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INVESTIGATION ON BIOMASS BRIQUETTE FROM CERBERA MANGHAS WASTE TWIGS AS RENEWABLE ENERGY SOURCE

Willyanto Anggono1, Fandi D. Suprianto2, Sutrisno3, Gabriel J. Gotama4, Jovian Evander5, Andreas W. Kasrun6 1,2,3,4,5,6

**Centre for Sustainable Energy Studies, Petra Christian University, , Surabaya** 60236, **Indonesia** **1**

1,2

**,3,4,5,** 6 **Mechanical Engineering Department, Petra Christian University, Surabaya** 60236, **Indonesia** E-Mail: **willy@petra.ac.id** **2**

ABSTRACT As a tropical country, Indonesia has numerous assortments of plants. However, it has not been fully utilized as assets. One of the many plants that are frequently seen in the group is Cerbera manghas. Cerbera manghas is commonly known to have strong roots in this way it is generally utilized for greening in Surabaya. Although useful to be a shading tree and to decrease air contamination in urban regions, squander from the twigs of this plant turns into a significant issue for the tidyness of the city. The waste from the falling twigs can possibly be utilized as a strong candidate as briquettes when handled fittingly. This

study intends to research the capability of waste Cerbera manghas twigs to be utilized as biomass briquettes and also to assess the properties of the briquettes. The proximate and ultimate analysis examination were conducted to obtain the characteristics of the briquettes. Furthermore, the impact of tapioca related to biomass calorific value briquettes was also obtained. Calorific values of five blends with different tapioca mixtures of 10 to 50% with 10% increment were assessed utilizing an oxygen bomb calorimeter. The outcomes demonstrated that the biomass briquettes costructed of waste Cerbera manghas twigs can be made by utilizing tapioca as the binder. The more prominent the mass rate of tapioca consisting in the briquettes, the lower is the calorific value produced. Biomass briquettes made of waste Cerbera manghas twigs can be made into a wellspring of manageable energy with the ideal mixtures of 90% Cerbera manghas waste twigs and 10% tapioca. Keywords: Cerbera manghas, biomass, twig, briquette, sustainable energy. 1. INTRODUCTION The shifting of energy source from non- renewable to renewable becomes eminent nowadays. While non-renewable fuels do still exist in some great number, it will only take some years before it becomes scarce and even longer to recuperate from the energy crisis derived from its exploitation. The emergency happens due to the development in fuel utilization rate and populace components. Other than sparing this non-sustainable power sources, the look for new option energy is expected to satisfy the human needs, for example, power, fuel and so forth. Biomass is the most well-known type of sustainable power source, generally utilized as a part of the third world. The cases of biomass fuel are, for example, biodiesel, biogas, horticultural waste and so on. The wellspring of biomass can be created from farming products and buildups, ranger service harvests and deposits, ocean weeds and green growth, creature deposits, modern buildups, metropolitan strong waste and sewage [1]. Biomass is a viable option for solving energy crisis, and its advancement for substitute of petroleum derivative, for example, biomass likewise ends up plainly famous these days. An analysis about bioenergy demonstrates that bioenergy has a potential as a source of energy option and the use of biomass additionally increments now and again [2-6]. Indonesia is one of the nation in the planet that has numerous assets of energy, for example, oil, and coal. Indonesia winds up noticeably beat exporter of coal in 2014. Moreover, Indonesia is an agrarian nation which was appeared by around 130 hectares are utilized to farming part [7]. This state gives a chance to create biomass elective energy utilizing rural waste. Because Indonesian government aims to become an environmentally friendly country, each city in Indonesia ought to grow more trees to limit a worldwide temperature alteration and counter the emanation of vehicle. Fig. 1. City Park with Cerbera manghas, Surabaya, Indonesia Trees are the primary component in the city stop and they are valuable in enhancing the quality of air in thickly populated urban areas, for example, city park with Cerbera manghas, Surabaya, Indonesia as appeared in Fig. 1. Then again, planting countless plants causes a great deal of waste twigs. Government and numerous groups in Surabaya are confronting difficult issue with the strong waste twigs (Cerbera manghas) transfer issue and extensive endeavors are being planned to decrease the amounts of civil strong waste. These waste twigs of Cerbera manghas can be utilized as an option energy through the correct procedure. Beforehand, there was a trial with respect to biodiesel creation from Cerbera manghas and it demonstrates the potential in Cerbera manghas as a viable energy source [8]. Biomass strong fuel can be delivered from waste item [9-12,13], for example, almond twigs, sawdust and rice husk, sugar, coco peat, stick twigs and rice straw. Strong geometries of fuel briquette have an alternate property, for example, briquette quality. Strong waste that originates from the twigs can be utilized as an option energy source through a correct procedure. Strong fuel briquette is an option energy which is grouped as biomass energy and created from waste item. For example, natural waste. Cerbera manghas twigs contain some synthetic sythesis that might be hurtful to living animal, for example, human and creature which guarantee us that Cerbera manghas is a non- palatable plant [14]. Different components discovered in Cerbera manghas twigs are, for example, p-hydroxybenzaldehyde, benzamide, n- hexadecane corrosive monoglyceride, loliolide, β- sitosterol, neriifolin, cerberin, daucosterol, and cerleaside A. In view of the different substances in the 1

twigs where the characteristic of the blend are hard to be known, thus it is critical to explore the major characteristic of biomass briquettes made of waste Cerbera manghas twigs, for example, proximate, extreme, calorific value and the impact of tapioca as a cover material. 2. EXPERIMENTAL METHOD The materials utilized in the study are the falling twigs of Cerbera manghas, because falling twigs indicate that they are old and begin to dry. Once collected, the twigs should be dried using heat from sunlight for three days. Briquettes were made by crumpling dried waste twigs of Cerbera manghas as shown in Fig. 2, mixing the crumples with binder material which is tapioca flour and combining the mixture into solid by pressurization. Fig. 2. Crushed Cerberra manghas twigs The measurement of biomass calorific value briquette from waste twigs Cerbera manghas is done by utilizing 1341 Plain Jacket type of oxygen bomb calorimeter Parr Instrument at numerous composition of Cerbera manghas waste. Initially, 100% Cerbera manghas twigs and 100% tapioca as binder measurement has been conducted. All experiments conducted in this study were conducted with mixtures of numerous tapioca as the binder material from 10% to 50%, which is also 90% to 50% Cerbera manghas composition, respectively.

3. RESULTS AND DISCUSSION Based on the result of the investigation 4

by utilizing oxygen bomb calorimeter, the calorific value of purely Cerbera manghas twigs (100% dry basis Cerbera manghas twigs) was 4790 Kcal/Kg and the calorific value of purely tapioca binder (100% tapioca) material was found to be 3574.47 Kcal/Kg. The biomass briquette calorific value from waste twigs Cerbera manghas at numerous composition mixtures are presented in Table 1. The summary of calorific value for Cerbera manghas- tapioca in numerous composition are shown Fig. 3. Table 1. Calorific value of dry basis biomass briquette from twigs waste of Cerbera manghas at numerous composition Composition of Biomass Briquette Calorific Value (Kcal/Kg) 90% Cerbera manghas waste twigs and 10% tapioca mixtures 4628 80% Cerbera manghas waste twigs and 20% tapioca mixtures 4393 70% Cerbera manghas waste twigs and 30% tapioca mixtures 4167 60% Cerbera manghas waste twigs and 40% tapioca mixtures 3989 50% Cerbera manghas waste twigs and 50% tapioca mixtures 3871 Calorific Value (kcal/kg) 5000 4750 4790.00 4500 4628.00 4393.00 4250 4167.00 4000 3989.00 3871.00 3750 3500 0% 10% 20% 30% 40% 50% Binder Material Composition Fig. 3. Binder material effect in relation with calorific value of biomass briquette from waste twigs Cerbera manghas at numerous composition The more noteworthy measure of tapioca is found in regard that the reduced biomass calorific value briquette derived from Cerbera manghas twigs. The most elevated biomass calorific value briquette Cerbera manghas twigs was the biomass briquette utilizing 90% Cerbera manghas twigs-10% tapioca blends as appeared in Fig. 4. The 90% Cerbera manghas-10% tapioca blends effectively makes a briquette demonstrate as appeared in Fig. 5. The creation of Cerbera manghas and tapioca as cover material can be utilized to shape a briquette display. The Cerbera manghas briquette molecule size is 60 Mesh. In the wake of squeezing procedure, the briquette must pass through drying process. This analysis utilizing normal temperature of room to dry the briquette. Fig. 4. Cerbera manghas twigs briquette mold Fig. 5. Cerbera manghas twigs briquette Tapioca as the binder material decreases the biomass calorific value briquette from waste twigs Cerbera manghas. The more significant is the measure of tapioca, the less is the calorific value of the Cerbera manghas twigs biomass briquette. In term of production cost, the successful structure additionally 90%:10% in light of the fact that Cerbera manghas twig is available without cost and the tapioca as a fastener material needs to be purchased (the tapioca cost in Indonesia around 0.5 USD/kg in September 2017). The greater the percentage of tapioca in the biomass briquette derived from waste twigs Cerbera manghas the greater is the production cost of the briquettes. Table 2. Proximate analysis dry basis result of Cerbera manghas twigs briquettes Parameters Unit Value Test Method Volatile Matter %wt 76.9

**ASTM D** 3175 **-11 Ash Content %wt** 4.9 **ASTM D 3174-12** Fixed Carbon **%wt** 18.2 **ASTM D** 1

3172-13 Gross Calorific Value Kcal/Kg 4628 ASTM D 5865-13 The proximate investigation have been inspected through a research center test. The test utilizes some ASTM institutionalization. The volatile matter was analyzed utilizing ASTM D3175-11. The ash content was analyzed utilizing ASTM D3174-12. Fixed carbon count was analyzed utilizing ASTM D 3172-13. The gross calorific value was analyzed utilizing ASTM D 3172-13. The proximate analysis dry basis result of Cerbera manghas twigs briquettes is shown in Table 2. Table 3. The Cerbera manghas twigs briquettes ultimate analysis result. Parameters

**Unit Value Test Method Carbon %wt** 20.81 **ASTM D 5373-14 Hydrogen %wt** 2.67 **ASTM D 5373-14 Nitrogen %wt 0.** 25 **ASTM D 5373-14 Sulfur %wt 0.** 04 **ASTM D** 5373- **14e1 Oxygen %wt** 14.75 **ASTM D** 5373 **-15** 1

The ultimate analysis used to examine the Carbon, Hydrogen, Oxygen, Nitrogen and Sulfur concentration in Cerbera manghas twigs briquettes. The examination of the ultimate analysis using ASTM D 5373-14, ASTM D 5373-14e1 and ASTM D 5373-15. The ultimate analysis result of Cerbera manghas twigs briquettes is shown in Table 3. Briquette derived from Cerbera manghas twigs has the greatest calorific value in comparison with briquette made of sawdust, sugarcane, rice straw and coconut coir. The calorific values of sawdust, rice straw, sugarcane, coconut coir briquette are 4161 kcal/kg, 3903 kcal/kg, 3927 kcal/kg and 4146 kcal/kg, respectively [12,15]. 4. CONCLUSIONS Biomass briquette derived from waste twigs Cerbera manghas is a continuous energy source and tapioca flour as the binder material on the Cerbera manghas waste twigs biomass briquette. The more prominent the measure of tapioca as the binder material, the less is the briquette calorific value and the greater the production cost of biomass briquette derived from waste twigs Cerbera manghas. The biomass briquettes produced from waste twigs Cerbera manghas utilizing 90% waste twigs Cerbera manghas and utilizing 10% tapioca binder was found to be the ideal proportion.
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REFERENCES [1] Baskar, C., Baskar, S., and Dhillon, R.S. 2012. BiomassConversion – The Interface of Biotechnology, Chemistry and Materials Science, Springer-Verlag, Berlin Heidelberg (Germany). [2] [3] [4] [5] [6] [7] [8] [9]

[10] [11] Anggono, W., Wardana, I.N.G., Lawes , M., Hughes, K.J., Wahyudi, S., Hamidi, N., and Hayakawa A. 2013. Biogas Laminar Burning Velocity and Flammability Characteristics in Spark Ignited Premix Combustion, Journal of Physics Conference Series, 423: 1–7. Anggono, W., Wardana, I.N.G., Lawes, M., and Hughes, K.J. 2013. Effects of Inhibitors on Biogas Laminar Burning Velocity and Flammability Limits in Spark Ignited Premix Combustion, International Journal of Engineering and Technology, 5: 4980– 4987. Anggono, W., Wardana, I.N.G., Lawes, M., Hughes, K.J., Wahyudi, S., and Hamidi, N. 2012. Laminar Burning Characteristics of Biogas-Air Mixtures in Spark Ignited Premix Combustion, Journal of Applied Sciences Research, 8: 4126–4132. Serrano, C., Hernandez, J.J., Mandilas, C., Sheppard, C.G.W., and Woolley, R.. 2008. Laminar Burning Behaviour of Biomass Gasification-Derived Producer Gas, International Journal of Hydrogen Energy, 33: 851–862. Rosua, J.M. and Pasadas, M. 2012. Biomass Potential in Andalusia, from Grapevines, Olives, Fruit Trees and Poplar, for Providing Heating in Homes, Renewable and Sustainable Energy Reviews, 16(6), Aug 2012, pp. 4190–4195. Widiarta, A., Rosyida, I., Gandi, R., and Muswar, H.S. 2009. Peasant Empowerment through Social Capital Reinforcement: Road to Sustainable Organic Agriculture Development, Asian Journal of Food and Agro-Industry, 2 (Special Issue): 297– 306. Ong, H.C., Silitonga A.S., Mahlia, T.M.I., Masjuki, H.H., and Chong, W.T. 2014. Investigation of Biodiesel Production from Cerbera Manghas Biofuel Sources, Energy Procedia, 61: 436–439. Raju, C.A.I., Jyothi, K.R., Satya, M., and Praveena, U. 2014. Studies on Development of Fuel Briquettes for Household and Industrial Purpose, International Journal of Research in Engineering and Technology, 3: 54–63. Prasityousil, J. and Muenjina, A. 2013. Properties of Solid Fuel Briquettes Produced from Rejected Material of Municipal Waste Composting, Procedia Environmental Sciences, 17: 603–610. Yank, A., Ngadi, M., and Kok, R. 2016. Physical Properties of Rice Husk and Bran Briquettes under Low Pressure Densification for Rural Applications, Biomass and Bioenergy, 84: 22–30. [12] Jittabut, P. 2015. Physical and Thermal Properties of Briquette Fuels from Rice Straw and Sugarcane Leaves by Mixing Molasses, Energy Procedia, 79: 2–9. [13] Sutrisno., Anggono, W., Suprianto, F.D., Kasrun A.W., Siahaan, I.A. The Effects of Particle Size and Pressureon The Combustion Characteristics of Cerbera Manghas Leaf Briquettes. ARPN Journal of Engineering and Applied Sciences, 12: 1-6. [14] Zhang, X.P., Pei, Y.H., Liu, M.S., Kang, S.L., and Zhang, J.Q. 2010. Chemical Constituents from the Leaves of Cerbera Manghas, Asian Pacific Journal of Tropical Medicine, 3: 109–111. [15] Lela, B., Barišić, M., and Nižetić, S. 2016. Cardboard/ Sawdust Briquettes as Biomass Fuel: Physical-Mechanical and Thermal Characteristics, Waste Management, 47(Part B): 236–245. 