Ovo Sandrine Flora AUGOU, et. al. International Journal of Engineering Research and Applications
www.ijera.com
ISSN: 2248-9622, Vol. 13, Issue 1, January 2023, pp. 127-130

RESEARCH ARTICLE OPEN ACCESS

Characterization of biochar based on sawdust and starch paste: Influence of clay on the combustion time of biocharcoals

Ovo Sandrine Flora AUGOU [(1)] *, Souleymane OUATTARA [(2)], et Jean-Eudes BOULINGUI [(3)]

(1) Université Alassane Ouattara, Département Sciences et Techniques, sandrineaugou@gmail.com
(2)*Université Félix Houphouët Boigny, UFR Sciences de la T erre, Laboratoire de Géomatériaux, Abidjan, 22 BP 582 Abidjan 22, Côte d'Ivoire*
(3) Ecole Normale Supérieure, B.P .17009 Libreville Gabon Département des sciences de la vie et de la terre

ABSTRACT
This work is part of the valuation of local resources for the manufacture of biocharcoals with a longer combustion time than that of charcoal.To do this, clay is used as a filler in the making of biocharcoals, the basic raw materials of which are charred sawdust and starch paste. These biocharcoals have two formulations. They are produced according to the EA / Sb ratios equal to 0.87 and 1, then their combustion time is respectively equal to 330 and 335 min. The clay content varies from 5 to 20%.The results obtained from the combustion test show that the 0.87 and 1 ratio biocharcoals containing 5% clay content show the best results. They have a longer combustion time (411 and 410 min) than that of biocharcoals without clay and that of charcoal whose values are 330, 335 and 406 min.

Date of Submission: 03-01-2023 Date of Acceptance: 16-01-2023

I. INTRODUCTION

A filler is defined as any inert, mineral or vegetable substance which, added to a base matrix, makes it possible to significantly modify the mechanical, electrical or thermal properties, to improve the surface appearance or, simply, to reduce the cost price of the transformed material [1].There are several types of mineral fillers including clay. It is used to develop biocharcoals based on sawdust and starch paste in order to improve their thermal properties.Indeed, the use of charcoal has developed very quickly and deforestation is largely linked to the development of this fuel.To make one kilogram of charcoal, you have to pyrolyze about ten kilograms of wood [2].
The objective of this work is to make biocharcoals with a longer combustion time than that of charcoal using clay as a filler.

II. MATERIAL AND METHODS

2-1- Clay

In general, the geologist considers "clay" as any mineral of low grain size, whose dominant fine fraction is generally less than 2 µm, coming from rocks and soils.On the other hand, groups clay minerals without any connotation of size [3].The clay used comes from the Nieky-agnéby deposit located in the suburbs of Dabou more precisely at 5°19'70" N and 4°22'80" W.

This clay has been the subject of several studies carried out by Emeruwa, Conand, Kouadio, Ouattara and the results obtained show that it is a plastic clay soil rich in silica SiO_2 (56.20%), in alumina Al_2O_3 (27.15%) and iron oxide Fe_2O_3 (6.6%).Due to the high level of silica in Dabou clay, it can withstand large and sudden changes in temperature. Minerals abundant in clay are kaolinite, illite and quartz [4].

2-2- Sawdust

The sawdustusedcomesfrom the wood of the iroko (*Chlorophoraexcelsa)* of brownyellowcolor, density 0,64 and hardness[5].It is first charred before being used. The technique used for carbonization is pyrolysis.

2-3- Starch paste

The binder used to agglomerate the sawdust particles is cassava starch. In the native state, the starch is whitish in color with a density equal to 1,47[6]**.** It isused in the modifiedform for the production of biocharcoals. To passfrom the native state to the modified state, the

cassavastarchisprepared in a quantityof water and, at the end of the cooking, a starchpasteisobtainedwhichforms at 60° C[7].

2-4- The characteristics of biocharcoals

The biocharcoals used are made from carbonized sawdust and starch starch with an EA/Sb ratio equal to 0.87 and 1. A previous study on the determination of the combustion time of biocharcoals showed that they take 330 and 335 min respectively before being completely consumed [8].

2-5-Study method

2-5-1-Elaboration of biocharcoals composed of carbonized sawdust (Sb), starch paste (EA) and clay (Ar)

To develop biocharcoals composed of carbonized sawdust (Sb), starch paste (EA) and clay (Ar), the EA/Sb ratio is kept constant and the clay content is varied from 5 to 20% in intervals of 5.

First, a mass of clay is added to a mass of carbonized sawdust and the mixture is made dry. Then, a quantity of the fluid EA is poured into the dry mixture, then the whole thing is kneaded until a homogeneous paste is obtained. 50 g of this paste is removed, then molded using the pressing technique and the material obtained is dried at 60°C in an oven.

The sample shown in Figure 1 is a perfect illustration of this.

Figure 1: Biocharcoal containing clay

2-5-2-Determination of the burning time (CD) of biocharcoals composed of carbonized sawdust, starch paste and clay

The burning time (CD) test consists of determining the total burning time of 600 g of fuel introduced into a clay hearth. It begins with lighting until the ashes are obtained. The burning time is written according to the formula below:

$\Delta t = t_f - t_i$

Δ t : time it takes for fuel to burn; tf : end of fuel combustion time;

ti : sample combustion onset time

Device

The device used to perform the burning time test is a clay hearth. This fireplace reduces heat loss. It is described as following:

- rectangular in shape;
- closed at its base and open at the top, 9.5 cm x 9 cm in size, with a furrow (3 cm) to allow air circulation;
- lengthwise opening serving as an air inlet measuring 7.5 cm x 5 cm
- the thickness of the clay blocks is 3 cm.

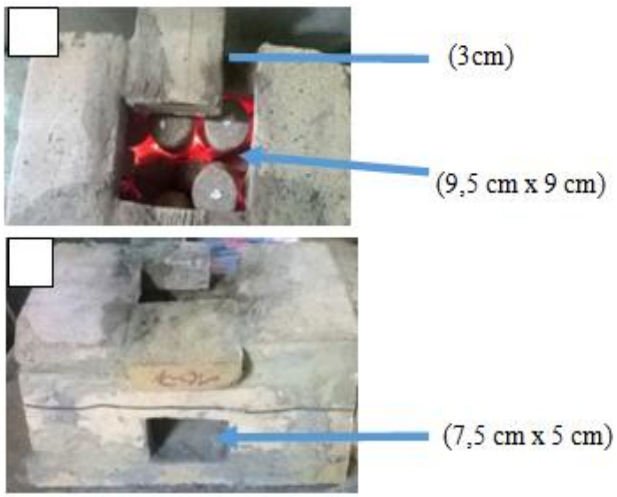

Figure 2: clay fireplace, a) top view of fireplace, b) side view of fireplace

III. Results and discussion

The combustion time of the biocharcoals will depend on the quantity of clay contained in the composition. Figure 3 presents the different results.

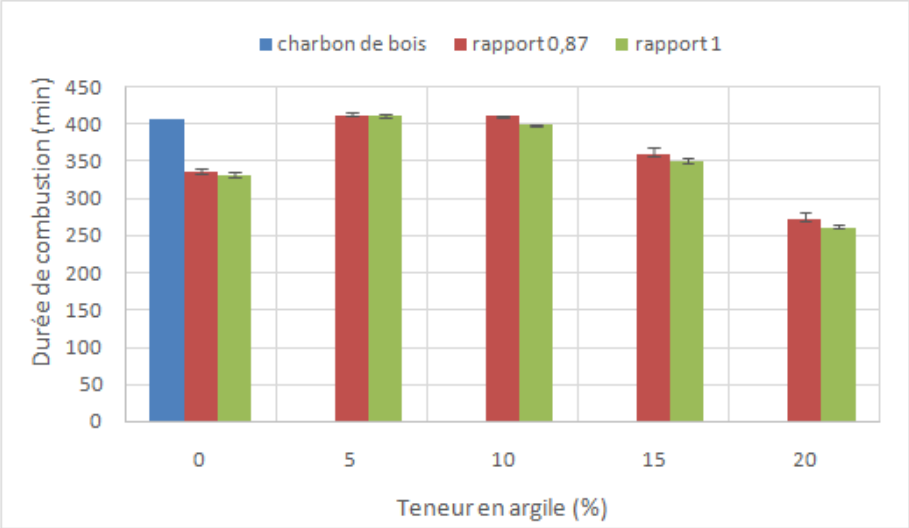

Figure 3 : Burning time of engineered biocharcoals containing clay

3-1- Analyse

The histogram above shows the variation in burning time (CD) of charcoal and that of engineered biocharcoals as a function of clay content.

The mass of 600 g of charcoal lasts 406 min before burning. From 0 to 5% clay content, there is an increase in CD and from 5 to 20%, a decrease in it. The values are as follows:

- when the biocharcoals do not contain clay, the DC is 330 and 335 min respectively for the ratios 0.87 and 1;
- when the biocharcoals contain 5, 10 and 15% clay content, the DC is respectively equal to 411, 409 and 357 min then 410, 397 and 348 min for the EA/Sb ratios equal to 0.87 and 1;
- when the clay content is 20%, the DC is 260 and 270 min for the ratios 0.87 and 1.

The results show that by adding 5 to 15% clay content, the CD becomes long compared to that of biocharcoals without clay and it decreases when the clay content is 20%.The more clay increases in the composition of biocharcoals, the burning time becomes shorter. The ideal clay content for which the burning time becomes longer than that of charcoal is 5%.

3-2- Interpretation

By adding 5-15% clay content, the burning time of biocharcoals becomes long compared to biocharcoals not containing clay due to the nature of clay and the variation in content of raw materials.

Indeed, clay being a mineral material, therefore not combustible, will tend to slow down the combustion of biocharcoals [9] [10]. It stores the heat produced by the sawdust and starch starch during combustion and releases it afterwards.

Also the addition of clay reduces the proportion of sawdust and starch. The EA/Sb ratios (0.87 and 1) being kept constant, the more the clay content increases, the content of the starch-sawdust mixture decreases.

For example, for the EA/Sb ratio equal to 0.87; when 5% clay is added, its content is 95% including 50.7% Sb and 44.3% EA. When 10% clay is added, its content is 90% including 48% Sb and 42% EA.

Thus, when the sawdust which is the basic fuel is consumed, the fuel is extinguished and the DC is reduced.

At 5 and 10% clay content, the substitution of Sb and EA by clay is not accentuated, which therefore makes it possible to prolong the CD of biocharcoals, in particular those of 5%.

On the other hand, at 15 and 20% clay content, the substitution being very high, the combustion of Sb and EA is rapid and therefore the combustion of biochar is faster. This attitude of clay to slow the combustion of biocharcoals is effective, when it is not in large quantity in the composition, namely 5%.

3-3- Discussion

Biocharcoals with 5% clay content have a longer burn time (410 and 411 min) than those with more clay content (10, 15 and 20%) because the fuel extinguishes. Abbo in his 2014 work [11] showed that briquettes containing 45% clay, 8% starch and

47% sawdust burn longer than other briquettes containing less than 45% clay.

If we refer to the proportions of Abbo, at 45% clay, the sawdust will have a content equal to 29.3% and the starch 25.66% for the ratio 0.87 then 27 .5% sawdust and 27.5% EA for ratio 1.

At these proportions, the basic organic matter, namely sawdust, is extremely reduced in composition, while for 20% the combustion time of biocharcoals is short because they go out. As a result, it appears that clay does not always promote the extension of the CO of fuels, but perhaps a brake when its content is abundant in the composition.Also, most biochar studies use clay as a binder because in their experience, it is an essential component that increases the burning time [12].

In Dusabe 2014 [13]; the consumption time of the briquettes is longer (200 min) than that of charcoal (130 min) due to the clay which increases the solidity of the briquette and therefore increases its combustion time.

It should be noted that in this study, they used 0.8 Kg of briquettes for 0.4 Kg of charcoal. The working conditions are not identical to ours. In our case, the clay does not act as a binder but rather as a filler although it has the nature of a binder.

Thus, its presence will increase the level of binder in the composition of the biocharcoals produced. There will thus be more non-combustible materials (clay + EA) than combustible materials (sawdust charcoal).

Therefore during the combustion, when all the combustible material will be consumed, the fuel will be extinguished and its combustion time will be reduced.

IV. Conclusion

At the end of this work, it appears that clay influences the combustion time of biocharcoals. The reactions are as follows:

- when the clay content varies from 5 to 15%, the combustion time of biocharcoals is longer than that of biocharcoals that do not contain clay;
- from 5 to 20% clay content, biocharcoals containing clay have a decreasing combustion time because the abundance of clay extinguishes the fuel;
- The ideal clay content for which the combustion time of biocharcoals becomes longer than that of charcoal is 5%.

Thus, biocharcoals with a ratio of 0.87 and 1 containing 5% clay content are the best fuels.

REFERENCES

[1]. Naudin C. A., Clozza C. (1987): Charges. Techniques de l'ingénieur. 11p.

[2]. Rossier G. et Micuta W. (1991). Le charbon de bois est- il un combustible satisfaisant. Rapport pour l'Institut de Développement de l'Energie Renouvelable (REDI).7p.

[3]. Alves de Azeredo G. (2005). Mise au point de procédures d'essais mécaniques sur mortiers de terre : application à l'étude de leur rhéologie. Thèse de doctorat à l'institut national des sciences appliquées de Lyon France. 359p.

[4]. Emeruwa E, Kouadio K. C, Kouakou C. H, Boffoue O. M, Assande A. A., Ouattara S, Coulibaly Y, Dauscher A. et Lenoir B. (2008). Caractérisation des argiles de la région d'Abidjan : Étude Comparée de quelques gites et leur perspective de valorisation. Review. Ivoi. Sci. Technol. ISSN 1813-3290 ; n°11 ; pp 177 – 192.

[5]. Cirad. (2012).Fiche de l'essence Iriko. TROPIX 7.4p.

[6]. Thieblesson L. M.(2018).Developpement et caractérisation d'éco-matériaux issus de déchets de papaier et de ressources bio-sourcées. Thèse soutenue à l'université Félix HouphouetBoigny. 171p.

[7]. Elie F. (2008).L'amidon. http://fred.elie.free.fr-p4 consulté en 2019

[8]. Augou S. (2021) : Recherche de substituts au charbon de bois : conception et caractérisation de combustibles à base de sciure de bois. Thèse de doctorat à l'université Félix Houphouët Boigny d'Abidjan (Côte d'Ivoire). 156p.

[9]. Hernot F. (2016) : L'argile, son utilisation à l'officine, Thèse pour le diplôme de d'Etat de docteur en pharmacie à l'université de Angers (France). 127p.

[10]. Villieras F. (2008) : Argiles : histoire d'avenir, éditions recréateurs, 144p

[11]. Abbo K. (2014). Fabrication de briquettes de poussière de charbon et étude des performances énergétiques des briquettes en fonction du pourcentage d'argile. Mémoire pour l'obtention du diplôme d'ingénieur. Ecole Polytechnique d'Abomey-Calavi ; Bénin. 70p.

[12]. Laval M. (2014). Le charbon vert, espoirs et réalités d'une alternative énergétique séduisante. Etude commandée par la guilde européenne du Raid. 69p..

[13]. Dusabe M. S. (2014). Etude de faisabilite technique et financière de la valorisation des déchets ménagers organiques, papiers et cartons pour la fabrication des briquettes combustibles à Bujumbura, Burundi. Master en ingénierie de l'eau et de l'environnement. 40p.