

Development of Job sheet Application in Making Biobriquette Based on Coconut (*Cocos Nucifera*) Coir with Variation of Particle Size and Banana (*Musa Paradisica*) Peels for Vocational Students

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Abstract: This study aims to determine the effectiveness of instructional media for vocational students regarding briquette material made of coconut (*Cocos Nucifera*) coir and banana (*Musa Paradisica*) peels with certain size variations using experimental demonstration method with learning video and job sheet application. The learning method used was the implementation of pre-test and post-test to students. Briquettes are made through several stages, include carbonization (250°C, 20 minutes), grinding, separation according to particle size, mixing, addition of binders, printing of briquettes, drying of the briquettes. When using 310-um carbon and 20% of mixture of banana peels, the best composition briquette can be obtained because it has the highest BR values caused by high calorific value that material has as a content and the ratio of mixture that makes the biobriquette have a right density. The conclusion obtained is the job sheet learning media can significantly increase students' knowledge, however it is insignificant when compared to video because the job sheet serves as a guide for training all aspects of learning in the form of experimental guides or demonstrations. This study produces new information about the importance of job sheet applications for improving student learning outcomes.

Keywords: Banana Peels, Biobriquette, Coconut Coir, Job Sheet, Learning Videos

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1. Introduction

The job sheet application is a worksheet that students must do during practicum which is packaged in an Android-based application. According to literature (Noktaviyanda and Aryadi, 2011), job sheet is a book written with the aim that students can learn independently without or with teacher guidance. Kusumam, Mukhidin and Hasan (2016) stated that one of the teaching materials that is packaged into learning media will support the development of students, especially in terms of improving learning outcomes. According to Trianto (2009), the job sheet serves as a guide for training in developing cognitive, psychomotor aspects, and all aspects of learning in the form of experimental or demonstration guides.

An electronic Job Sheet or e-Job sheet is a combination of teaching materials in the form of worksheets, which is packaged into electronic as well as other electronic materials that have been developed (Hafsah, Rohendi and Purnawan, 2016). However, the application of job sheets in the form of android-based applications has not been widely carried out so that research on the development of an android-based job sheet application is important to do to facilitate the learning process. The android-based job sheet application can be implemented into the practicum process contained in vocational education.

One of the subjects taught in vocational schools is "Production Process of Vegetable Product". "Production Process of Vegetable Product" is the study of processing the product of vegetable including vegetable, fruit, and tubers as well as packaging and processing of their waste. However, the basic competency of 4.27 regarding utilizing processed vegetable waste has not been implemented optimally due to the absence of a vegetable waste processing practicum. In the waste processing, students usually learn in composting,

therefore the knowledge of processing vegetable waste into biobriquettes as alternative energy for renewable fuels is important to do.

Based on research conducted by Makunti and Widjanarko (2019) regarding the product e-job sheet to improve students' competence, the teaching depended on indication that there was increase in students' learning outcomes from 31.90 to 76.66. However, there has been no research on development job sheet application for practicum processing vegetable waste into alternative energy in the form of biomass-based biobriquette. Specifically, we proposed the use of coconut (*Cocos Nucifera*) coir and banana (*Musa Paradisica*) peel makes this research important to be developed.

This study aims to determine the best carbon particles and levels of banana peel mixture against coconut coir briquettes and the effectiveness of learning media for making briquettes for vocational education students. The method used is an experimental demonstration using media in the form of instructional videos and job sheet applications.

2. Method

2.1. Making Biobriquettes

2.1.1 Preparation of Tools and Materials

We used raw materials of vegetable waste (coconut coir and banana peels) and additional materials (tapioca and water). The tools used were a knife, a ruler, an oven, an oven thermometer, a digital scale, a pocket balance, a mesh sieve, a beaker, a saw mill, and a briquette mold.

2.1.2 Biobriquette Production Process

The production process begins with the collection of raw materials and additional materials in Bandung area. Raw materials are cut and dried in an oven at 100°C for 60 min then carbonized at 250°C for 20 min until coals appear. The flames are removed by vacuum closing the oven until extinguished and the raw materials are completely carbonized. The resulting carbon is then pulverized using a saw-mill and sieved to produce carbon powders with different particle sizes. The carbon powder that has been sieved is mixed according to the formulations in Table 1 then added tapioca and hot water then stirred until it becomes a dense dough. The dough is molded and loaded and then dried at 130°C until the weight is constant.

Table 1. Briquette Formulation

Level of banana peel mixture (%)	Particle size (micron)			Tapioca concentration (%)
	1184	582	310	
10	A1	B1	C1	40
20	A2	B2	C2	40
30	A3	B3	C3	40
40	A4	B4	C4	40
50	A5	B5	C5	40

2.1.3 Data Analysis

Testing the characteristics of the biobriquette with variations in the size of the particles and the mixture was carried out to determine the quality of the briquettes produced. These tests include:

i. Compressed Density

Compressed Density (CD) is the biobriquette density after printing. The CD value is obtained by comparing the weight and volume of the newly minted briquettes.

ii. Relaxed Density

Relaxed Density (RD) is the density of biobriquette after drying. The RD value is obtained by comparing the weight and volume of briquettes that have been dried and achieving a constant weight.

iii. Relaxation Ratio

Relaxation Ratio (RR) is the ratio between CD and RD values. The RR value is obtained by comparing the CD and RD values.

iv. Percentage of Moisture Content

Percentage of Moisture Content (PMC) indicates the moisture of the biobriquette. The PMC value is obtained by comparing the weight of the briquettes that have just been printed and those that have been dried.

v. Percentage of Durability Index

Percentage of Durability Index (PDI) is the resistance of dry biobriquette PDI value is obtained by calculating the percentage of briquette weight after and before the briquette is dropped from a certain height.

vi. Percentage of Water Resistance Index

Percentage of Water Resistance Index (PWRI) shows the ability of briquettes to withstand water absorption. PWRI value is obtained by calculating the percentage of briquettes that do not absorb water.

vii. Burning Rate

Burning Rate (BR) is the average mass of biobriquette burned. The BR value is obtained by comparing the ratio of the mass lost after burning to the burning time.

viii. Specific Fuel Consumption.

Specific Fuel Consumption (SFC) shows the ratio of the mass of the biobriquette burned to the amount of water boiled.

The data obtained from the test is then analyzed and graphed

2.2 Teaching Method

The research subjects were 19 vocational students in Bandung, Indonesia. The educational test was carried out using three stages :

i. Students were given a pretest to find out their initial knowledge of biobriquette

ii. Students were given an 11-minute learning video containing biobriquette making, theoretical knowledge about biobriquette and the effect of variation on the characteristics of biobriquette. Students were then given posttest 1 to determine the improvement in learning outcomes.

iii. Students were given an android-based job sheet application about biobriquette making practicum and

theoretical knowledge about biobriquette and the effect of variation on its characteristics. Students were then given a post test to determine the effectiveness of the biobriquette making learning media through increasing learning outcomes.

The pre-test and post-test were given to students in the form of 10 true-false questions and 5 short-form questions to improve the accuracy of learning evaluation.

2.2.1 Making a job sheet application

Job sheets are made according to the Ministry of National Education's (2008) guidance for developing teaching materials which have a structure including titles, study instructions, basic competencies/ subjects, work steps and assessments. The title in the Job sheet is determined based on basic competencies, subject matter, or learning experience according to the curriculum, study instructions contain learning materials and work safety, basic competencies/ subjects are adjusted to the predefined syllabus, work steps contain the tools and materials used, procedures work in the form of explanations and practicum flowcharts, as well as assessments that aim to improve student learning outcomes. Job sheets are made in the form of an Android-based application using the smart apps creator and applied to students.

2.2.2 Job sheet evaluation

Evaluation is carried out to determine the effectiveness of the learning video and the job sheet. Evaluation is done by giving students pretest, posttest 1 and posttest 2 with the questions shown in Table 3.

3. Result and Discussion

3.1 Briquettes Characteristics

Biobriquette with variations in particle size and mixture content that has been made is then carried out by characterization testing to determine the quality of the briquettes produced.

3.1.1 Compressed Density (CD)

The compressed density test results for biobriquette with variations in particle size and mixture content are presented in the graph in Figure 1 showing that the highest average CD value was achieved by biobriquette with a particle size of 310 microns with the highest value found in biobriquette with a banana peel content of 30%, namely 0.40 g / cm³. This value indicates that the smaller the particle size, the higher the density and reach the maximum value with a banana peel mixture content of 30%. Based on the literature, the presence of larger particles offered less contact area between particles which is the major drawback in attaining higher stable density of the briquettes (Rahaman,2017).

3.1.2 Relaxed Density (RD)

The results of relaxed density testing for biobriquettes with variations in particle size and mixture content are presented in the graph in Figure 2 showing that the highest average RD value was achieved by biobriquette with a particle size of 310 microns with the highest value found in

biobriquette with a banana peel content of 20%, namely 0.23. g/cm³. This value indicates that the smaller the particle size, the higher the density and reach the maximum value with a banana peel mixture content of 20%. The relaxed density of the briquettes increases with increasing particle size of carbon (Bello, 2020).

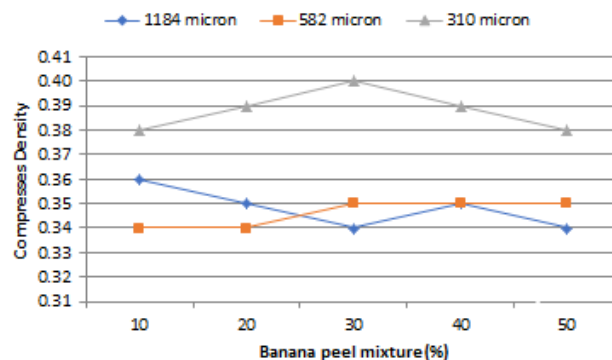


Fig 1. The compressed density test results

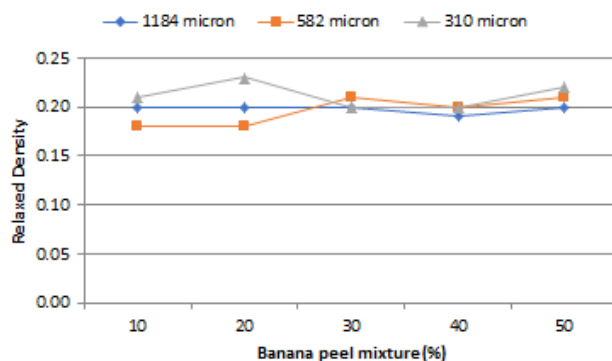


Fig 2. The relaxed density test results

3.1.3 Relaxation Ratio (RR)

The results of the relaxation ratio test to biobriquette with variations in particle size and mixture content are presented in the graph in Figure 3 showing that the highest average RR value was achieved by biobriquette with a particle size of 310 microns with the highest value found in biobriquette with a banana peel content of 30%, namely 2. Based on the literature, the higher the relaxation ratio value, the higher the briquette stability (Aransiola, Oyewusi, Osunbitan and Ogunjimi, 2019).

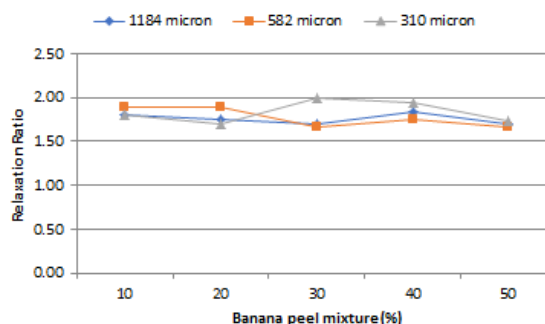


Fig 3. The relaxation ratio test results

3.1.4 Percentage of Durability Index (PDI)

The results of the percentage of durability index test for biobriquettes with variations in particle size and mixture content are presented in the graph in Figure 4 showing the highest average PDI value of 100% was achieved by biobriquette with a banana peel content of 10% with various particle sizes. This value indicates that the less the banana peel mixture, the higher the biobriquette resistance because the carbon particles of the banana peel do not coalesce homogeneously so that the density of the biobriquette particles with the least banana peel content is higher in resistance to collisions. Based on the literature, briquette with the smaller particle size, density, mechanical strength, hardness, mechanical, durability, impact resistance, and the burning time of densified briquettes are increased (Gurdil, 2018).

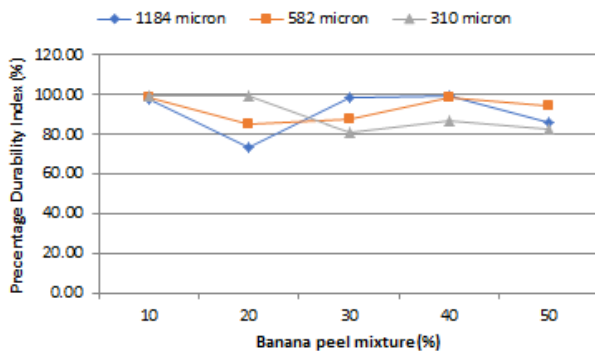


Fig 4. The percentage of durability index test results

3.1.5 Percentage of Moisture Content (PMC)

The results of the percentage of moisture content test for biobriquettes with variations in particle size and mixture content are presented in the graph in Figure 5. It shows that the highest average PMC value is achieved by biobriquette with a particle size of 310 microns with the highest value found in biobriquettes with banana peel content of 40%, namely 62.66%. This value indicates that the smaller the particle size, the higher humidity and reaching the maximum value with a banana peel mixture content of 40%. The higher the PMC value, the higher the water content in the briquettes. This result is inconsistent with the literature that the smaller particle, the lower the water content (Waluyo, Pratiwi and Sukmawati, 2017).

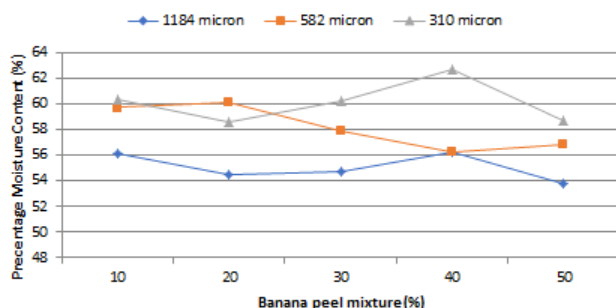


Fig 5. The percentage of moisture content test results

3.1.6 Percentage of Water Resistance Index (PWRI)

The results of testing the percentage of water resistance to biobriquette with variations in particle size and mixture content are presented in the graph in Figure 6 showing that the PWRI value of biobriquette is at an average of 50% -89% with the highest average achieved by biobriquette with particle size 310 microns with different variation banana peels mixture. This value indicates that the larger the particle size, the greater the ability of the biobriquette to absorb water. This condition is due to the fact that the larger particle makes a larger pores and surface of briquette. Based on the literature, pores on the surface of the briquettes produced with larger particle sizes were larger and allowed easier penetration of water into the briquettes (Orisaleye, Jekayinfa, Pecenka and Onifade, 2019).

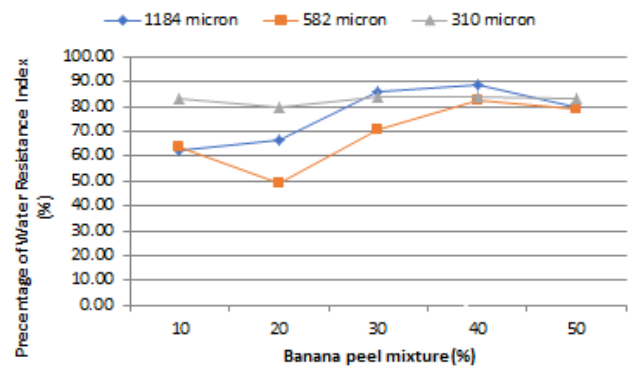


Fig 6. The percentage of water resistance test results

3.1.7 Burning Rate (BR)

The burning rate test results for biobriquette with variations in particle size and mixture content are presented in the graph in Figure 7 showing that the BR value has increased in biobriquette with a particle size of 582 microns, but has the highest value for biobriquette with particle size 310 and levels of banana peel mixture 20% which is 5.10 g/min. Based on the literature the burning rate of briquette decreases as the particle sizes decreases. A lower burning rate is more effective because the briquette can be used for a longer time and consequently can minimize the costs (Nazari, Othman and Yusuff, 2019).

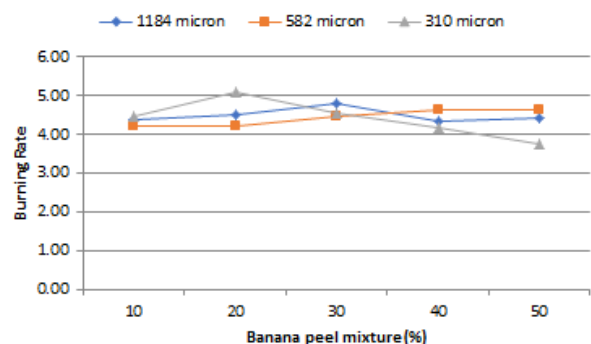


Fig 7. The burning rate test results

3.1.8 Specific Fuel Consumption (SFC)

The test results for the specific fuel consumption of biobriquettes with variations in particle size and mixture content are presented in the graph in Figure 8 showing that the SFC value has increased in biobriquette with a particle size of 582 microns but has the highest value for biobriquette with a particle size of 310 and a mixture of banana peels as much as 20% which is 5.42 g/ml. The SFC graph is in accordance with the BR graph, the burning rate of briquette decreases as the particle sizes decreases (Nazari, Othman and Yusuff, 2019).

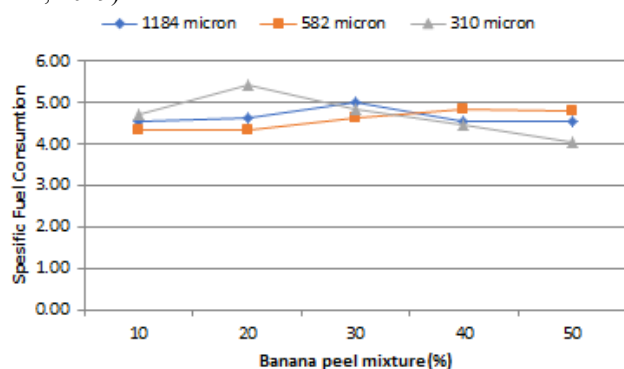


Fig 8. The specific fuel consumption test results

3.2 Teaching Result

3.2.1 Demographics

Students who are research subjects are vocational education students in Bandung, Indonesia. Figure 9 shows the distribution of students' IQs showing varying levels of intelligence.

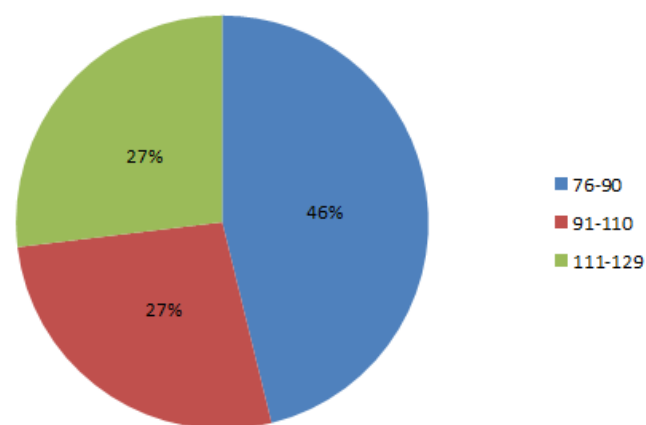


Fig 9. Distribution of student IQ

The value that is considered in addition to IQ is the average of biology, chemistry, and physics lessons to determine student interest in subjects that are the basis for processing vegetable waste, this value is presented in Table 2.

Table 2. Average scores of subjects

Subject	Students average score
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Biology	84.75
Chemistry	80.85
Physics	81

The results of the pretest, posttest 1 and posttest 2 tested on students and presented in Table 3 show the change in student scores after being given learning media in the form of videos and Job sheets. The pretest results showed the students' initial knowledge about biobriquette before being given the material. Students still do not understand about biobriquette due to a lack of information about the use of vegetable waste as a material for making biobriquettes. There is an increase in student learning outcomes which is indicated by the scores obtained by students during the post test, although in some points the students' scores decreased after being given the video, this is because the video duration is too long so that there is a material that is forgotten by students, but student scores increase again when after being given the job sheet application. This is in accordance with the research of Yulianto and Khairudin (2017) which shows that student learning outcomes by applying a scientific approach-based job sheet on the subject of the electro-pneumatic control system get an average value of 64.8 (pretest) to 78.7 (posttest) so it can be concluded that the use of Job sheets are able to increase student knowledge.

Table 3. Student scores at the time of pretest and post test

No	Question	Score (%)		
		Pre test	After video	After job sheet
1.	Briquettes are divided into coal briquettes, bio-coal briquettes, and biobriquettes	89.30	33.30	69.20
2.	Coal briquettes are one of the uses of biofuels	25.00	53.30	53.80
3.	Biobriquettes are briquettes made from biomass	85.70	93.30	100.00
4.	Briquettes can be used repeatedly as fuel	46.20	46.70	53.90
5.	The heating value of biomass affects the quality of the briquettes produced	42.90	93.30	100.00
6.	Comparison of the composition of raw materials will affect the quality of the briquettes	85.70	100.00	100.00
7.	The purpose of the adhesive on the briquette is to attract water and form a solid texture by binding the two substrates	80.80	100.00	100.00
8.	The higher the Burning Rate value, the worse the briquette quality	78.60	66.70	92.30
9.	The size of the carbon particles has an effect on the quality of the briquettes.	64.30	93.30	100.00
10.	Carbonization is the process of converting organic material into charcoal.	89.30	100.00	92.30
11.	What is yardstick to describe the physical quality of various solid fuels, one of which is briquettes?	9.60	20.10	46.20
12.	What kind of the particle size that make printing briquette easier?	85.80	100.00	100.00

13.	What characteristic that describe the ratio of the weight of water contained in the briquette to the briquette after heating?	32.20	33.30	53.90
14	What is the effect of smaller size of the briquette maker biomass to the carbonization process?	57.60	100.00	100.00
15.	What characteristic that increases with water content of briquette?	28.80	53.30	53.90

Table 4 shows the level of significance of students' scores before and after being given the learning video. The data were processed using the t-test formula pair test resulted in a t-count value of 0.247 which was greater than the t-critical value (0.05), therefore it can be said that the provision of instructional videos did not provide significant results on increasing student knowledge. This result does not match with the literature that adding video significantly increased participant's cognitive load when learning procedural knowledge (Hong, Pi and Yang, 2018).

Table 4. Paired sample test pretest and after video

	<i>Pre test</i>	<i>After video</i>
Mean	60.12	72.44
Variance	750.0374286	881.0511429
Observations	15	15
Pooled Variance	815.5442857	
Hypothesized Mean Difference	0	
df	28	
t Stat	-1.181456035	
P(T<=t) one-tail	0.123679706	
t Critical one-tail	1.701130934	
P(T<=t) two-tail	0.247359413	
t Critical two-tail	2.048407142	

Table 5 shows the level of significance of student scores before and after being given the job sheet application. The data were processed using the t-test formula pair test resulting in a t-count value of 0.03 which is smaller than the t-critical value (0.05). Therefore, it can be said that the provision of the job sheet application provides significant results in increasing student knowledge.

Table 5. Paired sample test pretest and after job sheet

	<i>Pre test</i>	<i>After Job sheet</i>
Mean	60.12	81.03333333
Variance	750.0374286	505.4080952
Observations	15	15

Pooled Variance	627.7227619
Hypothesized Mean Difference	0
df	28
t Stat	-2.28596698
P(T<=t) one-tail	0.015013661
t Critical one-tail	1.701130934
P(T<=t) two-tail	0.030027323
t Critical two-tail	2.048407142

Table 6 shows the level of significance of the student's score after being given a learning video and after being given a job sheet application. The data were processed using the t-test formula pair test resulting in a t-count value of 0.488 which was greater than the t-critical value (0.05). significant compared to students before being given learning media. This is in line with a previous study conducted by Setyawan and Suprianto (2014) with the development of job sheet that has been made to improve learning outcomes, it is obtained 38.08% of pretest and 61.76% of posttest.

Table 6. Paired sample test after video and after job sheet

	<i>After video</i>	<i>After job sheet</i>
Mean	72.44	79.49333333
Variance	881.0511429	630.5220952
Observations	15	15
Pooled Variance	755.786619	
Hypothesized Mean Difference	0	
df	28	
t Stat	-0.702627981	
P(T<=t) one-tail	0.244044242	
t Critical one-tail	1.701130934	
P(T<=t) two-tail	0.488088484	
t Critical two-tail	2.048407142	

4. Conclusion

The briquettes with the best composition are briquettes with a carbon particle size of 310 microns and a mixture content of banana peels as much as 20% of the total weight because it has the highest SFC and BR values caused by coconut coir which has a high calorific value and a banana peel content of 20% makes biobriquette not has a density that is too high. The biobriquette has a compressed density of 0.39 g / cm³, a relaxed density of 0.23 g/cm³, a relaxation ratio of 1.70, a percentage of moisture content of 58.55%, a percentage of durability index of 98.92%, a percentage of water resistance index of 80.14%, burning rate 5.10 g/min and specific fuel consumption 5.42 g/ml. Based on the result of the educational test, the learning media in the form of a job sheet application significantly increases students' knowledge but is not significant when compared to the

learning videos because the job sheet serves as a guide for training all aspects of learning in the form of experimental guides or demonstrations.

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References

- Aransiola, E. F., Oyewusi, T. F., Osunbitan, J.A and Ogunjimi, L.A.O. (2019). Effect of binder type, binder concentration and compacting pressure on some physical properties of carbonized corncob briquette. *Energy Reports*. 5(2019), 909–918.
- Bello, R S., Onilude, M A. (2020). physico-mechanical characteristics of high density briquettes produced from composite sawdust. *J. Appl. Sci. Environ. Manage.* 24(5), 779-787.
- Gurdil, G.A.K., Demirel, B. (2018). Effect of particle size on surface smoothness of bio-briquettes produced from agricultural residues. *Manuf Technol.* 18(5), 742-747.
- Hafsah, N.R., Rohendi, D. Purnawan, P. (2016). Penerapan media pembelajaran modul elektronik untuk meningkatkan hasil belajar siswa pada mata pelajaran teknologi mekanik. *Journal of Mechanical Engineering Education*, 3(1), 106-112.
- Hong, J., Pi, Z. Yang, J. (2018). Learning declarative and procedural knowledge via video lectures: cognitive load and learning effectiveness. *Innovations in Education and Teaching International*. 55(1), 74-81.
- Orisaleye, J.I. Jekayinfa, S.O. Pecenka, R., Onifade, T.B. (2019). Effect of densification variables on water resistance of corn cob briquettes. *Agronomy Research*. 17(4), 1722-1734.
- Kusumam, A., Mukhidin, M., Hasan, B. (2016). Pengembangan bahan ajar mata pelajaran dasar dan pengukuran listrik untuk sekolah menengah kejuruan. *Jurnal Pendidikan Teknologi dan Kejuruan*. 23(1), 28-39.
- Makunti, J. F., & Widjanarko, D. (2019). Increasing vocational school students' competency of automotive brake system by implementing diagnostic problem-based e-jobsheet. In *Journal of Physics: Conference Series*. 1273(1), 1-9.
- Nazari, M.M., Othman, W.W., Yusuff, K.M. (2019). Banana residue as biomass briquette: an alternative of fuel energy. In *The 7th International Conference on Sustainable Agriculture for Food, Energy and Industry in Regional and Global Context, ICSAFEI2015*” erişim. 18(7), 1-6.
- Noktaviyanda, M. F., Aryadi, W. (2011). Peningkatan hasil belajar melalui penerapan media pembelajaran job sheet pada panel peraga sistem kelistrikan otomotif. *Jurnal Pendidikan Teknik Mesin*, 11(2), 68-71.
- Rahaman, S.A, Salam, P.A. (2017). Characterization of cold densified rice straw briquettes and the potential use of sawdust as binder. *Fuel Processing Technology*. 158(2017), 9-19.
- Setyawan, F. Suprianto, B. (2014). Pengembangan trainer pan job-sheet plc sebagai media pembelajaran pada mata diklat plc di jurusan elektronika industri smk negeri 2 lamongan. *Jurnal Pendidikan Teknik Elektro*. 3(3), 509-515.
- Trianto. (2009). *Mendesain Model Pembelajaran Inovatif*. Jakarta: Kencana.
- Waluyo, J., Pratiwi, Y., Sukmawati, P.D. (2017). Biochar briquette from jackfruit crust: production, mechanical and proximate properties. *International Journal of Scientific Engineering and Science*. 1(11), 42-44.