Reducing Emissions CO, CO₂, and HC, on Vehicles with Gasoline Fuel

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Abstract. Merauke Regency is the largest regency in Papua with the highest fuel consumption by regency/city in Papua Province. The high fuel consumption is proportional to the emissions produced, so research on emissions absorbing media is needed to reduce emissions. Active charcoal has the ability to adsorption of emissions, one of the raw materials is plants. Buswood (eucalyptus) which grows a lot in Merauke can be used as raw material for activated charcoal which is used as an absorber of emissions. Research with the title "application of eucalyptus charcoal as emission adsorbent to reduce vehicle exhaust emissions" processes wood logs into emission adsorbents, through carbonation and activation processes, then activated charcoal is applied to vehicle vehicles and subsequent emission tests, to determine emission reduction capabilities. Based on the results of emission tests, the use of activated charcoal as an emission adsorber can reduce emissions. 0.07% CO emissions decreased to 0.01%, HC emissions 84 ppm, decreased to 39 ppm, and 14.7% CO₂ decreased 4.4%.

Keywords: Emission, Activated Charcoal, Adsorption

1. Introduction

Merauke Regency is the largest regency in Indonesia, which has an area of up to 46,791.63 km². The total population was 216,585 people in 2015, 220,006 people in 2016, 223,389 in 2017 [1]. The population of Merauke which continues to grow is directly proportional to fuel consumption, the more the population increases, the greater the fuel consumption, the greater the pollutants. Based on data on the number of customers and suppliers of fuel oil by type and month during 2011. The highest number of fuel customers by regency/city in Papua Province is in Merauke Regency, which is 23 customers, where aviation consumption is 5,313 kiloliters, 21,276 kiloliters premium, kerosene 8,864 kiloliters, and diesel oil 11,729 kiloliters. Research on emissions in the city of Merauke has been conducted by surveying vehicles during peak hours, to find out the percentage of emissions originating from motorized vehicles [2], other research on carbon emissions in Merauke concludes that emissions continue to increase [3].

A large amount of fuel consumption causes an increase in emissions, this is certainly a risk to human health. Preventive action needs to be sought, one way is to reduce pollutants in the air using adsorbents (absorbent media). Material that can absorb / Adsorption one of which is activated charcoal.
Activated charcoal is a material that has adsorption ability, so it can be used to absorb CO, NO, and NOx gas emissions produced by motor vehicles [4]. Active charcoal is also effective at absorbing HC emissions in vehicle engines [5]. The adsorption power of activated charcoal is influenced by pores on the surface. Activated charcoal that has good absorption is that which has small and large pores so that its surface is wider. Bus adsorption process simulation (Eucalyptus), is a wood that grows a lot in Merauke Regency. Bus wood can be produced into activated charcoal and can be applied as an exhaust gas absorbent on a gasoline motor.

The bus / eucalyptus wood is an endemic flora of Australia but is also scattered in parts of the eastern islands of Indonesia [6]. Several types of eucalyptus plants in Indonesia grow naturally in Papua, Sulawesi and East Nusa Tenggara. Eucalyptus habitat in Papua Province thrives including in Merauke Regency. This is the reason for researchers to conduct experiments with bus/eucalyptus wood raw materials so that local materials such as bus wood can be more useful.

2. Material and Method

2.1. Active Charcoal

Activated charcoal is produced through a carbonation process, where the raw material for bus wood is made up in a closed way until the perfect bus wood becomes charcoal. Activated charcoal has adsorption properties, namely the ability to absorb. Adsorption properties are obtained because activated charcoal has small and large pores. Active charcoal has an absorption of 25-100% of its total mass [7], [8].

2.2. Sample Preparation

Bus wood samples are taken and cut into small pieces, cleaned, and dried until completely dry.

2.3. Carbonation Process

The wood sample of the bus is chopped into small pieces and dried, then after it is dried it is put into prepared combustion can box, then closed and carried out burning for 120 minutes.

2.4. Physics Activation Process

Physical activation is carried out by burning active charcoal for 1 hour at a temperature of 300°C, 400°C, and 500°C. The activation process aims to increase pores and remove impurities that cover the pores.

2.5. Chemical Activation Process

This process uses ZnCl2 activator substances, the process is by mixing ZnCl2 activator substances with activated charcoal that has been blended. ZnCl2 was given as much as 5%, 7%, and 9%, then stirred evenly and allowed to stand for a day and night. After that, the activated charcoal is cleaned using distilled water and then dried and roasted for 4 hours at 100°C.

2.6. Catalytic Converter

A catalytic converter is a media that has the function of converting/converting harmful exhaust gases into gases that are more environmentally friendly. A catalytic converter is placed in the exhaust pipe of a motorized vehicle. The use of catalytic converters aims to reduce pollutants in motor vehicles that are sourced from the rest of the internal combustion process, to reduce air pollution [9], [10].
3. Results and Discussion

The carbonation process is the process of combining indoors without oxygen or minimal oxygen and other chemicals. After conducting the carbonation process, a chemical composition test is performed to determine the charcoal specifications of the carbonation process. Charcoal specifications are as follows as shown in the char composition table.

**Table 1. Chemical Composition of Bus Charcoal**

| No | Information          | Water (%) | Ash (%) | Volatile Matter (%) | Fixed carbon (%) | Calor Value (Kcal/Kg) |
|----|----------------------|-----------|---------|---------------------|------------------|------------------------|
| 1  | Eucalyptus Activated Charcoal | 22.23     | 6.68    | 7.90                | 63.19            | 5.981                  |

Chemical composition data was obtained from the results of tests conducted at the FMIPA UNHAS Biochemistry Laboratory. Data in the composition table shows that the wood charcoal bus has a high heating value.

The activation process is carried out chemically and physically. Chemical activation is carried out by adding certain chemical compounds to the charcoal. In this study, the chemical compound added to coconut shell charcoal was ZnCl\(_2\) 10%. The purpose of adding ZnCl\(_2\) is as an activator to break hydrocarbon bonds so that the surface pores of the charcoal become wider. This will facilitate the absorption process.

The mixture of activated charcoal and 10% ZnCl\(_2\) solution is stirred, covered with aluminum foil, and allowed to stand for 24 hours at room temperature. Activated coconut charcoal from the activation is washed with distilled water and dried in the oven for 4 hours at 100°C.

Activated charcoal that has been activated is applied to the adsorption of motor vehicle exhaust emissions. The application process is carried out by inserting 60 grams of activated charcoal into the adsorbent media. Furthermore, the adsorbent media is mounted on the exhaust tip of the vehicle.

The inner emission adsorbent tube consists of an 80 mesh wire, formed by a cylinder and coated with glass wool, which functions as an internal charcoal container. The external emission adsorbent tube is a galvanized pipe which is designed into two parts, namely the tube and the tube cover, both ends have holes as emission channels.

Emission testing is carried out at PT. Hasjrat Abadi (Dealer TOYOTA), in this case, direct measurements are shown from the results of measurements by the Gas Analyzer of vehicle exhaust. The results shown are complete in the form of CO, HC, and CO\(_2\) exhaust gases.

**Table 2. Emission Test Results**

| No | Type of Emission | Emission Percentage (%) |
|----|------------------|-------------------------|
|    |                  | No Emission Adsorption | Using Emission Adsorption |
| 1  | CO               | 0.07 %                  | 0.01 %                    |
| 2  | HC               | 84 ppm                  | 39 ppm                    |
| 3  | CO\(_2\)         | 14.7 %                  | 4.4 %                     |

Emission tests conducted at PT. Hasjrat Abadi (DEALER TOYOTA), using a Gas Analyzer, in the emissions test table it is known that the use of emission adsorbents can reduce the percentage of emissions.
Figure 1. Emission Test Process without using adsorbents

Figure 2. Exhaust Gas Comparison Chart, without the use of adsorption and by using adsorption.

In the comparison chart, the emissions are reduced when using emission adsorbents. 0.07% CO emissions dropped to 0.01%, HC emissions 84 ppm, decreased to 39 ppm, and 14.7% CO₂ decreased 4.4%.

4. Conclusions

Activated charcoal of activated bus wood can absorb exhaust emissions. Based on the results of emission tests, the data proves the use of bus wood as raw material for exhaust gas emission adsorbents, able to reduce HC emissions by 57.57%, reducing CO emissions by 98.57% and decreasing CO₂ emissions by up to 70.06%.

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