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Adsorption Analysis of Green Shells as Temperature Reducer In Coolbox

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Abstract. Green mussel (Perna Viridis) is a marine invertebrate from a group of soft-bodied animals that is used as a source of animal food. This high level of consumption is followed by a high amount of food processing waste in the form of shells that is allowed to accumulate in coastal areas. This can cause unpleasant odors and can cause disease in the surrounding community. Generally, shell waste is only used as handicrafts or wall decoration. In this study, green mussel shell waste was used as an adsorbent medium to reduce motorcycle exhaust emissions. Experiments were carried out by placing the adsorbent in a cool box which was tested on a heater which was simulated as a heat source. Tests of the function of lowering the air temperature with temperature variations on the heater control are 80, 100, 150^{0}C. Experiments were also carried out on motorcycle exhaust gases with variations in engine speed of 2500, 3900 and 4700 rpm. The test results on the heater showed that the green mussel shells were able to reduce the air temperature by 35% from the simulated heat source. Meanwhile, in the exhaust gas test, the motor at 4700 rpm with a temperature of 170^{0}C can be reduced by 71.48% (ie 130°C) from the heat of the motor in the exhaust. In addition, CO_2 emissions from motorcycle exhaust were reduced by 6.1%. Thus, green mussel shells can be used as an alternative medium for heat and emission adsorbents in motor exhaust gases.

Keywords: Adsorption, Green Mussel Shell, Wasted Air Temperature, CO_2

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1. Introduction

Green mussels (Perna Viridis) are marine animals with no vertebrates as a source of animal food that can be found in river mouths, mangrove forests and seagrass beds [1]. Based on a report from the Statistics Agency of the Ministry of Maritime Affairs and Fisheries in 2018, the production of shellfish produced by waters in Indonesia reached 94,708.84 tons. Shellfish in Indonesian waters consist of thousands of species, including those with high economic value, namely green mussels, blood clams, pearl oysters, scallops, and oysters. The higher the public interest in the consumption of this shellfish, the higher the wasted shells. The processing of green mussels as wall decoration material, handicrafts (key chains and other accessories), and as a mixture of animal feed, has not been fully utilized.

Several studies have been carried out for the utilization of green mussel shell waste in order to add value to it, one of which is as an adsorbent material. Green mussel shell powder to reduce iron metal content [2], manufacture of coagulants as water purifier [3], adsorption of metallic Cu and as chitosan [4]. Furthermore, through an exothermic process where the adsorbent (solid) and adsorbate (fluid) release heat, causing a decrease in the movement of the adsorbate molecules which

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causes the adsorbate to stick to the surface of the adsorbent, making the adsorbent used as cooling [5]. Based on previous research, this research uses clam shells as an adsorbent as a heat absorber/thermal reducer and as an adsorbent material to reduce CO_2 emissions in motor vehicle in the form of a cool box.

The working ability of the test equipment must be able to reduce the temperature which is influenced by the type of adsorbent [6]. The characteristics of the adsorbent needed for a better absorption process are as follows:

1. Surface area of the adsorbent. The more surface area, the faster the absorption process.
2. The size of the adsorbate must be smaller than the size of the pores of the adsorbent in order for the adsorption process to occur.
3. The absorption will be better if the adsorbent has a high purity.

2. Methodology

Experiments to determine the magnitude of the decrease in temperature by green mussel shells in the cool box were tested using a heater heating source using temperature variations on the heating controller 80, 100, 150^{0}C. Then to determine the amount of emission reduction that occurs in the exhaust gas of the motor, it is carried out with and using the exhaust gas of the motor with variations in engine speed of 2500, 3900, and 4700 rpm at idle conditions.

Experiments were carried out by placing the adsorbent in a cool box which was tested on a heater which was simulated as a heat source. The testing tools are as shown in Figure 1 below.

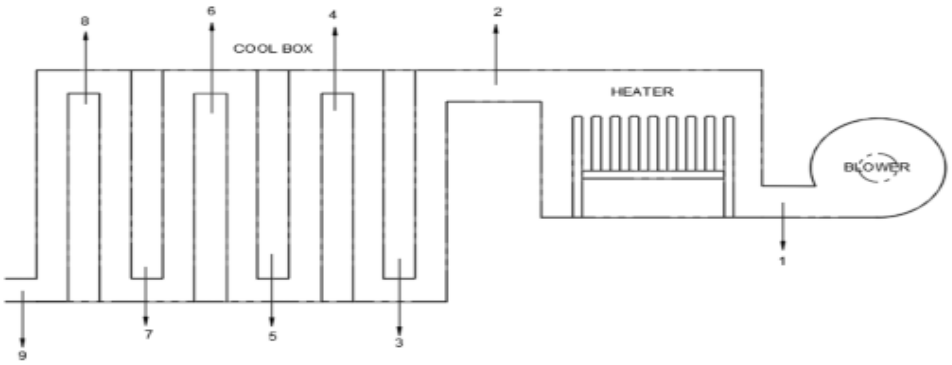

Figure 1. Cool Box for Heater Temperature Test

Where :
1. T1 = Ambient temperature
2. T2 to T8 = Air temperature into the material
3. T9 = Cool box exit air temperature

Tests to reduce air temperature with temperature variations on the heater control, namely 80, 100, 150^{0}C. The time range used for testing on the heater is 12, 25, and 28 minutes. The data obtained from the measurement results to see the difference between the cool box inlet temperature and cool box outlet temperature. Green scallop shell powder is placed in the box.

Cool box made of acrylic with dimensions of thickness: 3 mm, width: 166 mm, length: 326 mm, and height: 50 mm. A container for green mussel shells made of aluminum with dimensions of thickness: 1 mm, width: 30 mm, length: 150 mm, and height: 50 mm. Blower with a capacity of 1/4 hp (186.5 Watt) as a hot air blower from the heater so that air flows into the cool box. A heater with a capacity of 500 Watts is used as a heat source with the following specifications:

- Length, L = 300mm = 0.3m
- Power, Ph = 500Watt
- Outside diameter, d0 = 11mm = 0.011m

Furthermore, experiments were carried out on motorcycle exhaust gas using a tool as shown in Figure 2 below.

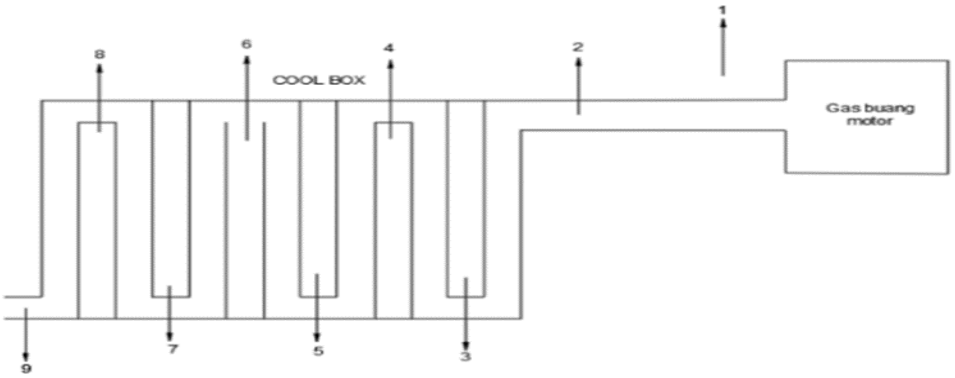

Figure 2. Cool Box for Temperature Test and Motor Exhaust Emissions

where:
1. T1 = Ambient temperature
2. T2 to T8 = Temperature in the material
3. T9 = Exit temperature

The type 4 gasoline motorcycle with the Yamaha Mio GT brand as a heat source and exhaust emission source is ignited with variations in engine speed of 2500, 3900 and 4700 rpm at idle, using the Mychron meter to measure engine speed. Figure 3 shows the Mychrons used to check the motor rpm speed mounted on the motor spark plug.

Figure 3. Brain Bee Gas Analyzer AGS-688

Conductivity meter, used to measure the conductivity of green mussel shell powder. The conductivity of green mussel shell powder was obtained at K= 2.35 J/m.s. The conductivity meter is shown in Figure 4.

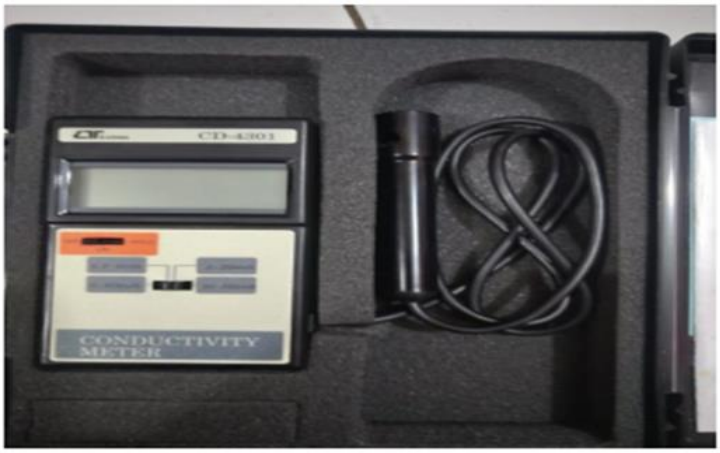

Figure 4. Conductivity Meter

The schematic drawing of the test equipment on the motor is shown in Figure 5.

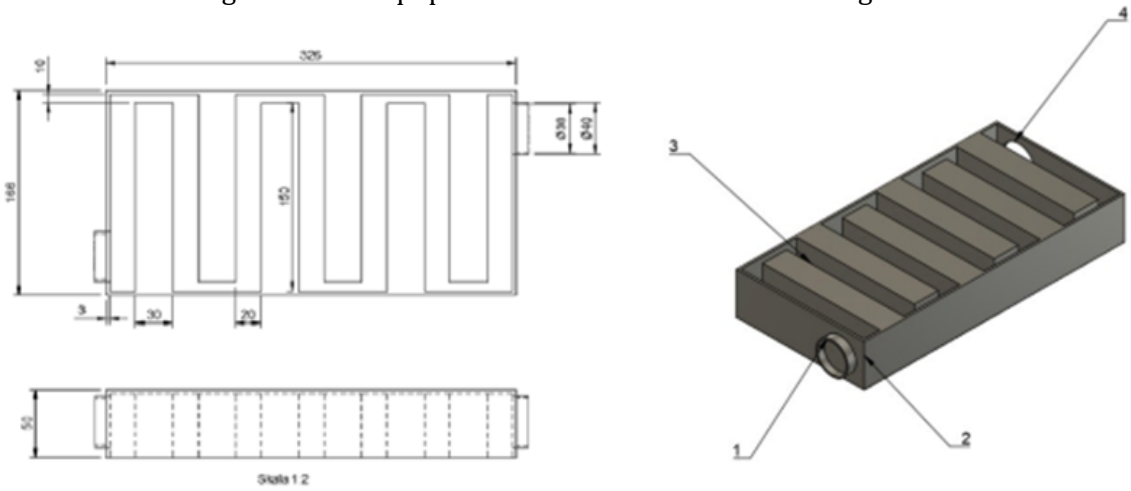

Figure 5. Schematic of Test Equipment on Motor

where:
1. The exhaust gas flow enters the cool box
2. Coolbox
3. Container for placing clam shell powder
4. The exhaust gas flow out of the cool box

Green scallop shell powder is obtained from grinding green mussel shells. The green scallop shell powder used is 125 mesh in size. The green scallop shell powder is shown in Figure 6.

Figure 6. Green Scallop Shell Powder in a Container

3. Result and Discussion

The experimental data shows how much the air temperature and exhaust gas emissions are reduced by the green mussel shell powder in the cool box. For temperature experiment data collection was carried out 3 times at the temperature controller in the heater 80, 100, 150°C and the carbon dioxide data collection was carried out on motorcycle exhaust emission tests at speeds of 2500, 3900 and 4700 rpm. Speed limits based on government regulations [7]. Measurement of the temperature and the amount of exhaust gas emissions is carried out before and after hot air or exhaust gases through the cool box.

3.1. Reduce Thermal

a. Testing on Temperature Controller Heater 80°C

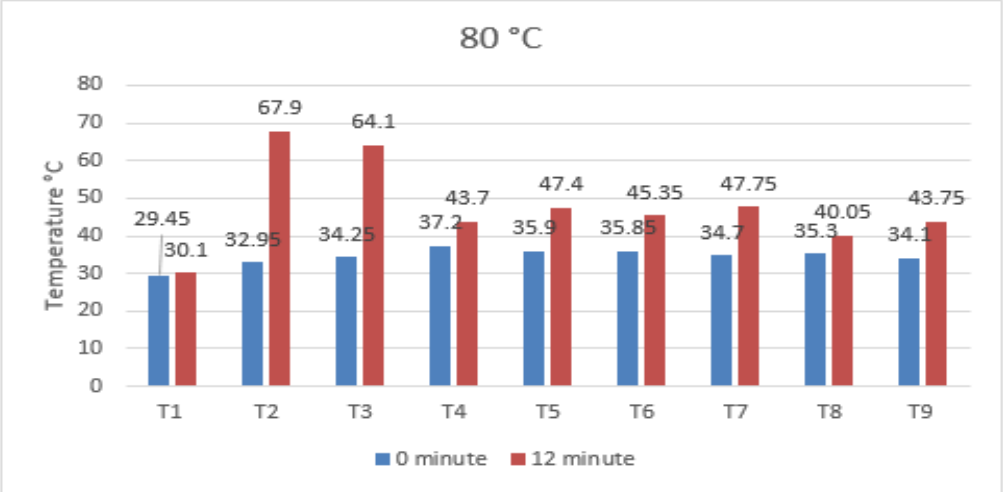

Figure 7. Test Results on Controller Heater 80 °C

where:
1. T1 = Ambient temperature
2. T2 to T8 = Temperature in the material
3. T9 = Exit temperature

In Figure 7 it is shown that the test uses a heater with a temperature of 80°C with ambient air temperature of 29.45°C going to a cool box for 12 minutes. The temperature of the air that enters the cool box is 67.9°C and is absorbed by the clam shell powder in the cool box so that the temperature that comes out decreases to 43.75°C.

b. Testing on Temperature Controller Heater 100 °C

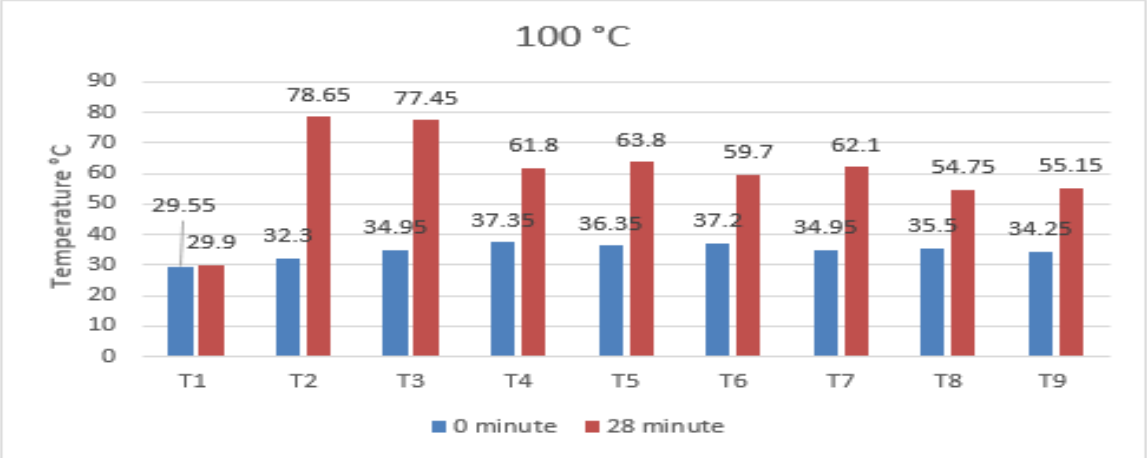

Figure 8. Test Results on Controller Heater 100 °C

In Figure 8, it can be seen that the ambient air temperature is at 29.9°C, the heater temperature is 100°C for 28 minutes, the air temperature entering the cool box is 78.65°C and is absorbed by the shellfish powder in the cool box, then the temperature of the outgoing air decreases to 55.15°C.

c. Testing on the Temperature Controller Heater 150 °C

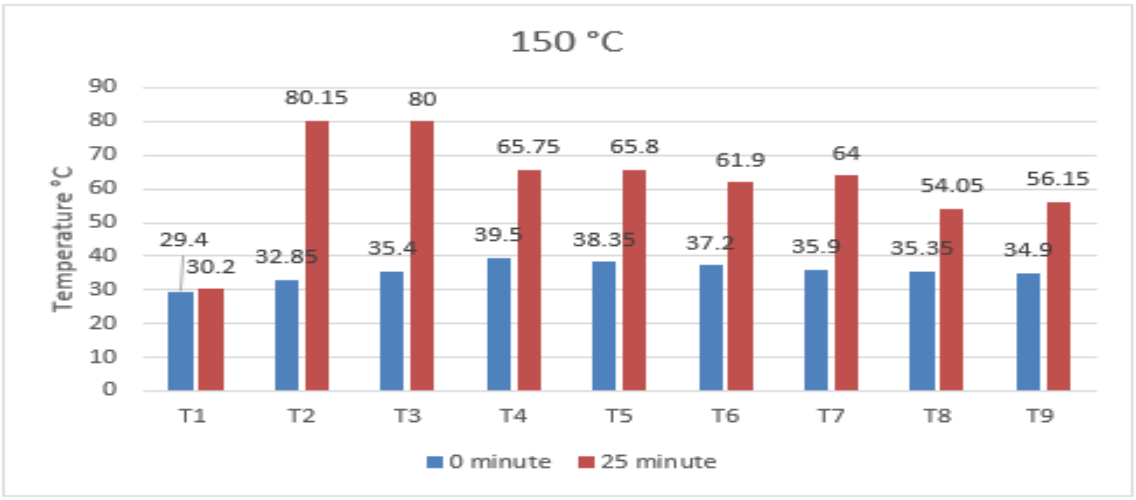

Figure 9. Test Results on the Controller Heater 150 °C

In Figure 9, it can be seen that the ambient air has a temperature of 30.2°C, the heater temperature is 150°C for 25 minutes, the temperature of the air entering the cool box is 80.15°C and is absorbed by the shellfish powder in the cool box. the air that comes out decreases to 56.15°C.

3.2. Reduce Thermal in Motor Exhaust

Tests at engine speed of 2500, 3900 and 4700 rpm with a test time of 10 minutes each, the test results can be seen as follows:

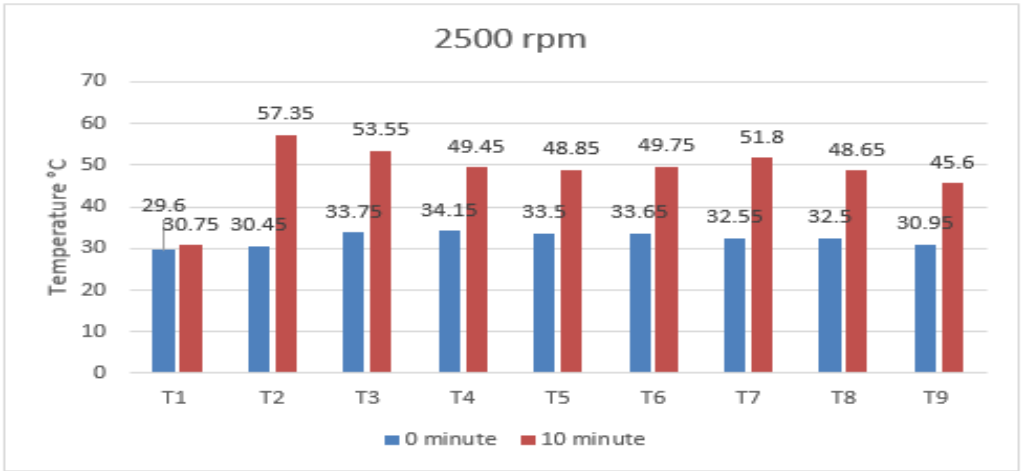

Figure 10. Test Results at 2500 rpm. Speed

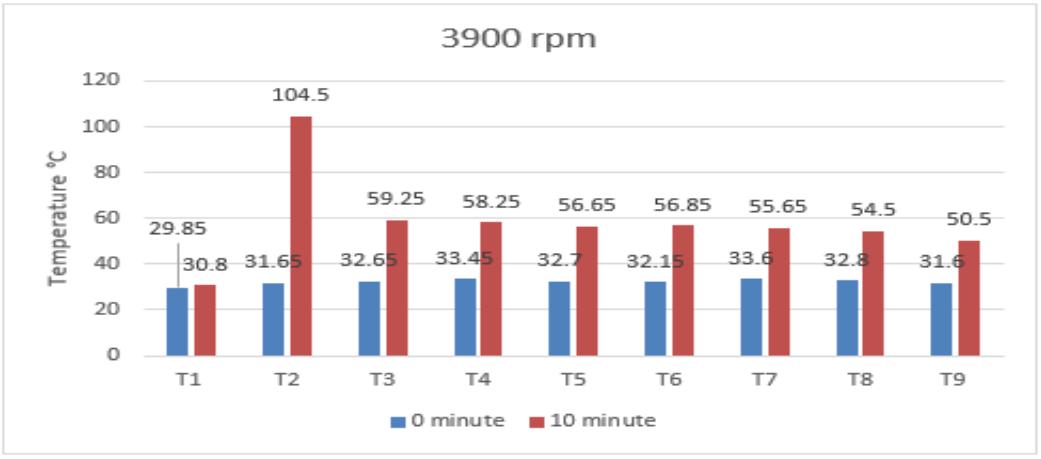

Figure 11. Test Results at 3900 rpm. Speed

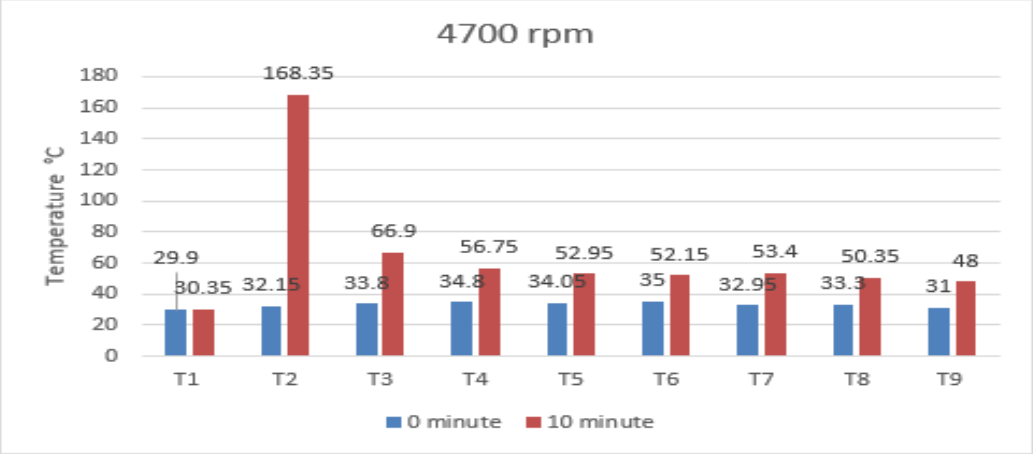

Figure 12. Test Results at 4700 rpm. Speed

At a speed of 2500 rpm in ambient air with a temperature of 30.75°C, the measured temperature of the air entering the cool box is 57.35°C and is absorbed by the shellfish powder in the cool box. exit decreased to 45.6°C. At a speed of 3900 rpm with ambient air temperature of 30.8°C, the temperature of the exhaust gas entering the cool box is 104.5°C and is absorbed by the clam shell powder in the cool box, then the temperature of the exit gas decreases to 50.5°C. At a speed of 4700 rpm with ambient air temperature of 30.35°C, the temperature of the motorcycle exhaust gas enters the cool box at 168.35°C and is absorbed by the clam shell powder in the cool box, then the gas comes out with a temperature that drops to 48°C.

3.3. Reduce motorcycle exhaust emissions

In the tests carried out using exhaust gases, especially CO_2 from a 4-stroke gasoline motorcycle at idle with variations in engine speed of 2500, 3900 and 4700 rpm. Here are the results of the test:

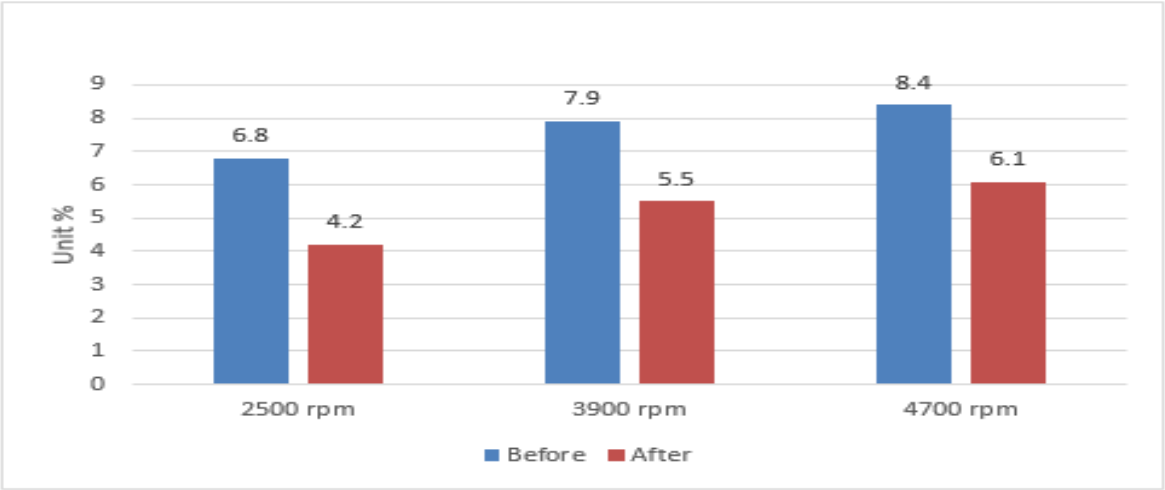

Figure 13. Motor Exhaust Emission Test Results

Based on Figure 13, in the first test using exhaust emissions from a motorcycle with a speed of 2500 rpm. Before using the cool box, the exhaust gas emission level is 6.8%, then after using the cool box the exhaust emission level drops to 4.2%. In the second test using exhaust emissions from a motorcycle with a speed of 3900 rpm. Before using the cool box, the exhaust emission level was 7.9%, then after using the cool box the exhaust emission decreased to 5.5%. In the third test using exhaust emissions from a motorcycle with a speed of 4700 rpm. Before using the cool box, the exhaust emission level was 8.4%, then after using the cool box the exhaust emission decreased to 6.1%.

From Figure 13, it is clear that green mussel shells in a cool box can reduce air and gas temperatures, besides that they can also absorb CO_2 gas from motorcycle exhaust emissions. The

model can be simulated using ANSYS FLUENT 17 as a didactic method to engage in depth understanding of this melting phenomenon [8].

4. Conclusions

After conducting a series of tests, it can be concluded that adsorption process based on green mussel shell powder as an adsorbent is proven to be able to reduce the temperature of hot air coming from the heater by 30%, even up to 70% for motorcycle exhaust gases. Meanwhile, green mussel shell powder as an adsorbent has been proven to absorb exhaust gas emissions from motorcycles (CO_2) even though it only reaches 2%.

During the testing process on the exhaust gas of the motor, the faster the rotation of the motor causes an increase in the temperature entering the cool box. The rotational speed of the motor also causes the water content to increase significantly in the combustion chamber, this causes the material in the cool box to become moist. As a result of the moist material causes the temperature of the air/exhaust gas coming out of the cool box to decrease.

Acknowledgments

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