The Utilization of Natural Zeolites and Coal Fly Ash Mixture Physically Activated Using Furnace as a Pellet-Shaped Air Filter to Increase Engine Torque, Tecumseh TD110. 4-Stroke Petrol Motor

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Abstract

An air filter made from a mixture of natural zeolite and coal fly ash can be used to remove nitrogen (N_2) and moisture (H_2O) in the air. This filter can produce oxygen-rich air (O_2) flowing into the combustion chamber to increase the quality of the combustion process so that complete combustion occurs and improve engine torque. In this research the filter was made from a physically activated mixture of natural zeolite and fly ash through heating in a furnace for 1 hour with temperature variations (200°C, 250°C, 300°C, 350°C), mass variations (50%, 75%, 100%) and variations in the composition of Z100%:F0%, Z75%:F25%, Z50%:F50%, Z25%:F75%, Z0%:F100%. Tests were carried out using a 4-stroke gasoline engine of Tecumseh TD110 located in the Propulsion Laboratory of the Mechanical Engineering Department, University of Lampung. Test results show that the biggest improvement in torque occurs in using a filter composition of Z50%:F50%, namely by 28.41%. The followed filter of the composition of Z75%:F25% is as big as 28.31%. The activation temperature of 350°C can improve the torque by 35.08%.

Keywords: *zeolite-fly ash adsorbent, physically activation, air filter, torsion.*

I. INTRODUCTION

In the combustion process, the air filter has a vital role in fuel combustion. The air content consists of O_2, N_2, CO_2 and H_2O. Suppose the air entering the combustion engine's combustion process is N_2 and H2O. In that case, these gases can absorb the heat of combustion in the combustion chamber so that the heat generated from the combustion process can be reduced and cause the combustion process to be incomplete [1,2]. Air filters by utilizing natural zeolite and coal fly ash can be used to filter the air entering the combustion chamber for the combustion process because these materials can act as adsorbents. Natural zeolites can capture nitrogen (N_2) and water vapor (H_2O) in the air, while coal fly ash can capture water vapor (H_2O) in the air [3]. The use of zeolite as a filter for combustion air adsorbent has been performed previously to improve the performance of a physically activated 4-Step gasoline engine obtained the best increase in cranking power of 0.127 kW (5.93%) in 2000 rpm [4].

Moreover, reduced by 0.0197 kg/kWh (7.50%) for using 50 grams of zeolite occurs at 1500 rpm. The material used is only pure zeolite which is physically activated at a temperature of 225^0C for 2 hours [5]. Based on the previous research, the manufacture and testing of physically activated fly ash pellets with different mass variations, namely 35, 45, and 55 grams on a 4-Step gasoline motor. Using fly ash pellets in the road test can save fuel consumption by 22.34% and 19.56% in the 1500 rpm static test [3,5].

Also, research on fly ash zeolite pellets have been used as a filter for air adsorbent on a 4-stroke gasoline motorcycle for the best activation temperature at a temperature of 225^0C [4]. At that temperature, with a mass variation of 100% in the road test. It can save fuel consumption up to 28.78%. In a stationary test for 5 minutes of testing, it reaches 42.85% for the overall

engine speed [2]. Based on research that has been conducted by Abdul Aziz (2018) on the effect of air filters made from zeolite and HCl-activated fly ash (coal) on the performance of a 4-stroke motorcycle engine, the best composition filter for improving engine performance is the Z75:F25 filter with a percentage of 55,09 %. The filter with the best physical activation temperature is at 225^{0}C with a total percentage of 58.31 %. The best filter for increasing engine power is the Z75:F25 composition filter with a normality of 1N and a drying temperature of 225^{0}C by 19.11% or about 4.42 seconds faster than without a filter [1].

From what has been described above, the researchers studied the effect of a mixture of physically activated zeolite and fly ash using a furnace with temperature variations, namely 200^{0}C, 250^{0}C, 300^{0}C, and 350^{0}C, as a combustion air filter to increase engine torque. A 4-stroke Tecumseh TD110 gasoline engine is located in the Fuel and Propulsion Motor Laboratory, Department of Mechanical Engineering, Faculty of Engineering, University of Lampung.

II. RESEARCH METHODOLOGY

2.1. Zeolite Filter Making- Fly Ash

The materials used to make zeolite-fly ash filters include zeolite, coal fly ash, adhesive (tapioca flour) and mineral water. The tools used are Furnace, collision, sieve with a size of 100 mesh, scales, frying pan, electric stove, roller, pellet mold and strain wire. Making dough and molding pellets with the composition of pellet dough, namely 54% (54 grams) of zeolite- fly ash , 4% (4 grams) of adhesive and 42% (42 grams) of distilled water with a ratio of Z100%:F0%, Z75%:F25% , Z50%:F50%, Z25%:F75% and Z0%:F100%. The finished dough is then levelled with a roller to a thickness of 3 mm and moulded with a diameter of 10 mm in the form of pellets.

The printed dough is then allowed to dry for 24 hours at room temperature. Afterwards, zeolite-fly ash pellets were activated using a furnace with temperature variations of 200^{0}C, 250^{0}C, 300^{0}C and 350^{0}C for 60 minutes. After activation, the pellets were packed using strain wire according to the shape of the filter used in the TD114. Instrumentation equipment test. The purpose of making this packaging is to make it easier to install pellets on the air filter of instrumentation tools.

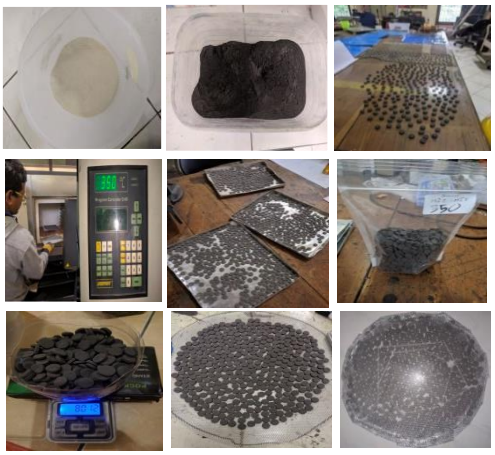

Figure 1. The process of making a zeolite-*fly ash* filter

2.2. Test Tool

In this study, the engine used for testing is a 4-stroke 1-cylinder gasoline engine Tecumseh TD110 equipped with an Instrumentation unit TD114 located in the Motor Bakar and Propulsion Laboratory Department of Mechanical Engineering, the University of Lampung with an engine cylinder capacity of 199.6 ccs. The TD114 Instrumentation Unit in this test is a panel for measuring engine speed, torque, temperature, exhaust gas, fuel consumption rate and combustion air usage rate (see Figure 2).

(a) (b)

Figure 2. (a) 4-Stroke Gasoline Motor Tecumseh TD110, (b) Instrumentation Unit TD114.

2.3. Testing Procedure

The calibration of the test equipment is carried out first so that the data reading results are more accurate. After the tool is calibrated, the engine is turned on for approximately 10 minutes to warm up the engine until the condition is stable. Data retrieval begins by setting the engine speed. The engine speed variations are 1000 rpm, 2000 rpm, and 3000 rpm. Activated zeolite fly ash used in this test is physical activation with temperatures of 200^{0}C, 250^{0}C, 300^{0}C, and 350^{0}C with variations in the mass density of 50%, 75%, 100% and variations in the composition of the zeolite mixture pellets - fly ash, namely Z100%:F0%, Z75%:F25%, Z50%:F50%, Z25%:F75%, and Z0%:F100%.

Fly ash composition and the second test determine the best activation temperature. The data collection process is carried out in 2 stages in the same cycle, the first stage is data collection without using zeolite- fly ash, and the second stage is data collection using physically activated zeolite- fly ash, which is heated in a furnace with a temperature of 350^{0}C, carried out repetition of data collection three times. In this case, the zeolite- fly ash air filter is placed in the air inlet so that the air entering the combustion chamber passes through the zeolite- fly ash pellets and undergoes an adsorption process carried out by the zeolite- fly ash pellets, using a fuel consumption rate of 8mL. After the torque is stable, then the data is recorded which is shown on the TD114 instrumentation and data collection is carried out for each engine speed.

III. RESULTS AND DISCUSSIONS

Data on the results of testing the effect of variations in mass and composition of zeolite- *fly ash* filter pellets on torque based on engine speed can be seen in Figure 3.

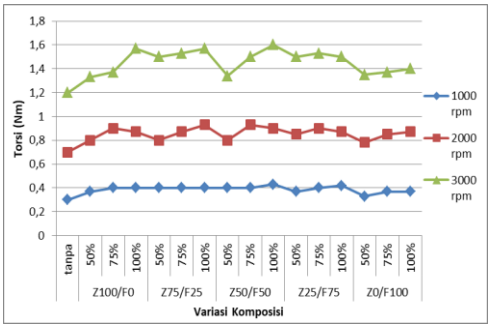

Figure 3. The effect of variations in the composition of the zeolite- *fly ash* filter on torque.

A Fly ash filter was proven to increase torque in the static test. At 1000 rpm, the torque increase occurs in the Z50%:F50% filter with a mass of 100% of 0.43 Nm (43.33%); at 2000 rpm, the torque increase occurs in the Z50%:F50% and Z75%:F25% filters. With a mass of 75% of 0.93 Nm (32.86%) and at 3000 rpm, an increase in torque occurs on the Z50%:F50% filter with a mass of 100% of 1.6 Nm (33.33%).

Using a zeolite filter based on Figure 3 with a composition of Z50%:F50% has the highest percentage in increasing engine torque, which is 28.41% and is followed by the second best composition in the Z75%:F25% filter of 28.31%. After obtaining the best zeolite-fly ash filter composition, the second test determines the best temperature for using the zeolite-fly ash filter. It can be seen in Figure 4 the effect of temperature variations on the torsion of the test results.

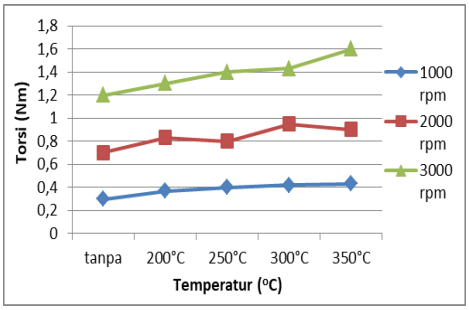

Figure 4. Effect of zeolite- *fly ash* filter activation temperature variation on torque.

The results of the stationary test on the filter with temperature variations were obtained at 1000 rpm rotation. There was an increase in torque at a temperature of 350^{0}C by 0.43 Nm (43.33%). Figure 4 shows the increase in torque which is not too different at 1000 rpm rotation between temperatures. Activation of 350^{0}C with 300^{0}C, 250^{0}C and 200^{0}C. The increase in torque at the 2000 rpm test was obtained with a temperature of 300^{0}C of 0.95 Nm (40.00%). At 3000 rpm, there was a significant increase in torque at a temperature of 350^{0}C of 1.6 Nm (33.33%).

Overall, the obtained activation temperature of 350^{0}C has the first best percentage increase in torque of 35.08% and the second best at an activation temperature of 300^{0}C of 31.63%. The test results show that a temperature of 350^{0}C is more effective in physically activating the zeolite-*fly ash filter*. Because it can reduce more water molecules and other impurities, the surface area of zeolite-*fly ash* and its adsorption power increases.

IV. CONCLUSIONS

A Fly ash filter with physical activation can increase the torque of a 4-stroke gasoline engine. The use of a filter with a composition of Z50%:F50% can increase torque up to 28.41% when compared to without using a zeolite-fly ash filter. The effect of the activation temperature of the filter shows that the greater the activation temperature will expand the surface pores so that the adsorption power increases as has been proven from the test results obtained that the highest activation temperature of 350^{0}C can increase engine torque by 35.08%

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