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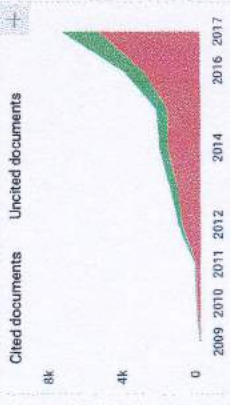
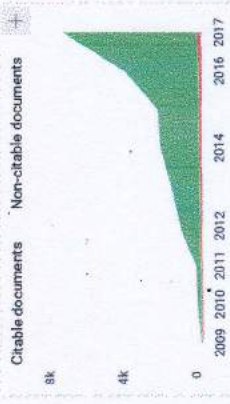
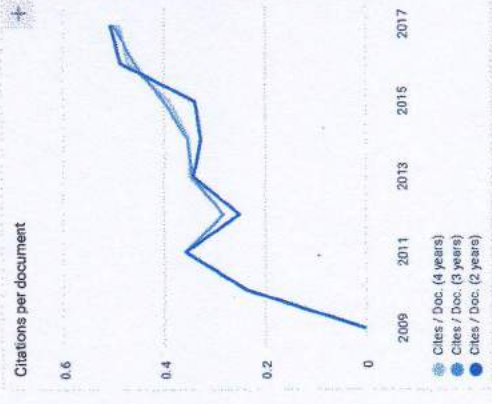
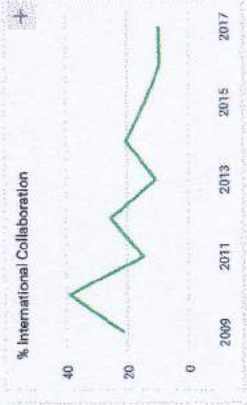
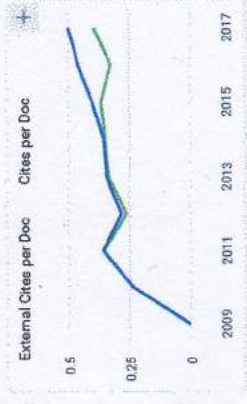
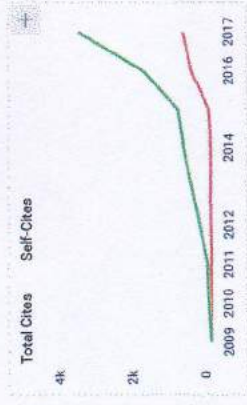
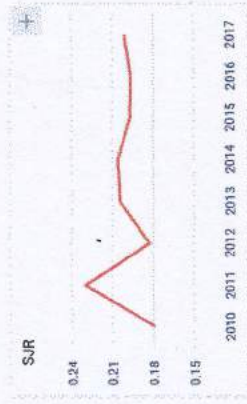
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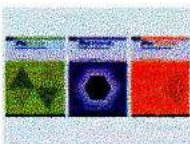
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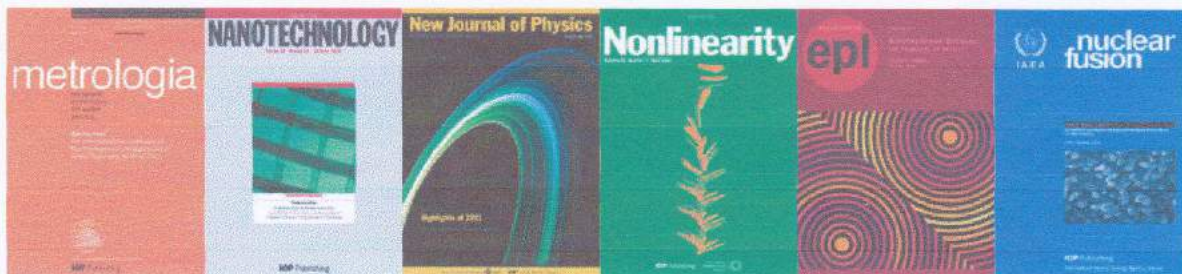
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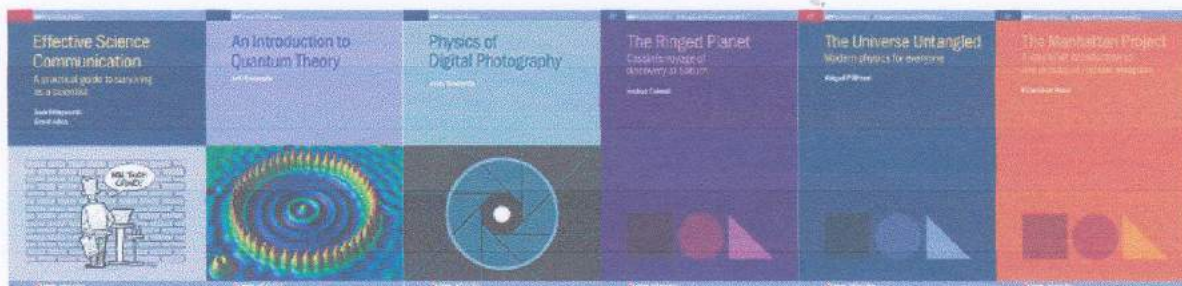
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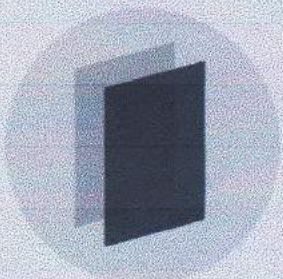
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PREFACE

It is our great pleasure to introduce you the proceedings of 2017 5th Asia Conference on Mechanical and Materials Engineering (ACMME 2017) held in Tokyo, Japan from June 9-11, 2017. ACMME 2017 is dedicated to issues related to mechanical and materials engineering. One of the objectives of the conference is to establish platforms for collaborative research projects in this field, and to find potential opportunities for international cooperation.

The conference program included keynote, oral, and poster presentations from scholars working in the areas of materials science and engineering. It covered recent trends and progress made in the field of mechanical and materials engineering. Professors from USA, Malaysia and Taiwan were invited to deliver keynote speeches regarding the latest information in their respective areas of expertise.

These proceedings present a selection from papers submitted to the conference by universities, research institutes, and industries. All the papers were subject to peer-review by conference committee members and international reviewers. The papers were selected based on their quality and their relevance to the conference. The volume presents recent advances in the field of mechanical and materials engineering as well as various related areas, including Materials Science, Biomaterials, Manufacturing Processes, and Mechanical Engineering, among others.

We would like to express our gratitude to all the members of the conference committee. We would also like to thank the reviewers, who spared their valuable time, for their advice. It has certainly helped improve the quality, accuracy, and relevance of each paper selected for the conference program and for publication. We also wish to thank all the authors who have contributed to this conference, as well as the organizing committee, reviewers, speakers, chairpersons, sponsors, and all the conference participants for their support for ACMME 2017.

Prof. Omar S. Es-Said, Loyola Marymount University, USA
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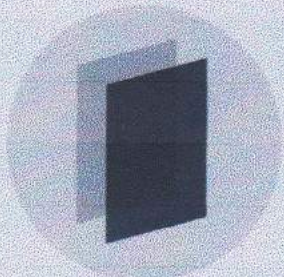
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Biomass Briquette Investigation from *Pterocarpus Indicus* Leaves Waste as an Alternative Renewable Energy

Willyanto Anggono¹, Sutrisno², Fandi D. Suprianto³, Jovian Evander⁴

^{1,2,3,4}Mechanical Engineering Department, Petra Christian University, Surabaya, Indonesia

^{1,2,3,4}Centre for Sustainable Energy Studies, Petra Christian University, Surabaya, Indonesia

E-mail: willy@petra.ac.id

Abstract. Indonesia is a tropical country located in Southeast Asia. Indonesia has a lot of variety of plant species which are very useful for life. *Pterocarpus indicus* are commonly used as greening and easily found everywhere in Surabaya city because of its characteristics that they have dense leaves and rapid growth. *Pterocarpus indicus* leaves waste would be a problem for residents of Surabaya and disturbing the cleanliness of the Surabaya city. Therefore, the *Pterocarpus indicus* leaves waste would be used as biomass briquettes. This research investigated the calorific value of biomass briquettes from the *Pterocarpus indicus* leaves waste, the effect of tapioca as an adhesive material to the calorific value of biomass briquettes from the *Pterocarpus indicus* leaves waste, the optimum composition for *Pterocarpus indicus* leaves waste biomass briquette as an alternative renewable fuel and the property of the optimum resulted biomass briquette using ultimate analysis and proximate analysis based on the ASTM standard. The calorific value biomass briquettes from the *Pterocarpus indicus* leaves waste were performed using an oxygen bomb calorimeter at various composition of *Pterocarpus indicus* from 50% to 90% rising by 10% for each experiment. The experimental results showed that the 90% raw materials (*Pterocarpus indicus* leaves waste)-10% adhesive materials (tapioca) mixtures is the optimum composition for biomass briquette *Pterocarpus indicus* leaves waste. The lower the percentage of the mass of tapioca in the biomass briquettes, the higher calorific value generated.

1. Introduction

Energy crisis is a concern because of the diminishing natural resources. Diminishing energy sources influence to the fuel prices. The fuel price will be increased due to the needs of a huge market but limited resources. Therefore, the renewable energy needed to meet the energy needs. Biomass is an alternative renewable energy. Biomass can be produced from wild plants, forest plants, plant waste, garbage, grass, etc. [1].

Biomass itself is much in demand by many people all over the world. It has been observed that the biomass is an alternative energy that can replace fossil fuels in the future. Indonesia is a tropical country with various types of plants. The plants in Indonesia have the potential to be used as biomass briquettes. *Pterocarpus indicus* is a plant road side which grow tall and large in Indonesia as shown at figure 1. The leaves of this plant often fall to the ground and the highway when the rain and heat as shown in figure 2 [2-5].





Figure 1. *Pterocarpus indicus* tree in Surabaya



Figure 2. *Pterocarpus indicus* leaves waste in Surabaya

Pterocarpus indicus plant is grown in tropical areas, particularly in parts of Southeast Asia. Surabaya is one of the city in Southeast Asia with a tropical climate, therefore *Pterocarpus indicus* trees can grow in the area of Surabaya, Indonesia. The *Pterocarpus indicus* tree can grow up to 15 meters' height and the rejected material of municipal waste can actually be used as biomass briquettes [6-9]. The *Pterocarpus indicus* leaves waste can be used as an alternative energy through the right process.

Table 1. Calorific values comparison of various wood [10]

Wood Type	Moisture Content (%)	Calorific Value (kcal/kg)
<i>Leucaena leucocephala</i>	10.13	4197
<i>Samanea saman</i>	10.36	3926
<i>Sesbandia grandiflora</i>	6.83	3965
<i>Glirisidia maculate</i>	23.97	4168
<i>Enterolobium cyclocarpum</i>	14.21	3948
<i>Hibiscus arborea</i>	10.33	4266
<i>Gmelina arborea</i>	9.24	4282

From the Table 1, it appears that *Gmelina arborea* (9.24 % moisture contents) has the highest calorific value of wood (4282 kcal/ kg), while *Samanea saman* (10.36% moisture contents) has lowest calorific value of wood (3926 kcal/ kg). The coal with better quality has the highest calorific value (6300 kcal/ kg at 2.1% moisture content) compare to all various wood [10].

2. Experimental Method

This study used *Pterocarpus indicus* leaves waste that they have already fallen from the plant. After collected, the leaves waste must be sun dried for three days. Biomass briquettes were made by

crushing dried *Pterocarpus indicus* leaves waste into the desired particle size (60 Mesh), mixing them with tapioca flour as a binder material, and compacting the mixtures under pressure (2 MPa). The calorific value biomass briquettes from the *Pterocarpus indicus* leaves waste were performed using a 1341 Plain Jacket oxygen bomb calorimeter Parr Instrument at various composition of *Pterocarpus indicus* leaves waste. The experiments in this paper were performed at various compositions of *Pterocarpus indicus* leaves waste biomass briquettes from 50% *Pterocarpus indicus* leaves waste (using 50% tapioca as a binder material) to 90% *Pterocarpus indicus* leaves waste (using 10% tapioca as a binder material) rising by 10% for each experiment. After that it will be tested heat values by using a bomb calorimeter.

3. Result and Discussion

Based on the experimental investigation using an oxygen bomb calorimeter, the calorific value of 100% *Pterocarpus indicus* leaves waste was 4909.89 kcal/ kg and the calorific value of 100% tapioca as a binder material was 3574.47 kcal/kg. The calorific value of biomass briquette from leaves waste *Pterocarpus indicus* at various composition mixtures are shown in Table 2 and the summary of the results from calorific value or calorific value of *Pterocarpus indicus*-tapioca mixtures at various composition are shown Figure 3.

The greater amount of tapioca the lower the calorific value of the biomass briquette *Pterocarpus indicus* leaves waste. The highest calorific value of the biomass briquette *Pterocarpus indicus* leaves waste was the biomass briquette using 90% *Pterocarpus indicus* leaves waste-10% tapioca mixtures as shown in figure 3. The 90% *Pterocarpus indicus* leaves waste-10% tapioca mixtures successfully creates the biomass briquette model as shown in figure 4. The composition of 90% *Pterocarpus indicus* leaves waste-10% tapioca mixtures using 60 mesh particle size was used as the best biomass briquette model.

Table 2. *Pterocarpus indicus* leaves waste biomass briquette calorific value of at various composition

Biomass Briquette Composition	Calorific Value (kcal/kg)
50% <i>Pterocarpus indicus</i> -50% tapioca mixtures	3913.16
60% <i>Pterocarpus indicus</i> -40% tapioca mixtures	4031.77
70% <i>Pterocarpus indicus</i> -30% tapioca mixtures	4155.85
80% <i>Pterocarpus indicus</i> -20% tapioca mixtures	4366.76
90% <i>Pterocarpus indicus</i> -10% tapioca mixtures	4648.15

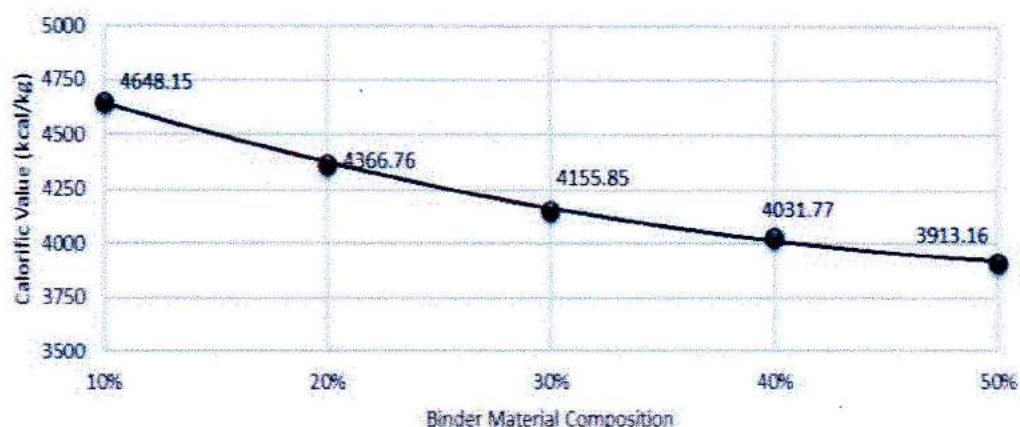


Figure 3. Effect of binder material to the calorific value *Pterocarpus indicus* leaves waste briquette



Figure 4. *Pterocarpus indicus* leaves waste biomass briquette

Tapioca as a binder material reduces the calorific value of the biomass briquette from leaves waste *Pterocarpus indicus*. The greater amount of tapioca, the lower the calorific value of the biomass briquette from *Pterocarpus indicus* leaves waste. In term of cost, the effective composition also 90%:10% because *Pterocarpus indicus* leave waste is cost free. The higher the percentage of tapioca in the biomass briquette from leaves waste *Pterocarpus indicus* the higher the cost of the biomass briquettes.

The proximate analysis and ultimate analysis also have been examined through a laboratory test. The test was carried using some ASTM standardization. The moisture content using ASTM D 2961-11. Fixed carbon calculation was examined using ASTM D 3172-13. The ash content was examined using ASTM D 3174-12. The volatile matter was examined using ASTM D 3175-11. The total sulfur was examined using ASTM D 4239-14E1. The gross calorific value was examined using ASTM D 5865-13. The proximate analysis result of *Pterocarpus indicus* leaves waste biomass briquettes (90% *Pterocarpus indicus* leaves waste and 10% tapioca) shows total moisture, fixed carbon, ash content, volatile matter, total sulfur and gross calorific value as shown in Table 3.

Table 3. Proximate analysis result of *Pterocarpus indicus* leaves waste biomass briquette

Test Method	Parameters	Unit	Value
ASTM D 2961-11	Total Moisture	%wt	5.2
ASTM D 3172-13	Fixed Carbon	%wt	15.3
ASTM D 3174-12	Ash Content	%wt	6.2
ASTM D 3175-11	Volatile Matter	%wt	73.3
ASTM D 4239-14E1	Total Sulfur	%wt	0.25
ASTM D 5865-13	Gross Calorific Value	kcal/kg	4648.15

Table 4. Ultimate analysis result of *Pterocarpus indicus* leaves waste biomass briquette

Test Method	Parameters	Unit	Value
ASTM D 5373-14	Carbon	%wt	49.12
ASTM D 5373-14	Hydrogen	%wt	6.67
ASTM D 5373-14	Nitrogen	%wt	0.19
ASTM D 4239-14E1	Sulfur	%wt	0.25
ASTM D 5373-15	Oxygen	%wt	33.40

The ultimate analysis result of *Pterocarpus indicus* leaves waste biomass briquettes (90% *Pterocarpus indicus* leaves waste and 10% tapioca) used to investigate the carbon, hydrogen, oxygen, nitrogen and sulfur concentration on the *Pterocarpus indicus* leaves waste biomass briquettes. The examination of

the proximate analysis using ASTM D 5373-14, ASTM D 5373-14E1 and ASTM D 5373-15. The result of ultimate analysis of *Pterocarpus indicus* leaves waste biomass briquettes shown in Table 4. The *Pterocarpus indicus* leaves waste biomass briquette has the highest calorific value compared to *Cerbera manghas* leaves waste biomass briquette (4164.00 kcal/kg), sawdust biomass briquette (4161.08 kcal/kg), sugarcane biomass briquette (3902.96 kcal/kg), rice straw biomass briquette (3926.86 kcal/kg) and coconut coir biomass briquette (4146 kcal/kg) [1,2].

4. Conclusion

Biomass briquette from *Pterocarpus indicus* leaves waste is an alternative renewable and sustainable energy and tapioca as a binder material play a role to the calorific value on the biomass briquette from *Pterocarpus indicus* leaves waste. The lower the amount of tapioca as a binder material, the greater the calorific value of the biomass briquette from *Pterocarpus indicus* leaves waste and the cheaper the cost of the biomass briquette from *Pterocarpus indicus* leaves waste. The biomass briquettes have been developed as energy source from *Pterocarpus indicus* leaves waste using 90% *Pterocarpus indicus* leaves waste and 10% tapioca as the optimum composition.

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