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Physical and Thermal Characteristics of Solid Bio Ethanol

I Wayan Arnata I Wayan Gede Sedana Yoga Bambang Admadi Harsojuwono*
Technology of Agriculture Industry, Faculty of Agriculture Technology, Udayana University, Bali, Indonesia

Abstract
The production of solid bio ethanol is one way to develop bio ethanol downstream products. This study aims to determine the best solid bio ethanol characteristics in various concentrations of bio ethanol and ratio of bio ethanol with stearic acid. Research using Factorial Random Block Design. Factor I is the concentration of bio ethanol with 3 levels i.e. 70% (v / v), 80% (v / v), and 90% (v / v). Factor II is the ratio of bio ethanol with stearic acid to 3 levels i.e. 2: 1 (w / w); 1: 1 (w / w) and 1: 2 (w / w). The results of the study shown that the concentration of bio ethanol and the ratio of bio ethanol and stearic acid significantly affect the specific fuel consumption, the interaction is very significantly to hardness, density, long flame, burning residue, calorific value, thermal efficiency and water boiling test value, but does not affect the ash content of the solid bio ethanol. The best characteristic was obtained from bio ethanol concentration treatment of 90% in the ratio of bio ethanol and stearic acid of 2: 1 with a hardness value of 0.938 N / cm2, density of 0.702 g/cm3, ash content of 0.0002%, residual burning of 1.93%, calorific value of 7.003,47 cal /g and thermal efficiency of 79.99%, Water Boiling Test of 36.95 minutes and Specific Fuel Consumption of 72.65 g / L
Keywords: bio ethanol, stearic acid, solid bio ethanol, physical and thermal characteristics

1. Introduction

Bio ethanol as a result of fermentation production can be applied in a variety of fuels with higher economic value (Rashid, 2012). It's just that nowadays a lot of researched and developed is bio ethanol as fuel of gasoline superstores. But to be able to make bio ethanol as a gasoline substitute, Required a high level of purity (Rarasati and Rizky, 2013). Based on SNI 7390: 2008 stated that the standard requirement for bio ethanol to be used as fuel, must have at least 99.6% purity. For purification process is certainly not can be done with the usual distillation process as has been commonly applied in the community. Its purification technology, in addition to the distillation process, also has to go through the dehydration process that usually uses additional materials or compounds, such as the 3 Angstrong synthetic zeolite adsorbent that is still imported (Hambali, 2007). Dehydration technology is what causes the cost of bio ethanol production becomes expensive. Seeing this condition is certainly to make bio ethanol as fuel petrol substitute relative difficult to be developed, especially on the scale of populist.

To solve this problem, bio ethanol products should be developed into downstream products of fuels that do not require high levels of purity, since bio ethanol with a concentration of at least 40% can burn. One of the downstream products of fuels that can be developed is solid bio ethanol. Solid bio ethanol can be used just as we use paraffin. Paraffin is a solid fuel that is often used by soldiers and nature lovers. It's very compact shape is very useful to use in emergency condition. Paraffin is very practical to carry on the way, no risk of spill and very easy to get. However, paraffin also has some disadvantages: paraffin is derived from petroleum so it is not renewable, causes soot during burning and produces toxic gas emissions. In addition, the odor of burning of paraffin is quite strong and stinging. The opposite characteristic is possessed by solid bio ethanol that is renewable, as long as the burning is not smoky, does not cause soot, and produces no harmful gases, non-carcinogenic and non corrosive. Its solid form makes it easy to pack and distribute. Solid bio ethanol is perfect for use chafing dish fuel in the catering industry, during camping, and for army purposes (Merdjan and Matione, 2003). Solid bio ethanol is also prospective as a substitute of methanol fuel or spritus in the catering industry. Methanol is toxic and not all people know the methanol production process so it is difficult to develop on a populist scale. With the same function and see the deficiencies possessed by paraffin and methanol, solid bio ethanol is very effective to develop in populist or household industries, especially to support catering industry or catering industry.

The characteristics of solid bio ethanol are influenced by the concentration of bio ethanol and stearic acid used as a binder or compacting medium. At low concentrations of bio ethanol and high stearic acid weight causes solid bio ethanol to have a hard texture, it is difficult to ignite but tends to have a long burning time. In contrast, at high concentrations of bio ethanol with low stearic acid weight causes solid bio ethanol to have a soft texture, easy to ignite but short-burning time. In relation to this condition, it is necessary to examine the level of bio ethanol concentration and the weight of stearic acid which gives the best characteristic in making solid bio ethanol.

This study aims to determine the effect of bio ethanol concentration and the ratio of bio ethanol with stearic acid to solid bio ethanol characteristics, (2) to determine bio ethanol concentration and bio ethanol weight ratio with stearic acid yielding the best solid bio ethanol characteristics.

2. Research Methods

2.1 Materials and Reserach Equipmnent

The materials used in this research are bio ethanol fermented with concentration of 22% (v / v), stearic acid and silica gel adsorbent obtained from Bratachem. The equipment used is a set of column distillation tools, bomb calorimeter (PARR 6775), Texture analyzer (TAXT Plus Analyzer Microstable USA), analytical scales (Sartorius CP323S), stop watch, furnace, thermometer, alcohol meter and tools glass. This research was conducted at the Laboratory of Agriculture Industrial Technology, Udayana University.

2.2 Experimnental Design

The process of producing solid bio ethanol using Randomized Block Design with two factors. The first factor is the concentration of bio ethanol consisting of three levels, 70%, 80% and 90% (v / v), while the second factor is the ratio of bio ethanol with stearic acid which consists of 3 levels i.e. 2: 1, 1: 1 ratio, And 1: 2 (w / w). Of these factors will be obtained 9 treatment combinations and grouped into 2 based on the production process time so there are 18 units of experiments. The data obtained were analyzed of variance (ANOVA) and continued by Duncan's different test.

2.3.Implementation of Research

This research was conducted in two stages, namely purification process of bio ethanol and solid bio ethanol production process. The bio ethanol purification process uses a distillation and dehydration process simultaneously with an adsorbent column distillatory. The adsorbent used is silica gel. Silica gel before use as an adsorbent is activated physically to increase absorption capacity. This activation was carried out by the process of curing at a temperature of 200 ± 2^{o}C for 2 hours. The activated adsorbent is 2.5 kg, then inserted into the adsorbent column on the dehydrator device. Bio ethanol with a concentration of 22% bio ethanol (v / v) of 5 liters was fed into the feed tank. In the dehydration distillation process, the distillation temperature of the feed tank is set to 100 ° C. In the dehydration process, ethanol and water will evaporate and pass through the adsorbent column so that water will be absorbed, while ethanol will continue to carry flow to the condenser column. In the condenser, ethanol vapor will change into a liquid phase. The resulting ethanol is accommodated in the product tank to further measure the alcohol content. In the solid bio ethanol production stage, stearic acid is heated in the oven until it melts at 70 ° C, after stearic acid melts; bio ethanol is mixed according to the treatment. The treated factor was a combination of bio ethanol concentration with the ratio of bio ethanol weight to stearic acid. The mixture of bio ethanol and stearic acid is stirred until homogeneous. The mixture is then poured into a tubular mold with a diameter of 10 cm with a height of 2.5 cm. Once poured, the bio ethanol is left to solidify and ready for analysis.

2.4. Variables Observed

Variables measured as work indicator are hardness of solid bio ethanol, density, ash content, long flame, and calorific value, percentage of burning residue, thermal efficiency, Water Boiling Test (WBT), and Specific Fuel Consumption (SFC).

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3. Result and Discusion

3.1 Hardness

Hardness testing is conducted to determine the ability of solid bio ethanol to withstand external pressure, causing the solid bio ethanol to break. The results showed that the interaction treatment of bio ethanol concentration and bio ethanol ratio with stearic acid significantly affect the hardness value of solid bio ethanol. The highest hardness value of 37.08 N / cm2 resulted from the treatment using 70% bio ethanol concentration on bio ethanol weight ratio with 1: 2 steric acids. For the lowest hardness value of 2.68 N / cm2 resulted from the treatment using 90% bio ethanol concentration with 2: 1 stearic acid ratio. Hardness values of solid bio ethanol are presented in Table 1.

Table 1. Hardness value of solid bio ethanol (N / cm^2)

Treatment	P2:1	P1:1	P1:2	Average
B70	2,96 fg	15,06 b	37,08 a	18,37
B80	2,68 g	5,68 e	13,61 c	7,32
B90	0,94 h	3,96 f	9,03 d	4,64
Average	2,19	8,23	19,90	

Description : The same alphabet is behind the average in the columns and rows show not significantly different
at the level of 5% error
B : bio ethanol concentration
P : ratio bio ethanol with stearic acid

The hardness value of solid bio ethanol is influenced by bio ethanol concentration and the ratio of bio ethanol with stearic acid with values ranging from 0.94 N / cm2 to 37.08 N / cm2. This value is different from Figure 1 shows that the hardness value of solid bio ethanol increases with the lower concentration of bio ethanol and the lower value of the ratio of bio ethanol weight with stearic acid. High value hardness of solid bio ethanol caused by high stearic acid content. Stearic acid used as a binder effect on the resistance of solid bio ethanol to pressure. This is in line with Statement Akhiroh (2015) which states that the higher the content of stearic acid in solid bio ethanol the higher the value of compressive strength.

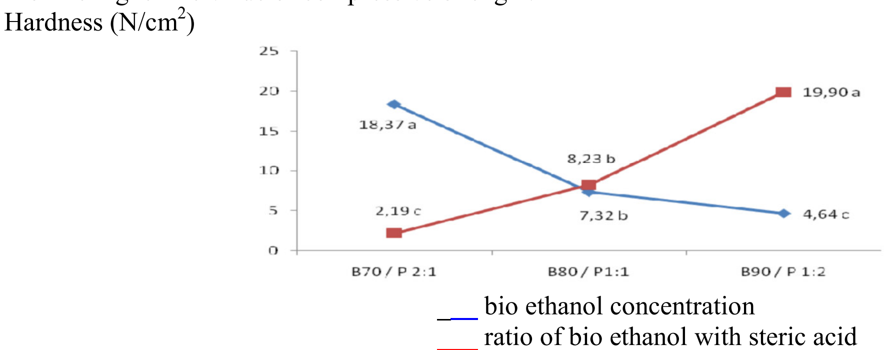

Figure 1. The relationship of bio ethanol concentration and ratio of bio ethanol with stearic acid to solid bio ethanol hardness

3.2 Density

Density shows the comparison between briquette weight and volume. Briquette density affects briquette quality, because high density can increase burnt briquette calorific value. The size or magnitude of the density is influenced by the size and homogeneity of the briquette material itself. Density may also affect the firmness of the press, the length of the burning, and the ease at which the briquette will be turned on. Density is too high to cause charcoal briquettes are difficult to burn, while briquettes that have a density that is not too high it will facilitate the burning because the greater the air cavity or the gap that can be passed by oxygen in the combustion process. Briquettes with too low densities can cause briquettes to run low in combustion due to lower briquette weight (Hendra and Winarni, 2003).

The density indicates the degree of porosity of the material. High-density materials tend to have low porosity. The results showed that the interaction treatment of bio ethanol concentration and bio ethanol ratio with stearic acid significantly influenced the solid bio ethanol density value. The highest density value of 3.22 g / cm3 resulted from the treatment using 70% bio ethanol concentration at ratio of bio ethanol with 1: 2 steric acid. Use of bio ethanol with the 90% concentration in the bio ethanol ratio with 2 : 1 and 1: 1 stearic acid yielded no significant different density values, i.e. 0.70 g / cm3 and 0.88 g / cm3, respectively. This density value is also not significantly different with the treatment resulted from the use of 80% bio ethanol concentration in the ratio of bio ethanol with stearic acid of 2: 1 that is equal to 0.89 g / cm3. The solid bio ethanol density values are presented in Table 2.

Table 2. Density value of solid bio ethanol (g / cm^3)

Treatment	P2:1	P1:1	P1:2	Average
B70	1,11 cde	1,41 bc	3,22 a	1,91
B80	0,89 def	1,05 de	1,23 bcd	1,06
B90	0,70 f	0,88 ef	1,48 b	1,02
Average	0,90	1,11	1,97	

Description : The same alphabet is behind the average in the columns and rows show not significantly different
at the level of 5% error
B : bio ethanol concentration
P : ratio bio ethanol with stearic acid

The bio ethanol density increases with the lower concentration of bio ethanol and the ratio value of bio ethanol with stearic acid. Conversely decreases with the higher concentration of bio ethanol and the ratio value of bio ethanol with stearic acid. The solid bio ethanol density is closely related to the hardness value of solid bio ethanol. High density solid bio ethanol tends to have high density values as well. Graph of bio ethanol concentration relationship and ratio of bio ethanol with stearic acid to solid bio ethanol density are presented in Figure 2.

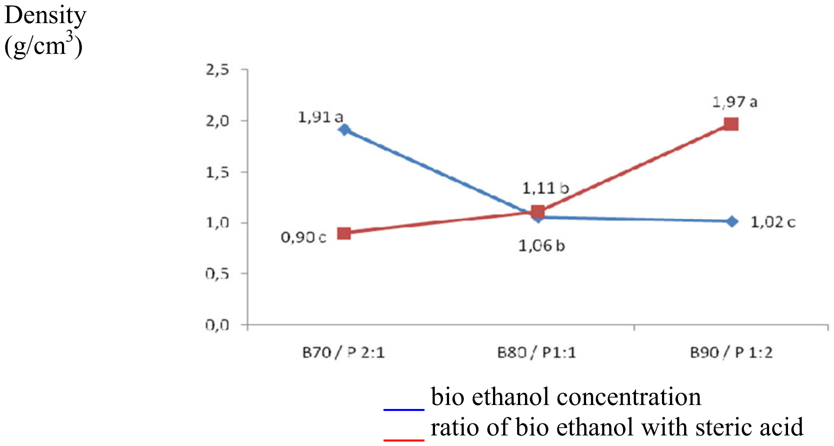

Figure 2. The relationship of bio ethanol concentration and ratio of bio ethanol with stearic acid to solid bio ethanol density

3.3 Ash Content

The ash content indicates the content of inorganic compounds present in a material, further Jamilatun (2011) states that the ashes present in solid fuel are non-combustible minerals and left behind after the combustion process and the accompanying reactions are completed . The higher the ash content of a solid fuel, the lower the quality of the fuel (Wahyu et al., 2013). This is caused by the high ash content will decrease the calorific value of briquettes (Ismayana and Afriyanto, 2011). The results showed that the treatment of bio ethanol concentration and the ratio of bio ethanol weight with stearic acid had no significant effect on ash content of solid bio ethanol. The absence of differences in ash content resulting from stearic acid is used only as a bio ethanol binder. The resulting content of bio ethanol ash ranged from 0.0002% to 0.04%. The values of ash content of bio ethanol solids are presented in Table 6. This ash content is much different from that of Akhiroh (2015) which produces solid bio ethanol with sodium carboxy methyl cellulose and stearic acid which ranges from 1.04% to 4.30%. The difference of ash content in solid bio ethanol is caused by the difference of type and composition of raw materials used as compacting material.

In Table 3, it is seen that there is a tendency of ash content to increase with the lower value of the ratio of bio ethanol with stearic acid. In other words, the higher the weight of stearic acid used, the higher the ash content of the resulting solid bio ethanol. The ash content contained in this solid bio ethanol can be derived from the raw materials used, especially stearic acid.

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Table 3. The value of ash content of bio ethanol (%).

Treatment	P2:1	P1:1	P1:2	Average
B70	0,0008 a	0,0043 a	0,0069 a	0,004
B80	0,0099 a	0,0120 a	0,0236 a	0,015
B90	0,0002 a	0,0024 a	0,0404 a	0,014
Average	0,004	0,006	0,024	

Description : The same alphabet is behind the average in the columns and rows show not significantly different

at the level of 5% error
B : bio ethanol concentration
P : ratio bio ethanol with stearic acid

3.4 Long flame

The results showed that the treatment of bio ethanol concentration and the ratio of bio ethanol with stearic acid significantly affected the long flame of solid bio ethanol. The highest long flame was obtained from the treatment using 90% bio ethanol concentration in the ratio of bio ethanol with 2: 1 stearic acid i.e. 101 min / 100g. The use of bio ethanol concentration of 70% and 80% both in the ratio of bio ethanol with 1: 1 and 1: 2 stearic acid did not significantly different that is between 21.86 minutes / 100g to 30.59 minutes / 100g. The long flame of solid bio ethanol are presented in Table 4.

Table 4. Long flame values of solid bio ethanol (minutes / 100 g)

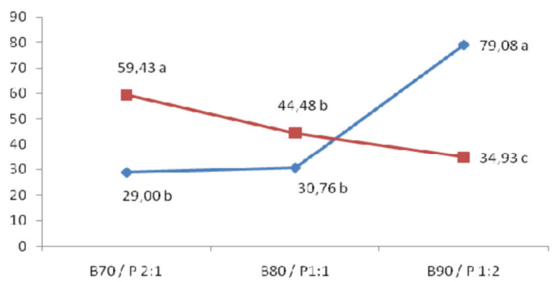
Treatment	P2:1	P1:1	P1:2	Average
B70	36,78 de	25,81 f	24,40 f	29,00
B80	39,82 d	30,59 ef	21,86 f	30,76
B90	101,68 a	77,04 b	58,52 c	79,08
Average	59,43	44,48	34,93	

Description : The same alphabet is behind the average in the columns and rows show not significantly different

at the level of 5% error
B : bio ethanol concentration
P : ratio bio ethanol with stearic acid

Bio ethanol solids have longer flame with higher concentrations of bio ethanol and ratio of bio ethanol with stearic acid. Relationship between the bio ethanol concentration and ratio of bio ethanol with stearic acid to long of flame of solid bio ethanol is presented in Figure 3.

Long flame
(minutes/100 g)



bio ethanol concentration
ratio of bio ethanol with steric acid

Figure 3. The relationship of bio ethanol concentration and the ratio of bio ethanol with stearic acid to long flame of solid bio ethanol

3.5. Burning residue

The remaining burning is the residual solid of combustion (Naryono and Soemaryo, 2011). This solid can be ash which is the inorganic elements of the material (Belevi and Langmeier, 2000). The results showed that the treatment of bio ethanol concentration and the ratio of bio ethanol with stearic acid significantly influenced the burning residue of solid bio ethanol. Use of bio ethanol with a concentration of 90% both on the ratio of bio ethanol with stearic acid of 1: 2; 1: 1 and 2: 1 produce residual burning which is not significantly different from 0.01% to 0.04%. The highest burning residue resulted from the treatment using 70% bio ethanol concentration with the ratio of bio ethanol weight with 1: 2 stearic acid which is 60,43%. The percentage of solid bio ethanol residual is presented in Table 5.

Table 5. Percentage of burning residue of solid bio ethanol (%)

Treatment	P2:1	P1:1	P1:2	Average
B70	29,02 f	51,74 c	69,43 a	50,06
B80	32,72 e	49,20 d	65,46 b	49,13
B90	0,01 g	0,02 g	0,04 g	0,02
Average	20,58	33,66	44,97	

Description : The same alphabet is behind the average in the columns and rows show not significantly different

at the level of 5% error

B : bio ethanol concentration

P : ratio bio ethanol with stearic acid

The higher concentration of bio ethanol that is used means the smaller the water content in solid bio ethanol, so causing less burning residue. Materials with lower moisture content will be easier and longer to burn than those with high moisture content. At 90% bio ethanol concentration, the burning residue is black soot. This shows that stearic acid used as a binder medium also burns. It's just that with the burning of stearic acid produce a reddish flame. The opposite condition on the use of lower bio ethanol concentrations is the concentration of bio ethanol 70% and 80% which still leave the remaining combustion in the form of solid acid stearic. At the concentration of bio ethanol and the ratio of bio ethanol with stearic acid the lower will produce the higher burning residue, but not produce the student in the form of black soot. The relationship of bio ethanol concentration and the ratio of bio ethanol with stearic acid to the remaining combustion of solid bio ethanol is presented in Figure 4.

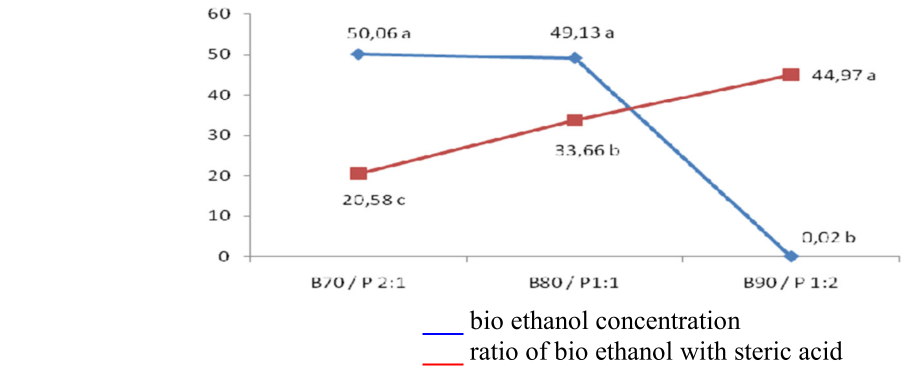


Figure 4. The relationship of bio ethanol concentration and ratio of bio ethanol with stearic acid to burning residue of solid bio ethanol

3.6. Calorific Value

The results showed that the treatment of bio ethanol concentration and the ratio of bio ethanol with stearic acid significantly affect the calorific value of bio ethanol. The highest heating value was obtained from the treatment using 90% bio ethanol concentration in the ratio of bio ethanol with stearic acid of 1: 2 i.e. 7,927.15 cal / g. In the ratio of bio ethanol with stearic acids of 1: 2, the use of 80% and 90% bio ethanol concentration shows the results of calorific values that are not significantly different. The lowest heating value of 6,071.39 cal / g resulted from the treatment using 80% bio ethanol concentration in the bio ethanol 2: 1 weight ratio. The calorific value of bio ethanol is presented in Table 6.

Table 6. Calorific value of bio ethanol (cal / g)

Treatment	P2:1	P1:1	P1:2	Average
B70	6511,58 e	6609,00 e	7592,14 bc	6904,24
B80	6071,39 f	7026,49 d	7788,69 ab	6962,19
B90	7003,47 d	7460,13 c	7927,15 a	7463,59
Average	6528,81	7031,87	7769,33	

Description : The same alphabet is behind the average in the columns and rows show not significantly different

at the level of 5% error

B : bio ethanol concentration

P : ratio bio ethanol with stearic acid

The calorific value is influenced by the high concentration of bio ethanol and the weight of stearic acid contained in solid bio ethanol. The higher concentration of bio ethanol and the weight of stearic acid used, it will produce a higher calorific value. The high value of the heating value depends on the high level of carbon content attached to the fuel. The relationship of bio ethanol concentration and the ratio of bio ethanol with stearic acid is presented in Figure 5.

Calorific value (cal/g)

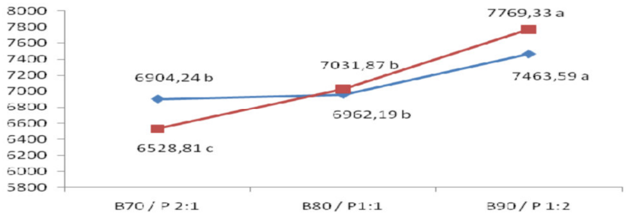


Figure 5. The relationship of bio ethanol concentration and ratio of bio ethanol with stearic acid to solid bio ethanol calorific value

3.7 Thermal Efficiency

Thermal efficiency is an indicator of the magnitude of displable energy to heat and evaporate water in a container (Oketch et al., 2014). The results showed that the bio ethanol concentration treatment and the ratio of bio ethanol with stearic acid significantly influenced the thermal efficiency of solid bio ethanol. The highest thermal efficiency was obtained from the treatment using 90% bio ethanol concentration in the ratio of bio ethanol with stearic acid of 2: 1 which was 79.99%. The lowest thermal efficiency value resulted from the treatment using 80% bio ethanol concentration in the ratio of bio ethanol with stearic acid of 1: 2 that is 29.27%. In the ratio of bio ethanol with the same stearic acid that is 1: 2, this thermal efficiency is not significantly different with 70% bio ethanol concentration. The value of thermal efficiency of solid bio ethanol is presented in Table 7.

Table 7. The value of thermal efficiency of solid bio ethanol (%)

Treatment	P2:1	P1:1	P1:2	Average
B70	52,32 c	46,05 cd	34,16 ef	44,18
B80	67,16 b	52,95 c	29,27 f	49,79
B90	79,99 a	68,98 b	39,55 de	62,84
Average	66,49	55,99	34,33	

Description : The same alphabet is behind the average in the columns and rows show not significantly different

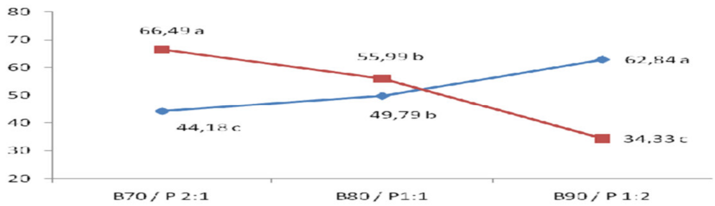
at the level of 5% error

B : bio ethanol concentration

P : ratio bio ethanol with stearic acid

The thermal efficiency of solid bio ethanol is influenced by the high concentration of bio ethanol and the high low ratio of bio ethanol with stearic acid. The higher concentration of bio ethanol tends to produce higher thermal efficiency. The same thing also happens if the comparison ratio of bio ethanol with stearic acid higher will tend to produce higher thermal efficiency. Graph of correlation effect of bio ethanol concentration and comparison the weight of bio ethanol with stearic acid on the thermal efficiency of the solid bio ethanol is presented in Figure 6.

Thermal Efficiency **(%)**



bio ethanol concentration

ratio of bio ethanol with steric acid

Figure 6. The relationship of bio ethanol concentration and ratio of bio ethanol with stearic acid on thermal efficiency of solid bio ethanol

3.8. Water Boiling Test Value

The water boiling test shows the time required to boil 1L of water using solid bio ethanol. The results showed that the concentration of bio ethanol and the ratio of bioethanol and stearic acid significantly influenced the water boling test value of solid bio ethanol The fastest time required to boil 1 liter of water with solid bio ethanol was obtained by using a 90% bio ethanol concentration in the ratio of bio ethanol with stearic acid of 1: 1 was 36.13 minutes. The result of this water boiling test is not significantly different with the treatment of 90% bio ethanol concentration in 2: 1 ratio. The value of solid water boiling test of bio ethanol is presented in Table 8.

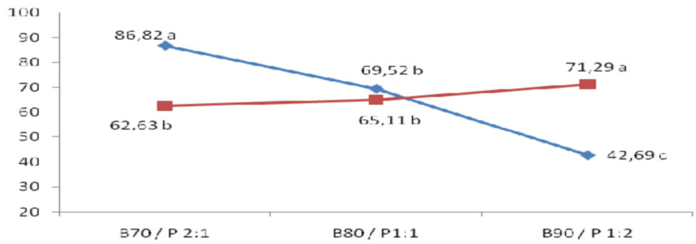
Table 8. Water boiling test of solid bio ethanol (minutes)

Treatment	P2:1	P1:1	P1:2	Average
B70	86,18 a	84,27 ab	90,01 a	86,82
B80	64,76 cd	74,94 bc	68,85 c	69,52
B90	36,95 e	36,13 e	55,00 d	42,69
Average	62,63	65,11	71,29	

Description : The same alphabet is behind the average in the columns and rows show not significantly different
at the level of 5% error
B : bio ethanol concentration
P : ratio bio ethanol with stearic acid

Figure 7 shows that the higher the concentration of bio ethanol used the faster the time it takes to boil 1 L of water, and vice versa, the lower the ratio of bio ethanol to stearic acid, the time required to boil 1L of water tends to last longer. However, on the ratio of bio ethanol with stearic acid of 2: 1 and 1: 1 showed the value of test boiling water that was not significantly different.

Water boiling value
(minutes)



bio ethanol concentration
ratio of bio ethanol with steric acid

Figure 7. The relationship of bio ethanol concentration and the ratio of bio ethanol with stearic acid to the water boiling test value of solid bio ethanol

3.9 Specific Fuel Consumption

Specific Fuel Consumption (SFC) is the bio ethanol gel weight required to boil 1 L of water. The results showed that the interaction of bio ethanol concentration and the ratio of bio ethanol with stearic acid did not significantly affect the value of Specific Fuel Consumption. The Specific Fuel Consumption value of solid bio ethanol is presented in Table 9.

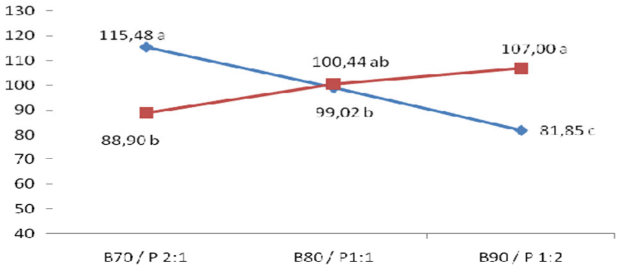
Table 9. Specific Fuel Consumption values of solid bio ethanol (g / L)

Treatment	P2:1	P1:1	P1:2	Average
B70	102,91	119,49	124,05	115,48 a
B80	91,15	100,02	105,89	99,02 b
B90	72,65	81,82	91,07	81,85 c
Average	88,90 b	100,44 ab	107,00 a	

Description : The same alphabet is behind the average in the different columns and rows show not significantly
different at the level of 5% error
B : bio ethanol concentration
P : ratio bio ethanol with stearic acid

In Table 8 and Figure 8 it can be seen that the bio ethanol concentration and the ratio of bio ethanol with stearic acid significantly affect the value of Specific Fuel Consumption. Higher concentrations of bio ethanol lead to impairment of Specific Fuel Consumption. The same thing also happens with the higher value of the ratio of bio ethanol with stearic acid will decrease the value of Specific Fuel Consumption. This means to boil 1 L of water will need higher bio ethanol weight. The use of 90% bio ethanol concentration in the average solid bio ethanol production requires about 81.85 g to boil 1 L of water, while on the use ratio of bio ethanol with 1: 2 stearic acid, on average it takes about 107.00 g to boil 1 L water.

Specific fuel consumption (g/L)



___ bio ethanol concentration
___ ratio of bio ethanol with steric acid

Figure 8. The relationship of bio ethanol concentration and the ratio of bio ethanol with stearic acid to the value of Specific Fuel Consumption of solid bio ethanol

4. Conclusion

From the results of the study can be concluded that the concentration of bio ethanol and the ratio of bio ethanol and stearic acid significantly affect the specific fuel consumption, the interaction is very significantly to hardness, density, long flame, burning residue, calorific value, thermal efficiency and water boiling test value, but does not affect the ash content of the solid bio ethanol. The best characteristic was obtained from bio ethanol concentration treatment of 90% in the ratio of bio ethanol and stearic acid of 2: 1 with a hardness value of 0.938 N / cm2, density of 0.702 g / cm3, ash content of 0.0002%, residual burning of 1.93%, calorific value of 7.003,47 cal / g and thermal efficiency of 79.99%, Water Boiling Test of 36.95 minutes and Specific Fuel Consumption of 72.65 g / L.

References

Acharya, S. and Anita, C. (2012). Alkaline cellulase produced by a newly isolated thermophilic Aneurinibacillus thermoaerophilus WBS2 from hot spring, India. African Journal of Microbiology Research 6: 5453-5458.

Ahmed, S., Ammara, B., Huma, S., Mubshara, S. and Amer, J. (2009). Production and purification of cellulose degrading enzymes from a filamentous fungus Trichoderma harzianum. Journal of Botany 41: 1411-1419.

Akponah, E. and Akpomie, O.O. (2012). Optimization of bioethanol production from cassava effluent using Saccharomyces cerevisiae. African Journal of Biotechnology 11: 8110-8116.

Alriksson, B., Horvath, I. S., Sjode, A., Nilvebrant, N. O. and Jonsson, L. J. (2005). Ammonium hydroxide detoxification of spruce acid hydrolysates. Applied Biochemistry and Biotechnology 121: 911-922.

Anindyawati, T. (2010). Potential cellulase in degrading lignocellulose agricultural waste for organic fertilizer. Cellulose News 45: 70 - 77

Antonius, J. A, Maris V., Derek, AA, Eleonora, B., Joost, VDB, Marko, K., Marijke, AH, Luttik, H., Wouter, W., Alexander, S., Johannes, P ., Dijken, V. and Jack, TP (2006). Alcoholic fermentation of carbon sources in biomass hydrolysates by Saccharomyces cerevisiae: current status. Journal of Antonie van Leeuwenhoek 90: 391-418.

Belevi, H. and M.Langmeier. 2000. Factors determining the element behavior in municipal acid waste incinerators 2 laboratory experiments. Journal of Enviromental Science and Technology. 34: 2507-2512.

Eko Naryono and Soemarno. 2011. Utilization of Residue of Organic Household Waste Burning. Journal of Development and Nature Lestari 2: 1-9.

Mitchual S.J., Kwasi F.M and Nicholas A. D. 2014. Evaluation of Fuel Properties of Six Tropical Hardwoods Timber Species for Briquettes. Journal of Sustainable Bioenergy Systems 4: 1-9

OketchP.O., Ndiritu, H.M. And Gathitu B.B. (2014). Experimental Study of Fuel Efficiency and Emissions Comparison from Bio-ethanol Gel Stoves. European International Journal of Science and Technology 3: 328-339.

Onuegbu1, T.U., Ekpunobi, U.E., Ogbu, I.M., Ekeoma, M.O. And Obumselu, F.O. (2011). Comparative Studies Of Ignition Time And Water Boiling Test Of Coal And Biomass Briquettes Blend. Journal of Research and Reviews in Applied Sciences 7: 153-159.

Patabang, D. (2013). Characteristics of Thermal Briquette of Meranti Wood Sawcle Charcoal. Mechanical Journal 4: 410 - 415.