Conference Paper

# The Utilization of Metroxylon Sago (Rottb.) Dregs for Low Bioethanol as Fuel Households Needs in Papua Province Indonesia

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## Abstract

The rate of energy needs in Indonesia has increased and the availability of derived fuel energy from fossil has waned. It became worse because of the increase of the population growth, followed by the accretion of life needs that impact on the increase of fuel needs. As much as 55 % fuel oil is used for household industry and transportation. This condition motivates the government to develop alternative energies which are cheaper, renewable and environmentally friendly. One of them is the utilization of sago waste to produce bioethanol as alternative fuel source to fulfill the energy availability in our country especially in the provinces. The Sago potential in Indonesia is ± 1 250 000 ha, where ± 1 200 000 ha of which is in Papua. Thus, Papua has the largest sago potential in the world. This study was conducted to produce clean combustion processes that are healthy, fuel saving and environmentally friendly. The research method consisted of three steps; they were the production of bioethanol from sago dregs using fermentation, the test of fuel characteristics of lower heating value using a bomb calorimeter and the measurement of combustion efficiency with water boiling test as well as heat release rate using a cone calorimeter. The fuel used was bioethanol from sago waste that contained 60 % ethanol.

**Keywords:** Bioethanol; heat release rate; lower heating value; sago dregs.



## 1. Introduction

Acceleration of infrastructure development, particularly in the energy sector as the demand of fossil fuels is increasing in an inversely proportional rate to the energy supply available, and is unbalanced as, there are still area especially eastern Indonesian cities, that still lacks energy supply. However, the eastern region of Indonesia has the potential of new renewable energy sources such as biofuels from sago that can be utilized.Energy demand is constantly increasing due to population growth and the decreasing reserves of energy resources available. In addition, the main problem of the fossil fuel energy emission impacts on every state to immediately switch to producing and using renewable energy that is safe and comfortable [1].To reduce the consumption of the fuel, the government issued a Presidential Decree of Indonesia No. 5 of 2006 on national energy policy to develop alternative energy sources. The Indonesian government encourages biofuel consumption by 5 % of Indonesia's oil consumption, or 1.33 % of the total energy mix by 2025.The government set rules that will replace fuel oil $1.48 \times 10^9$ L of gasoline with bioethanol. It is estimated bioethanol requirements will increase by 10 % in 2011 to 2015, and 15 % in 2016 to 2025, thus the government require an average of $30.833 \times 10^6$ L of bioethanol / month [2].This condition motivates researchers to develop a cheaper alternative energy, renewable and environmentally friendly. One of them is the utilization of sago pulp to produce bioethanol fuel to meet the needs, availability and acces of potensial energy in the area. Utilization of sago dregs as biofuel energy has great potential due to availability in Indonesia, which has 1 250 000 ha of sago, where 1 200 000 ha is located in Papua [3]. Therefore, Papua became world sago potential that can be utilized to meet the 15 % of biofuel in Indonesia. Sago industry people in Papua is quite high produces dreg of waste sago disposed of into the environment so it heavily polluting environment, the research is carried to utilize sago dregs of bioethanol as a fuel for industrial use household fuel [4].

Sago (*Metroxylon sago* Rottb.) dregs are the waste generated from the processing of sago, rich in carbohydrates and other organic materials. The utilization of sago dregs is still limited and it is often discarded or relocated to the rivers around the region, thus pose as threat of pollution to the environment. Furthermore, Sago has economic value, thus utilizing it can increase the welfare of the farmers' develop, small and medium industries, maintain cultural wisdom, and create self sufficiency and local energy independence. This research is important because it address the problems of energy, especially the province of Papua. Utilization of sago waste need to be developed as bioethanol fuel in the household of the Papuan people, especially in remote areas that are not covered by government fuel distribution [5], thus the use of bioethanol low level of 60 % of the sago waste in this study is very feasible based on the results of laboratory tests, the concentration levels of ethanol, test lower heating value (LHV), test of heat release rate (HRR), and test of Flame Tip temperature, The test were conducted as a requirement for fuel [6]. Over the past few years, the amount of ethanol are needed for household appliances such as cooking and other hearth requirements for domestic purposes, but the need for further research to reduce the impact of accidental fire due to fuel and unsafe to use [7].

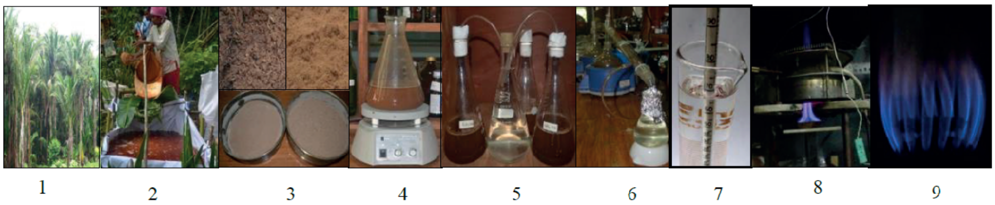


**Figure** 1: Road map of the research.

**Figure** 2: Sago waste pre-treatment.

## 2. Research Method

Sago dregs utilization research methods as bioethanol fuel for combustion in a household needs specific to remote areas such as Papua province of Indonesia can be seen on the roadmap of research in Figure 1.

The method in the picture 1 shows the potential of the sago tree forest in Papua, pic. 2 shows a traditional sago production process by the community, pic. 3 describes the dregs sago in material waste disposed of in the environment and can be utilized as a fuel, pic. 4 is a preheating process of preparation and hydrolysis process for the preparation of fermentation, pic. 5 is a fermentation process, pic. 6 is a distillation process low grade 45 % bioethanol, pic. 7 is a process of of purificationthe advanced stage of distillation bioethanol low levels of 60 %, pic. 8 is a test flame bioethanol on a cone calorimeter for measuring the temperature and the exhaust gases of combustion, pic. 9 is the result of the experimental results of bioethanol fuel combustion sago dregs very feasible as a fuel for remote areas in Papua province Indonesia.

### 2.1. Physical and Mechanical Pretreatment

Sago waste pretreatment is done to facilitate the conversion of sago dregs into cellulose and then into glucose using enzymes. The other function of the pretreatment procedure is to improve the waste components into carbohydrates. The production of bioethanol from sago residue pretreatment phase would require crushing the sago dregs to a particle size of 150 mesh.

| Parameter Test | Total |
|---|---|
| Physical | brownish |
| Water content | 16.3 % |
| Ash | 0.50 % |
| Proteins | 0.80 % |
| Fat | 0.01 % |
| Carbohydrate | 82.4 % |
| Crude fiber | 1.67 % |

Table 1: Characterization of Sago Dregs.

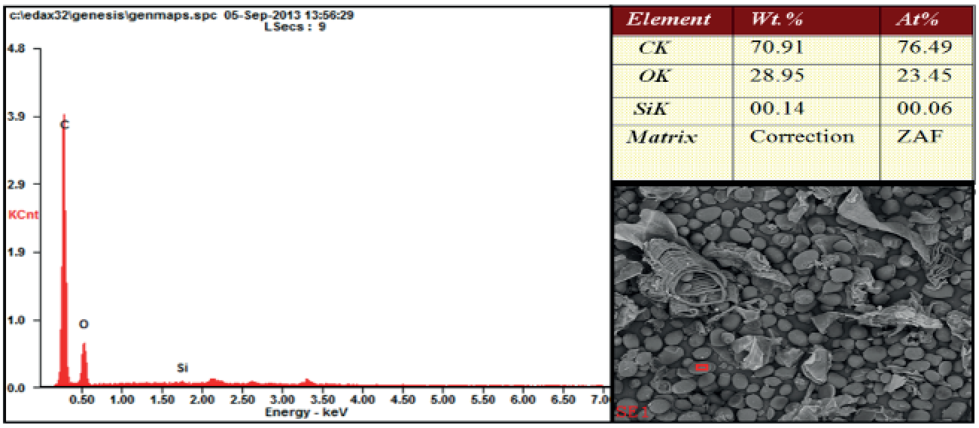


**Figure** 3: Photo SEM EDX.

## 2.2. Characterization of Sago Dregs

Characterization of Sago dregs showed that the content of cellulose and carbohydrates can be optimally used as an energy source of bioethanol.

Scanning Electron Microscopic EDX was conducted to describe the structure of the hydrocarbon components of sago dregs biasedin conversion to energy bioethanol.

## 2.3. Bioethanol Production from Sago Dregs

The production of sago dregs for bioethanol can be seen from the characterization results that the sago dregs contained 82.4 % carbohydrate, which was very decent as bioethanol candidate. Distillation was performed continuously. The first stage produced 40 % ethanol while the second stage produced 60 % ethanol.

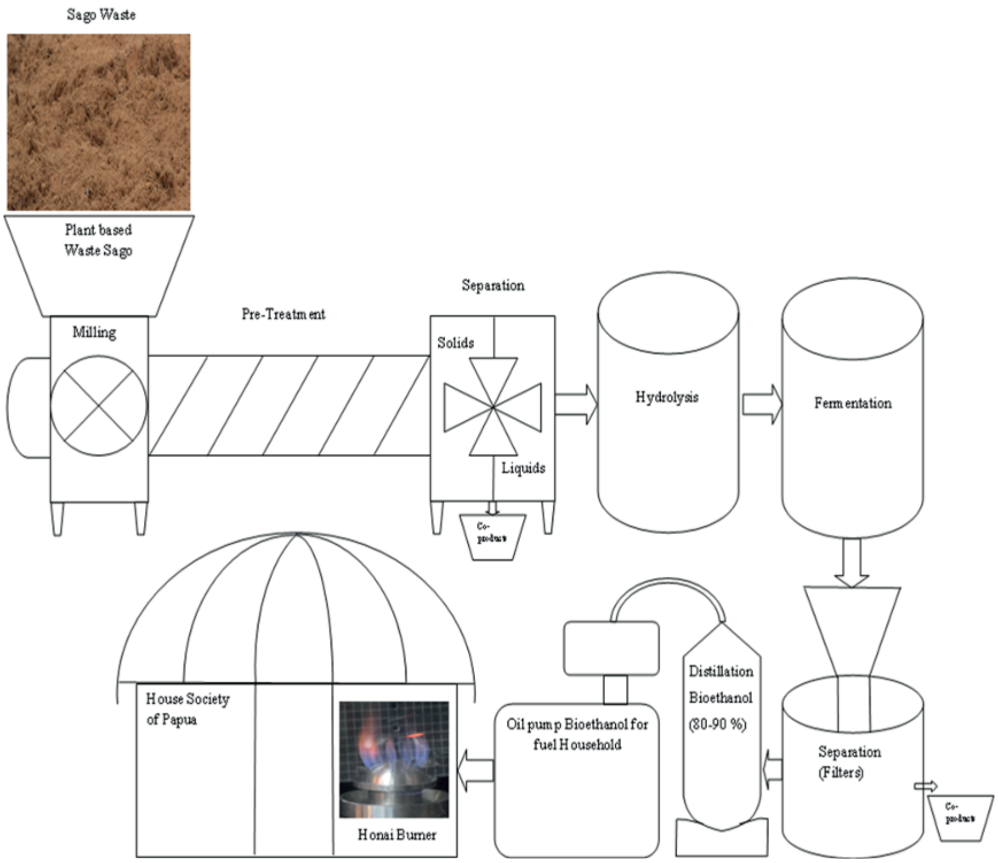


**Figure** 4: Schematic bioethanol production from sago waste.

## 2.4. Experimental Set-up for Heat Release Rate Test of Bioethanol using Cone Calorimeter

The experiment was conducted by using cone calorimeter to measure the heat release rate (HRR) and to test the exhaust gases of combustion of bioethanol sago dregs using gas analyzer, as a condition of cleaner fuels and environmentally friendly are an important aspects [7]. Principle the fireplace is filled with 200 mL of denaturised ethanol. The exhaust flow rate is fixed initially at 0.024 m3/s. Combustion occurs in ambient air, in quiet air velocity. A thermocouple is fixed to the bottom of the fireplace tank.The heat release rate is measured with an oxygen consumption calorimetry technique [8]. The heat release rate rate ▯ (t) (kW), is expressed in the standard (ISO 5660-1:2002) by the following Equation:

$$q = (13,1 \times 10^3) \cdot 1,10 \cdot C\sqrt{\frac{\Delta P}{Te}}\frac{(XO_2^{\circ} - XO_2)}{(1,105 - 1,5XO_2)} \quad (1)$$

The first objective is to characterize the heat and gases released by combustion ethanol in cone calorimeter, depending on the fuel used [9]. The second is to provide a source term of heat and gases for further analyses, for produces temperature distribution data and other gases of combustion products of fuel bioethanol sago dregs.

**Figure** 5: Experimental set-up for heat release rate.

# 3. Results and Discussion

## 3.1. Temperature Combustion Bioethanol

The data retrieval flame temperature distribution to 60 % bioethanol fuel using a cone calorimeter as a combustion chamber with a measurement using K-type thermocouple, the data of loger 9213 NI Compact DAQ 9174 to input data into the computer processed further as the graphic shown in Fig 6. Optimal temperature settings of fuel bioethanol 60 % occur at temperatures 1 and 2 are at 700 °C with a time of 200 min.

Flame temperature data collection was conducted by using a K-type thermocouple contained in the cone calorimeter. Fig 7 shows a graph of temperature vs. time on the combustion of 60 % bioethanol in the cone calorimeter. Phenomenon that occurs in the combustion chamber temperature of the fire showed an instability of the flame so that the temperature went down to 450 °C and the temperature of smoke increased (60 to 100) °C, while the temperature or office of temperature (40 to 80) °C, it can be concluded that low levels of bioethanol fuel 60 % can be used as household fuel.

## 3.2. Heat Release Rate Low Bioethanol

Heat Release Rate (HRR) is the rate of heat production or calorific value per unit time in release of a sample of the fuel due to the exothermic reaction after the activation energy is exceeded. The function of HRR is as a quantitative parameter of combustion events that can be identified and measured (kW/m$^2$) based on the characteristics of

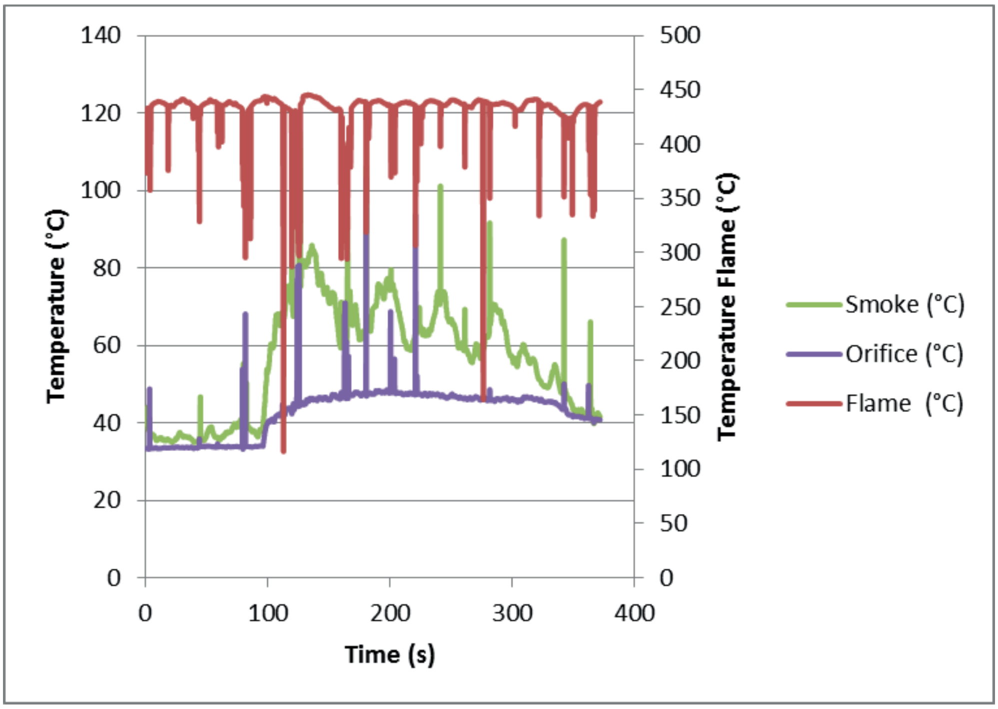


**Figure** 6: Temperature flame, orifice and smoke of 60 % bioethanol.

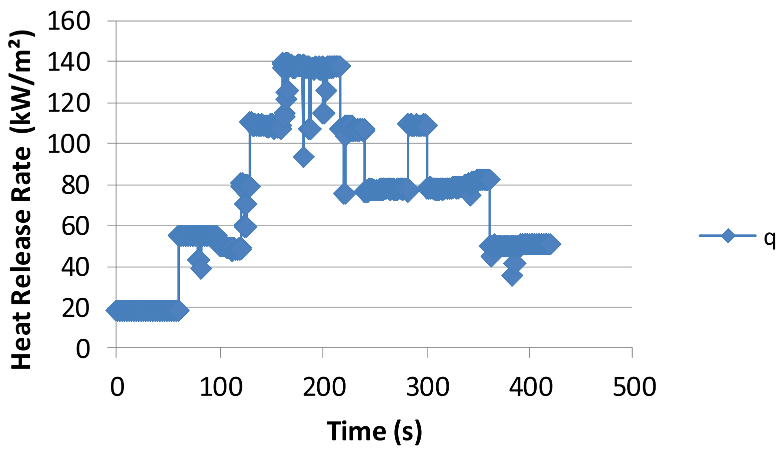


**Figure** 7: Heat Release Rate Low Bioethanol 60 % versus Time.

unwanted flame. The method used to measure heat release rate experimental with cone calorimeter. Figure 10 shows a graph of heat release rate of 60% bioethanol vs. time.

## 4. Conclusion

Based on the characteristics of calorific value of LHV which has already been tested in LEMIGAS, using ASTM-D.4809-09a., it was found that 60 % bioethanol fuel from the sago waste resulted in 14.584 MJ/Kg. Thus, the value from low level of 60 % bioethanol fuel could qualify for the combustion process. This is proved by the heat release rate

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tests with bioethanol content of 60 % by mass of 50 mL, with the cone calorimeter which gave out a result among (20 to 140) kW/m$^2$. Furthermore, for temperature measurement, the optimal combustion was at 450°C with about 6 min in the combustion process. Flame tip temperature measurement results for 60 % bioethanol could reach 700 °C. Therefore from this study, it can be concluded that 60 % bioethanol could be an alternative fuel for areas that are difficult to be reached by fuel distributors, such as Papua. The 60 % bioethanol from sago waste is very suitable to use in order to fulfill household daily needs in Papua regions.

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