Journal of Sustainable Technology and Applied Science (JSTAS)
Vol. 4 No.1, May 2023, pp. 1-5
ISSN: 2722-2403 (online)

EFFECT OF (CH2)N ON CHARACTERISTICS ORGANIC THE WASTE PELLET FUEL

Widodo Pudji Muljanto[1*], Lalu Mustiadi[2], Kartiko Ardi Widodo[3]
[1,3] Department of Electrical Engineering, Faculty of Industrial Technology, National Institute of Technology, Malang
[2]Department of Mechanical Engineering, Faculty of Industrial Technology, National Institute of Technology, Malang
***Corresponding Email: widodo_pm@lecturer.itn.ac.id**

ABSTRACT: The effect of (CH2)n on the combustion characteristics of organic waste pellet fuel has been studied visually and experimentally at atmospheric pressure and temperature in the experimental room. Organic waste particles contain (C, O, Mg, Al, Si, Ca) and plastic bottle oil formed as polyethene (CH2)n. Pellet fuel is made from a mixture of polyethene and organic waste charcoal particles based on the percentage mass ratio (1, 5; 10 %). The burning characteristics of the pellets were identified from the time and temperature signals of the flame by ignition of a shot under the junction of the thermocouple. The results showed that the larger the mass of the mixture, the more substantial the effect on the pellet burning process, indicated by the faster starting time of the flame, with the increasing rate of pellet burning. The catalyst in organic waste charcoal binds hydrogen from (CH2)n, forming a weak molecular structure (CH2)n with a low density so that it quickly evaporates and burns. As the mass of the mixture increases, the moles of carbon in the pellets increase. So, the more significant the mass ratio of the mix, the more critical the energy absorption characteristic, forming a stoichiometric reaction equilibrium by producing an increased combustion energy release rate. The increasing mass of the mixture helps generate more incredible activation energy in burning organic waste charcoal pellets, confirmed by the more excellent absorption of infrared %T energy.

Keywords: Charcoal pellets, Hydrogen bonding, Combustion characteristics.

1. Introduction

Green Technology Development Strategy Based on Sustainable Environmental Management, treatment of abundant waste in the Faculty of Industrial Technology ITN Malang, East Java, by forming charcoal pellet fuel is a possible alternative. By converting plastic bottle waste into oil, which is included as polyethene (CH2)n, and converting organic waste into charcoal particles, the results of chemical structural characteristics analysis for organic waste charcoal particles, using the EDAX test, are shown in Figure 1 and Table 1.

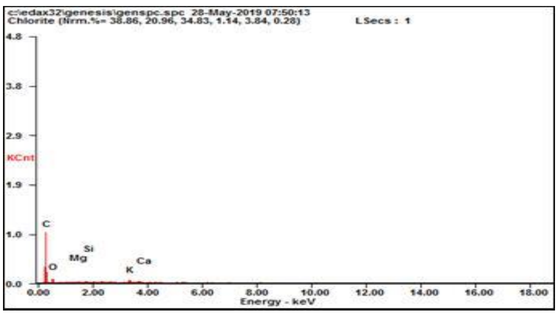

Figure 1 Graph of chemical element content of organic waste charcoal particles

Table 1 Chemical element content of organic waste charcoal.

Element	Weight (%)	Wide-scale%
Carbon	67,03	74,76
Oxygen	27,16	22,75
Magnesium	01,12	00,62
Aluminium	00,62	00,31
Silika	01,46	00,70
Kalium	02,59	00,96
Calcium	02,60	00,87

They are forming pellet fuel based on the percentage of the mass ratio of the mixture to know the combustion characteristics of pellet fuel for organic waste charcoal particles. The combustion characteristics are expressed by the initial burning time of the pellets and the scalding temperature, identified experimentally from the time and flame temperature signal.

Several studies on the manufacture of fuel pellets from various biomass materials have been conducted, including Christian et al. [1], forestry biomass, spruce (S) and pine (P), agricultural

Vol. 4 No.1, May 2023, pp. 1-5
ISSN: 2722-2403 (online)

biomass, alang-alang grass (RCG), timothy straw (H) and switchgrass (SW) biomass from wood, hay and straw [2]; fuel briquettes from urban solid waste [3].

Meanwhile, mixtures of biomass pellets have also been carried out, including B. Christian, A. Sevault, and R. A. Khalil [1]. A combination of agricultural biomass and forestry biomass, and a mix of straw and sawdust [4]. Likewise, the characteristics of biomass pellets have been observed, such as pattern burning fire [5], pellet durability consisting of storage conditions and handling frequency [6], evaluated mechanical properties (density and intrinsic yield stress) and analysis of combustion emissions (CO, NO and SO2) [7].

From some of these studies, the technology for making pellets of campus organic waste carbon particle pellets with a mixture of plastic bottle oil (CH2)n, with combustion characteristics identified from the time and flame temperature signal, has not been informed, so this research can be said to be a novelty in the industrial sector of biomass pellet fuel.

1.1 Hydrogen Bonding

The mixing process produces hydrogen bonds, the movement of hydrogen atoms into the catalyst due to the catalyst having many protons. The chemical elements (magnesium, aluminium, silica, potassium) in organic waste charcoal will be a catalyst, making it more energetic than the compound (CH2)n. At the same time, the chemical element (carbon) in the chain molecule (CH2)n will increase the concentration of carbon molecules in the organic waste charcoal pellets. Depending on Hudha [8], catalysts will quickly interact and bind hydrogen from oil.

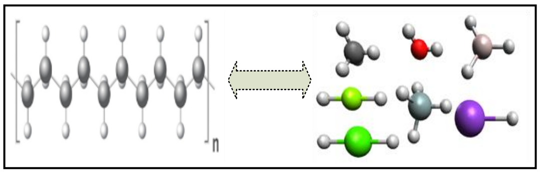

Figure 2 Plastic bottle oil hydrogen bonding by organic waste charcoal catalyst.

As an acceptor for hydrogen atoms, the catalyst is attracted and bonded to the trigger because it consists of s and p orbitals. There is an electron withdrawal from the hydrogen atom from the chain molecule (CH2)n by the more electronegative atom (catalyst); the bond is formed by having shared electrons, creating a covalent bond. So that the mass of hydrogen molecules in the oil (CH2)n is reduced, including a low density of oil and a weak surface tension. When the catalyst attracts hydrogen atoms, electrons become reactive by having enough energy to move to the catalyst's surface, so the molecular mass (CH2)n decreases, and the chain molecular bonds (CH2)n become weak, Figure 3.

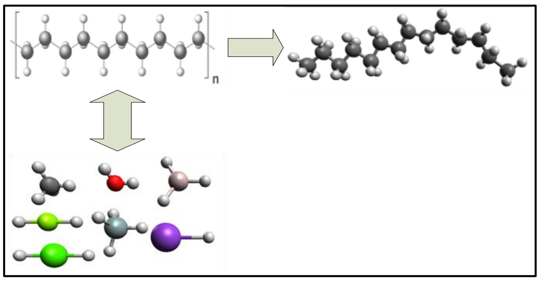

Figure 3 The chain molecular bonds (CH2)n become weak.

The mixture of (CH2)n with organic waste charcoal particles causes (CH2)n to ignite to burn pellets, so the initial flame time of pellet burning becomes faster. On the other hand, electron transfer makes the ignition temperature easier to reach, and combustion (CH2)n occurs quickly, as indicated by the shorter pellet start time. With heating, the oil temperature increases rapidly, causing rapid combustion with a quick initial ignition time, so plastic bottle waste oil (CH2) with a low density quickly evaporates and burns.

2. Materials And Methods

The catalyst in organic waste charcoal binds hydrogen from (CH2)n, forming a weak molecular structure (CH2)n with low density. The larger the mass ratio of the mixture, the greater the thermal energy absorption characteristics of the oil molecules (CH2)n. This can form a weaker molecular bond of oil (CH2)n and is more reactive to absorb heat energy so that it quickly evaporates and burns.

Meanwhile, chemical elements (carbon) will increase the concentration of carbon molecules in the organic waste charcoal pellets. As the mass of the mixture rises, the moles of carbon in the charcoal pellet fuel increase. The mass amount of the oil mixture (CH2)n added to the organic waste carbon increases the moles of carbon in the pellet. The results of the mixing show the characteristics of faster absorption of heat energy during combustion, resulting in the release of more incredible combustion energy. The result of mixing, with the use of oil (CH2) and added to the organic waste charcoal particles, allows the improvement of the performance of the pellet fuel.

To understand this very well, the FTIR test was carried out.

The research was carried out visually and experimentally by determining the mass ratio of the oil (CH2) in a mixture with organic waste charcoal particles (1; 5; 10) %. The mass of organic waste charcoal particles was measured using a mass balance, while the volume of oil (CH2)n was measured using a measuring cup. Mixing uses an electric motor-powered mixer with an AC 220-V power supply and 50 rpm rotation at 2 A electric current, with mixing for 10 minutes. Pelleting was performed using a vertical pellet press machine with a course of 500 rpm. The aim is to know the combustion characteristics of organic waste charcoal pellet fuel, expressed by the initial time of the pellet burning flame and the pellet burning temperature, identified from the time and signal of the flame temperature.

The pellet-burning apparatus is shown in Figure 4. One pellet of organic waste charcoal is placed in a spiral heating coil (Ni-Cr material, wire diameter 0.4 mm, spiral diameter 5 mm, spiral length 30 mm) ignited using electricity. The heater is a 220V, 2 Amp AC electric heater. The pellet combustion process was carried out at atmospheric pressure and room temperature. A high-speed Casio camera captured the pellet flame from start to finish at a recording speed of 120 fps. Pellet temperature during combustion was recorded using a thermocouple sensor made of platinum-rhodium Pt/Rh-13% (wire diameter 0.1 mm) and connected to a data logger with a sampling frequency of 1 kHz. The time and temperature data of the burning process were recorded five times, and then the average data was validated. The average data was collected, and a graph of the results was made using Microsoft Excel software.

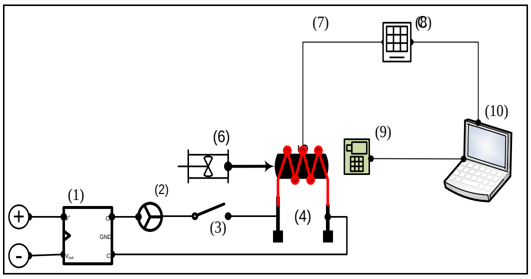

Figure 4 Experiment circuit diagram.

Legend:
(1) Power Supply, (2) Current Regulator, (3) Switch, (4) Heating coil, (5) Pellet, (6) Fan, (7) Thermocouple, (8) Data logger, (9) High-speed camera, (10) Laptop/computers.

3. Results and Discussion

3.1 Analysis of the interaction between the (CH2)n chain and the catalyst.

Mixing compounds (CH2)n and organic waste charcoal particles, with a mixed mass ratio of (1; 5; 10) %, forms hydrogen bonds, as shown in Figure 3. There is a withdrawal of bonded electrons (hydrogen atoms) by more electronegative atoms (catalyst), forming covalent bonds. With the movement of hydrogen atoms into the trigger, it has more protons, making it more energetic than the compound (CH2)n. When the catalyst attracts hydrogen atoms, electrons become reactive and have enough energy to move to the catalyst surface, so the molecular mass (CH2)n decreases, with the chain molecular bonds (CH2)n becoming weaker, as shown in Figure 5.

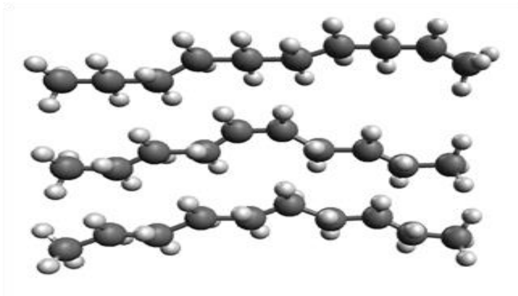

Figure 5 The chain molecular bonds (CH2)n become weak.

Multiple catalysts (C, O, Mg, Al, Si, K, Ca) as acceptors for 18 hydrogen atoms from the (CH2)n chain are attracted and bonded to the catalyst. Respectively, the molecular hydrogen atoms of the chain (CH2)n will be pulled out first because they consist of s and p orbitals, and the hydrogen atoms in the p orbitals tend to be pulled out first because they are farther from the nucleus of the positive atom. After that, the outermost hydrogen atom is farthest from the bond of the carboxyl compound, and the last is the hydrogen in the carboxyl group. It makes the molecular mass of the chain (CH2)n smaller; the bond is unstable and polar, making the catalyst soluble in oil. The increasing mixing of (CH2)n in the organic waste charcoal particles makes the bond (CH2)n unstable. The distance of each carbon chain is further apart, reducing the dipole-dipole interaction, and the strength of the intermolecular forces becomes weaker, as described in Figure 5.

The increasing mass of oil (CH2)n in the organic waste charcoal particles forms a larger mixture mass. Pellet fuel specifications, experimentally for pellet fuel dimensions, consist of a diameter of 5 mm, length of 13,742 mm, and mass (0.192; 0.206; 0.214) grams, then the density of organic waste charcoal pellet fuel increases, as shown in Figure 6.

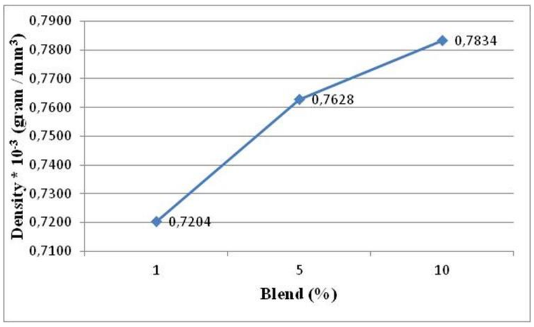

Figure 6 Density of organic waste charcoal fuel pellets.

3.2 Analysis of the interaction between the chain (CH2)n and organic waste charcoal.

Mixing results in the movement of hydrogen atoms because the catalyst has many protons, making it more positive than the compound (CH2)n. When the catalyst attracts hydrogen atoms, electrons become active and have enough energy to move to the catalyst's surface, thus forming a reduced molecular mass of carbon (CH2)n chain.

The increase in the release of combustion energy is produced when the mass ratio of the mixture increases, as indicated by the rise in the maximum flame temperature (Figure 7). As the mass of the mixture rises, the moles of carbon in the pellets also increase. So, the more significant the mass ratio of the mix, the more comprehensive the energy absorption characteristic, forming a stoichiometric reaction equilibrium by producing an increased combustion energy release rate.

Based on the results of the FTIR spectrum analysis (Figure 8), for the sample ratio of the mass ratio of oil (CH2)n to organic waste charcoal particles that increased (1; 5; 10) %, it was seen that there were several specific peaks seen at each length certain waves, there are C-O groups found at wavelengths of 1050 – 1300 cm-1, C=C groups of alkenes are found at wavelengths of 1610-1680 cm-1, C-H groups of Alkanes are found at wavelengths of 2850 - 2970 cm-1, and C groups =O of CO2 is located at a wavelength of 2368.59 cm-1. From these groups, it can be seen that there is an increased content of element C, which forms an increase in the combustion temperature of the pellet fuel.

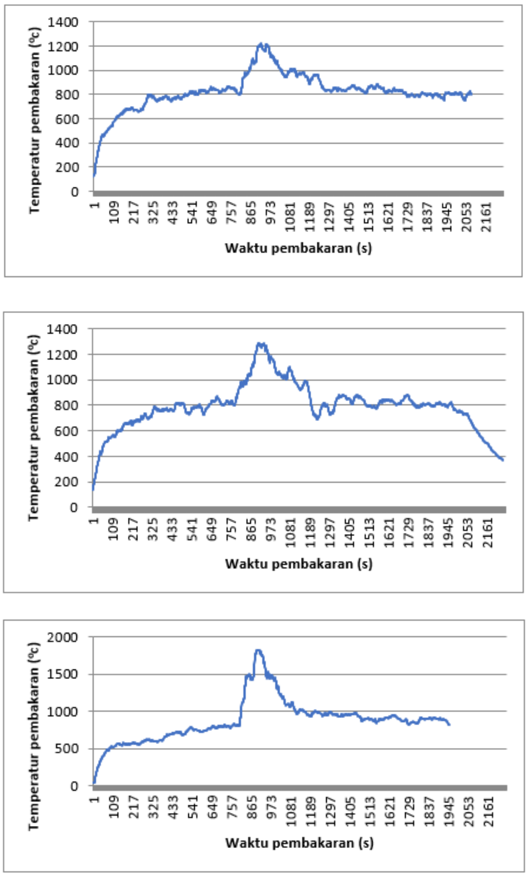

Figure 7 Graph of combustion temperature of organic waste charcoal particle pellets, mixture (1; 5; 10%).

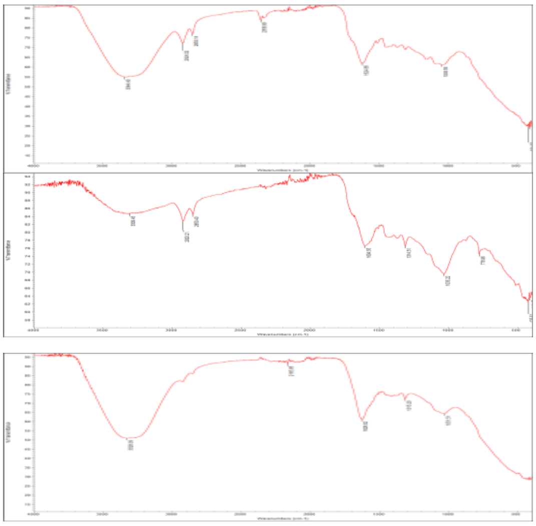

Figure 8 Graph of energy absorption %T FT-IR. Mix 1; 5; 10%

Waste charcoal particles cause (CH2)n to ignite to burn pellets so that the initial ignition time of pellet fuel becomes faster, as shown in Figure 9.

The chemical element (carbon) in (CH2)n will increase the concentration of carbon molecules in the organic waste charcoal pellets. The mixing results show the characteristics of faster absorption of heat energy during combustion, resulting in the release of combustion energy at a higher temperature, as shown in Figure 9.

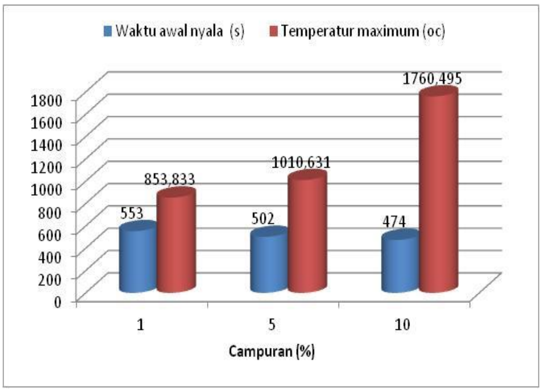

Figure 9 Graph of initial flame time and combustion temperature of organic waste charcoal particle pellets.

4. Conclusions

With the increase in the mass of the oil mixture (CH2)n in the organic waste charcoal particles, the catalyst will interact and bind hydrogen from the oil quickly so that the hydrogen molecular mass in the oil decreases, forming a weaker oil molecular bond structure (CH2)n with a higher density. It is lower, and the molecules are reactive more quickly when they absorb heat energy. So with heating, the temperature of the oil (CH2)n increases rapidly, then evaporates and burns faster, making the initial flame time of burning organic waste charcoal pellet fuel faster.

With the increase in the mass of the mixture (CH2)n, the concentration of carbon molecules in the organic waste charcoal pellets increases so that the absorption of heat energy is faster during combustion, releasing tremendous combustion energy. So, in burning organic waste charcoal particle pellet fuel, the combustion temperature of organic waste charcoal particle pellet fuel increases. This can be confirmed by the infrared %T of the increased heat absorbed.

References

[1] B. Christian, A. Sevault, and R. A. Khalil (2017), Science Direct Performance Evaluation of a Modern Wood Stove Using Charcoal Assessing the feasibility of Seljeskog using the heat Kempegowda heat demand forecast, *Energy Procedia*, vol. 142, pp. 192–197.

[2] C. Whittaker and I. Shield (2017), Factors affecting wood, energy grass and straw pellet durability – A review, *Renew. Sustain. Energy Rev.*, vol. 71, no. January 2016, pp. 1–11.

[3] Tri Poespowati, Lalu Mustiadi (2012), Municipal Solid Waste Densification as an Alternative Energi, Journal of Energy Technologies and Policy, Vol. 2, No. 4.

[4] M. Zhu, Y. Ma, and D. Zhang, “Effect of a homogeneous combustion catalyst on combustion characteristics of single droplets of diesel and biodiesel,” vol. 34, pp. 1537–1544, 2013, doi: 10.1016/j.proci.2012.06.055.

[5] Y. Wei, W. Deng, and R. Chen, “International Journal of Heat and Mass Transfer Effects of insoluble nano-particles on nanofluid droplet evaporation,” *Int. J. Heat Mass Transf.*, vol. 97, pp. 725–734, 2016, doi: 10.1016/j.ijheatmasstransfer.2016.02.052.

[6] M. Zhu, Y. Ma, and D. Zhang, “Effect of a homogeneous combustion catalyst on combustion characteristics of single droplets of diesel and biodiesel,” vol. 34, pp. 1537–1544, 2013, doi: 10.1016/j.proci.2012.06.055.

[7] Y. Wei, W. Deng, and R. Chen, “International Journal of Heat and Mass Transfer Effects of insoluble nano-particles on nanofluid droplet evaporation,” *Int. J. Heat Mass Transf.*, vol. 97, pp. 725–734, 2016, doi: 10.1016/j.ijheatmasstransfer.2016.02.052.

[8] Hudha, I. Mohammad, D., Rini Kartika, S., Galih Purwa, Yohanes, Riardus. Utilisation of Vegetable Waste as an Environmentally Friendly Natural Decomposer. Journal of Sustainable Technology and Applied Science, 3 (1), pp 1-5, 2022, https://doi.org/10.36040/jstas.v3i1.3695.