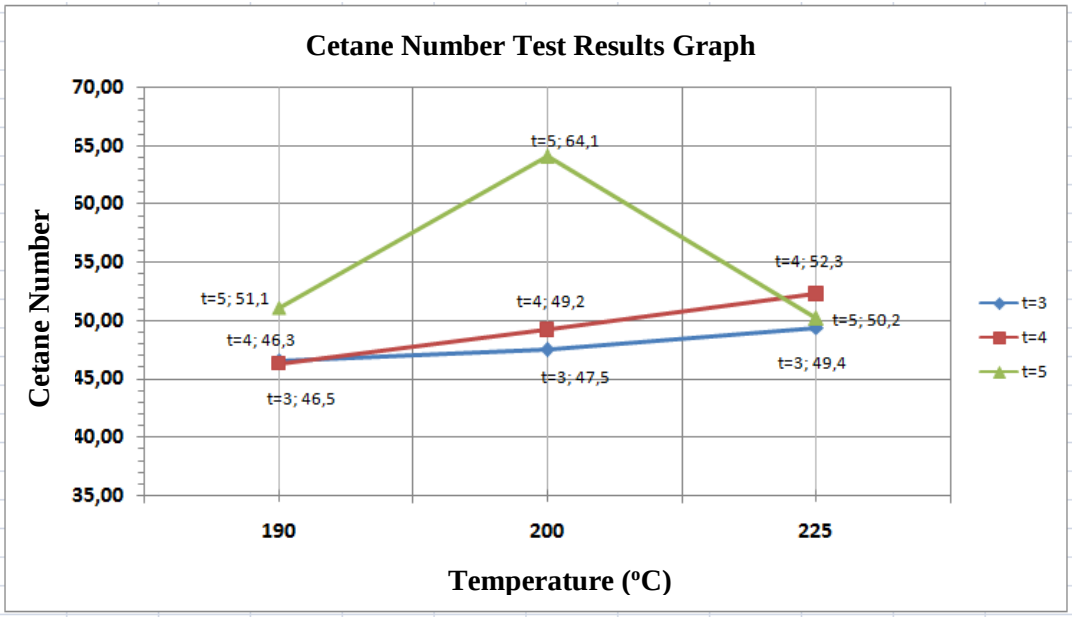


**Figure 4.** Graph of Cetane Number as a function of *T* (°C) against *t* (hours)

## 4. Conclusions

From this research, the conclusions are shown as follows:

1. The largest cetane number is obtained in the heating process at a processing time of 5 hours and at a process temperature of 200°C, which is a cetane number of 64.1. The cetane number obtained from this study is better than diesel fuel on the market in the range of 48 cetane numbers and Pertamina Dex's cetane number is only in the 53 cetane number range.
2. The lower the heating temperature, the cetane number obtained in the polypropylene pyrolysis process will be smaller and the diesel formation process is more imperfect because the heating of the plastic material is also not perfect.

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