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Effectiveness of Variable Size of Composite Activated Carbon Sugar Palm Bunches (*Arenga Pinnata*) and Extract of Iron Sand on Adsorption of Motor Vehicle Exhaust Gas (CO, CO_2, HC)

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Abstract

This analysis aims to define the effectiveness of grain size variations of the composites of activated carbon from aren bunches (*Arenga pinnata*) and iron sand to analyze the levels of absorption of motor vehicle exhaust gas (CO, CO_2, HC). Samples of sugar palm bunches were obtained in Lalodati Village, Kendari City while iron samples obtained in Bubu Village, District, North Kambowa Buton Regency. Samples of sugar palm bunches and iron sand were washed and dried in the sun for 5 days. Waste bunches samples sugar palm is then carbonated with a temperature of 250 - 400^0C for 8 hours. Then for the iron sand extraction process is carried out using magnets.

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After that, carbon samples of sugar palm bunches and iron sand were mashed with a mortar and sieved with a grain size of 60 mesh, 80 mesh, 100 mesh, and 200 mesh. Samples Carbon of palm bunch waste were activated using temperature at 700 ° C for 30 minutes. Then, activated carbon samples of sugar palm bunches and iron sand waste homogenized with a ratio of 3:2 hours using a homogenizer for 8 hours After that, composite samples that have been homogeneous compacted on a pipe measuring 8 cm, with a pressure of 10 Newton. Samples are then inserted into the adsorption tube and analyzed using *Anycar Autocheck Gas and Smoke* (AAGS) analyzer. The results obtained showed that the activated carbon composite and iron sand extract had an influence on variations in grain size, where composite with grain size 100 mesh and 200 mesh are more effective in absorbing exhaust gas vehicle than composites measuring 60 mesh and 80 mesh.

Keywords: Activated carbon; sugar palm bunches waste; iron sand; adsorption; motor vehicle exhaust gas.

1. Introduction

Environmental pollution in this case air pollution has become a severe problem in urban areas. Not only big cities but even small cities are also now starting to experience air pollution problems, the source of primary pollutants comes from motor vehicles. Data of the Central Statistics Agency record that the number of motorized vehicle use in Indonesia has increased from year to year until 2016 the number of motorized vehicles in Indonesia reached 129,281,079 vehicles. According to Jayanti, the increasing use of motorbikes as a means of transportation has caused air pollution, resulting in environmental pollution. Motor vehicle air pollution comes from exhaust gases left over from burning fuels that do not decompose or burn completely [1]. The supported by Basuki, that motorized vehicles can emit exhaust emissions including SOx, NOx, CO, HC, and dust particulates [2]. This is also supported by the DKI Jakarta BPLH which states that motorcycle exhaust emissions contain hydrocarbons (HC), carbon monoxide (CO), which are air pollution parameters that are very important because they are the impact of the density of motorized vehicle traffic and between gases. Toxic, CO has the most significant percentage of 60%. In addition, for CO gas is colorless, and does not smell so tricky to know. If above the standard quality, the gas is quite dangerous for human health and can even lead to death [3]. As Rusdianto discovered, in his research HC levels were profoundly breathe it so that it causes polluting the environment and triggering the danger of poisoning for those who health problems, disorders, eye irritation, dizziness, coughing, drowsiness, skin spots, such as breathing code genetic changes, triggering asthma and lung cancer and even causing death [4]. Jalaluddin also states that the source of exhaust emissions from the combustion process of motor fuels produces exhaust gas which theoretically contains elements of H_2O (water), HC (hydrocarbon), CO gas (carbon monoxide), CO_2 (carbon dioxide) and NO_x (nitrogen oxide compounds), N_2 (nitrogen dioxide), and SO_2 (sulfur dioxide) [5]. Then that the exhaust gas produced by motorized vehicles is hazardous so it needs an effort to reduce the amount of the harmful element content. One of them is by using exhaust gas adsorbing media such as activated carbon [4]. Activated carbon is amorphous carbon gas which can apply for activation of charcoal consisting of atoms that carbon is water vapor (H2O), CO2 or N2, H2 [6], and has a deep so that it has good ability in adsorption [7]. The activity of adsorbing power from this activated carbon depends on the number of carbon compounds ranging from 85% to 95% free carbon. Making activated carbon utilizes organic and inorganic materials containing carbon, for example, wood waste, coconut shell, coal, and agricultural waste such as rice husk, corn cobs, cashew nut shells, and palm bunches [8].

Research conducted by Sumaiyah, proves that palm bunches have high fiber content (62-72% fiber content). The chemical compounds found in palm sugar bunch waste are 18.9% lignin, 81.2% hemicellulose, 81.2% cellulose, 66.5% moisture content, and 80% extractive, so that the palm bunches are highly potential to be used as adsorbents [9]. In addition to activated carbon, other materials that are often used as adsorbents are iron sands related to the characteristics and characteristics of magnetic minerals (Fe_3O4) contained in iron sand so that it has the potential to become an adsorbent that can be used. From the results of research conducted by Haslinda, sand Iron found in the Laompo area of Batauga Subdistrict, South Buton Regency, South Sulawesi, has elements such as Silicon Dioxide (SiO2) 33.756%, Magnesium Oxide (MgO) 6.617%, Ferries Trioxide (Fe2O3) 12,613 %, Iron (Fe) 8,829%, Calcium Oxide (CaO) 4,058%, and Aluminum Oxide Al2O3) 8.096% [10]. Seeing the benefits of these two materials, namely the activated carbon of aren bunches and iron sand as an absorbent material, with the presence of activated carbon from palm sugar bunches which are very abundant and less optimal in its utilization, and possibly also have different capabilities in adsorbing motor vehicle exhaust . Therefore, this study aims to make a combination of both palm sugar bunches (*Arenga Pinnata*) and Iron Sand Extracts in the Adsorption of Motor Vehicle Exhaust Gas.

2. Methods

2.1. Time and Place of Research

This research was carried out in the village of Lalodati, Puuwatu Subdistrict, Kendari City, Southeast Sulawesi for sampling palm sugar bunches (*Arenga pinnata*) and carried out in the village of Bubu, Kambowa sub-district, North Buton Regency, for sampling iron sand. Then the preparation of samples of aren bunches (Arenga pinnata) and iron sand and carbonated samples of palm sugar (*Arenga pinnata*) were carried out in the Punggolaka village, Puuwatu District, Kendari, Southeast Sulawesi. After that, it was carried out in the Development Laboratory of the Chemistry Education Department to measure and activate the samples of sugar palm bunches (Arenga pinnata) while the process of sifting samples of palm sugar bunches (*Arenga pinnata*) and iron sand and homogeneous processes and compacting samples was carried out at laboratory Survey and Materials Testing Faculty of Engineering at the Halu Oleo University. Furthermore, for the adsorption tube making stage and the sample testing process was carried out at the Kendari City Living Environment Laboratory in Southeast Sulawesi.

2.2. Material/Research Material

The material used in this study as the active ingredient is sugar palm bunch waste obtained from the village of Lalodati, Puuwatu Subdistrict, Kendari City, Southeast Sulawesi and composited with the iron sand extract obtained in the village of Bubu, Kambowa sub-district, North Buton Regency.

2.3. Research Procedure

2.3.1. Preparation Process for Palm Sugar Bunch of Waste (Arenga pinnata)

Palm sugar bunches (*Arenga pinnata*) are first washed with distilled water, then dried in the hot sun for 3 days. After drying, palm sugar bunches (*Arenga pinnata*) are carbonized using a pyrolysis tube at temperatures of

250^0C - 400^0C [11]. Then the carbonized bunch of palm waste is crushed using mortar. Then, samples were sieved with sieves measuring 60 mesh, 80 mesh, 100 mesh, and 200 mesh. After obtaining samples with variations in grain size of 60 mesh, 80 mesh, 100 mesh, and 200 mesh, physical activation was carried out by using an electric furnace at a temperature of 700^0C for 30 minutes [12].

2.3.2. Iron Sand Sample Preparation Process

Iron sand samples were washed first using distilled water, then dried under the hot sun for two days. The washing process aims to remove impurities and facilitate the extraction process. After dry iron sand, extraction is carried out to separate between magnetic and non-magnetic elements using a permanent magnet wrapped in cloth. The sand attached to the magnet separated from the beaker, which first cleaned with alcohol. Then, the mortar was done grinding. After that, filtering was carried out using sieves measuring 60 mesh, 80 mesh, 100 mesh, and 200 mesh [13].

2.3.3. Process of Making Adsorbent Media

Preparing samples of activated carbon and iron sand extract, mixing the two materials each measuring 60 mesh with a comparison of iron sand and activated carbon palm sugar bunches (Arenga pinnata) 2: 3. The sample was homogenized using a homogenizer for 8 hours. After that, the sample printed into briquettes at a pressure of 10 N with a length of 8 cm. Then perform the same procedure on samples of 80 mesh, 100 mesh, and 200 mesh.

2.3.4. Adsorption Tube Making Process

The adsorption tube was used to place the activated palm sugar bunches composite media of (*Arenga pinnata*) and iron sand extract. The tools needed in making adsorption couplings include aluminum pipes, parallel pipes, cloth, scissors, pipe saws, and rulers. The planned specification data for the equipment is as follows: sample length 8 cm, outer tube length 20 cm, outer tube diameter 3 cm, inner tube diameter 2 cm as in Figure 1.

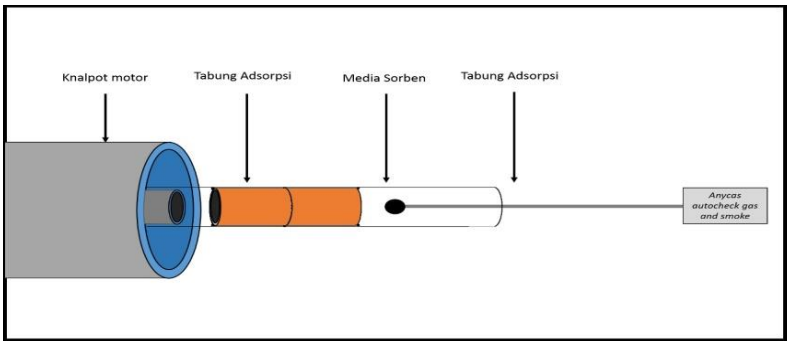

Figure 1: Tube of Adsorption

2.3.5. Process of Measuring Gas Emissions

Procedure for measuring exhaust gas emissions (CO, CO_2, and HC) on motorbikes with the composite sample length of activated carbon palm sugar bunches (Arenga pinnata) and iron sand extract 8 cm with variations of grain 60 mesh, 80 mesh, 100 mesh, and 200 mesh namely (1) insert the sample with a size of 60 mesh in length 8 cm into the outer tube; (2) Connecting the absorption tube at the motorcycle exhaust tip which is in the ON (engine running) state with the stationary state; (3) Inserting any car auto check gas and smoke sensors into absorption tubes when data is read out; (4) Record the results of reading the tools seen on the display screen any car auto check gas and smoke. Gas sampling is done using digital equipment, namely anycar autocheck gas and smoke is a gas analyzer type SPTC-Autocheck gas. To measure the percentage of absorption equation (1).

$$\text{Adsorption power} = \frac{(\%\ \text{initial exhaust gas} - \%\ \text{last exhaust gas})}{\%\ \text{initial exhaust gas}} \times 100\% \quad (1)$$

Where : % $\text{initial exhaust gas}$ = Flue gas concentration without composite

% last exhaust gas = Flue gas concentration with composite

3. Result and Discussion

3.1. Result

3.1.1. Results of reading of the motor vehicle exhaust analyzer

The results of the exhaust gas analyzer reading using the Anycar Autochek Gas and Smoke tool can be seen in Table .1

Table 1: Results of analyzer reAdings on motor vehicle exhaust gases

Data	Measurement Parameters	Time Variation(minute)	Time Variation (minute)		
			CO (%)	CO2 (%)	HC (%)
1	Without Composite	1	0.87	2.68	0.708
		2	1.29	2.93	0.9574
		3	1.34	2.96	1.0358
2	60 Mesh Composite	1	1.58	3.09	1.0693
		2	1.76	3.12	1.0275
		3	1.87	3.11	0.9461
3	80 Mesh Composite	1	1.34	2.74	0.824
		2	1.34	2.78	0.9779
		3	1.35	2.77	0.9507
4	100 Mesh Composite	1	0	1.73	0.163
		2	0	1.73	0.1628
		3	0	1.73	0.1626
5	200 Mesh Composite	1	0	1.75	0.2014
		2	0	1.75	0.2048
		3	0	1.75	0.2067

Based on Table 1 above, it can be seen that the results of the readings of the analyzer on motor vehicle exhaust gas with measurement parameters without composite exhaust gas concentrations obtained increased with increasing time. As for the results of analyzer readings with variations in grain size of 60 mesh and 80 mesh experienced irregular changes, Moreover for the results of the analyzer readings on motor vehicle exhaust gases for variations in grain size of 100 mesh and 200 mesh has decreased well.

3.1.2. Results of Analysis of Motor Vehicle Exhaust Absorption Concentration Data

The results of the data analysis of the concentration of motor vehicle exhaust gas absorption power presented in Table 2.

Table 2: Concentration of motor vehicle exhaust gas absorption

Data	Measurement Parameters	Time Variation (minute)	Time Variation (minute) (%)		
			CO (%)	CO2 (%)	HC (%)
1	60 mesh	1	81.60	15.29	51.03
		2	36.43	6.48	7.321
		3	39.55	5.06	8.65
2	80 mesh	1	54.02	2.23	16.38
		2	3.875	5.11	2.14
		3	0.746	6.41	8.21
3	100 mesh	1	100	35.44	76.97
		2	100	40.95	82.99
		3	100	41.55	84.30
4	200 mesh	1	100	34.70	71.55
		2	100	40.27	78.60
		3	100	40.87	80.04

Based on Table 2, it can be seen that the results of data analysis on the concentration of absorptive capacity of motorized vehicle exhaust gas for measurement parameters for 60 mesh and 80 mesh variations are not good at absorbing exhaust gases. While the parameters for measuring grain size variations of 100 mesh and 200 mesh are good at absorbing motor vehicle exhaust gases.

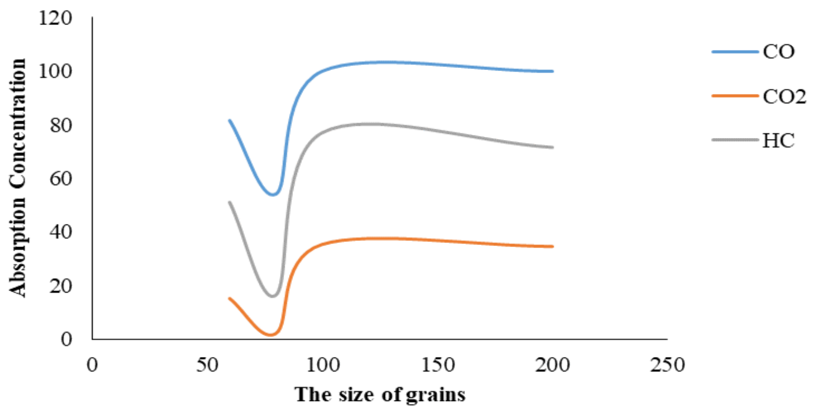

Figure 2: Graph of the relationship between the concentration of composite absorption on composite grain size at minute 1

Based on Figure 2, it interpreted that for the first minute the motor vehicle exhaust gas absorption concentration has an effect on each grain size variation which shows that the smaller the size of the grain the better the absorption capacity, while for the 80 mesh grain size it decreases.

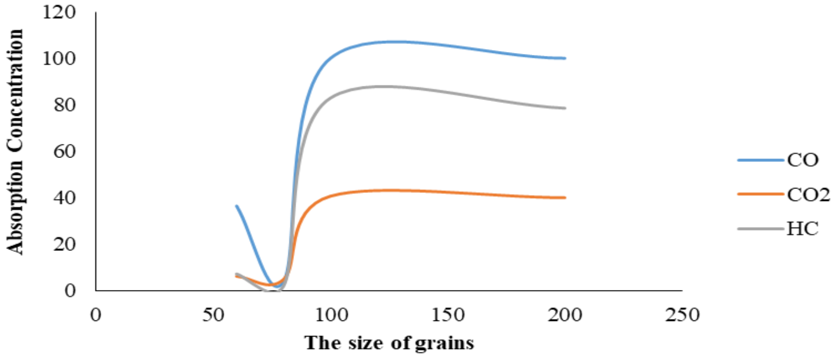

Figure 3: Graph of the relationship between the concentration of bunch gas absorption of motorized vehicles and the size of the particles in minute 2

Figure 3 can be said that the concentration of exhaust absorption of motor vehicles for the second minute of grain size variations also experienced a good effect with the smaller the size of the grain in this case 100 mesh and 200 mesh the better the absorption, the smaller the mesh size of 80 mesh.

Based on Figure 4, it can be seen that the concentration of exhaust absorption of motorized vehicles for the third minute on the effect of grain size variations obtained a notable increase in absorption of motorized exhaust gas compared to the first and second minutes.

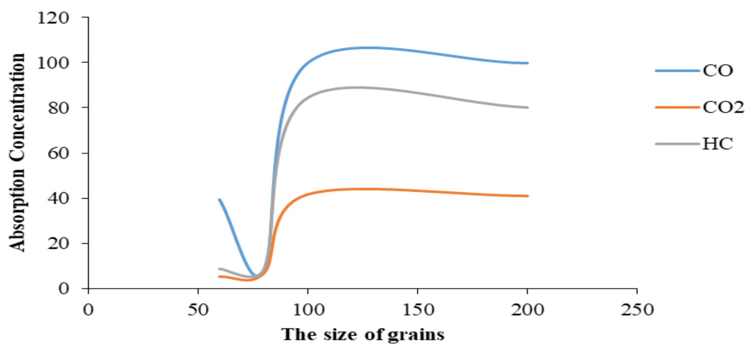

Figure 4: Graph the relationship between the concentration of absorptive capacity of motorized vehicle exhaust gas to size 3 minutes

3.2. Discussion

The results of the effectiveness of composite palm sugar bunches (Arenga Pinnata) and iron sand extract with the initial results of measurement of motorcycle exhaust emissions tested on old motorcycles in this case 2 stroke motors obtained without the use of adsorption media tend to increase as shown in Table 1 with an increase emission time which is on CO gas parameters, which is 0.87%; 1.29%; and 1.345%; CO_2 which is 2.68%, 2.93%, and 2.96%; and HC gas is 0.708%, 0.9574%, and 1.0358%. With an interval of 1 minute for 3 minutes in a row in a stationary or constant state. The increase is due to the exponential function that is recorded as positive which illustrates that emissions will continue to increase throughout time, this is because more indirect combustion on motorized vehicles so that the number of exhaust gases of motor vehicles will continue to increase from the previous amount, and the measurement reading results will be higher [14] The condition with the increase in the concentration of gas emissions in vehicles that continues to increase will then have a negative impact on the environment. In the Regulation of the Minister of Environment No. 5 of 2006 Concerning Old Motor Vehicle Exhaust Emission Threshold that motorcycle category 2 No manufacturing year below 2010, CO parameter determination is 4.5%, CO_2 is 12% - 15% and HC is 1.2%. Based on Table 1 Results reading of the analyzer on motorized vehicle exhaust gas, the motorbike used in this study for gas HC is a category that is almost close to the threshold. Where the most substantial HC reading results in a composite of 60 mesh is 1.069% due to incomplete combustion, where a minimal amount of fuel supply mixed with clean air [15]. The results obtained for the concentration of HC gas can pollute the environment and be harmful to the body when inhaled. As Rusdianto found, in his research the high HC content polluted the environment and triggered the danger of poisoning for those who breathe it causing health problems. While for CO and CO_2 parameters the results obtained ranged from 1.34% - 1.87% which means that the resulting exhaust gas is absorbed well by the absorption media used. It is because O_2 which is too much out of the gas residue indicates that the combustion process in the engine is inefficient so that the O_2 content in the combustion process is still below the threshold of no more than 2% [3]. Furthermore, the measurement results in Figure 2 to Figure 4 show that the content of gas CO, HC and CO_2 of motor vehicles for an interval of 1 minute for 3 minutes measurement of grain size variations, it appears that the smaller the size of the grain the lower the concentration of motor vehicle exhaust gas. These results indicate that the decrease in the concentration of CO, HC and CO gas emissions inversely proportional to the size of the media composite grain of aren bunches (*Arenga pinnata*) and iron sand extract in the adsorption tube. This is following the research conducted by Das, in his research study stated that particle size and activation temperature greatly influence the adsorption ability. The higher the activation, the larger the pore size of the particle will be, so that it has a higher absorbent ability, while the smaller the particle size the interaction style between particles increases and the particular arrangement becomes tighter [16]. However, the measurement of 80 mesh grain size at 1 minute intervals for 3 minutes showed irregular changes because the installation of the adsorption tube was not so good that the exhaust gas of the motor vehicle was not entirely through the adsorbent media which was connected directly to the anycast auto check gas and smoke. The accordance with the research conducted by Reynold, which stated that there was a lack of absorption from the sample caused by one of the factors that is not absorbing a substance (molecule or ion) at the surface of the adsorbent [7]. Therefore, it can say that the activated carbon composite of aren bunches (*Arenga pinnata*) and iron sand extract can be used as a medium for absorption or adsorbent in motor vehicle exhaust gases..

4. Conclusion

Based on the effects of research that has been done, it can be concluded that grain size variations affect the adsorption of motor vehicle exhaust gas concentration, where the smaller the size of the grain, the lower the concentration of exhaust gas and the more effective the absorption capacity of 100 mesh and 200 mesh size variations mesh.

Acknowledgments

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