# A Comparative study Of Catalityc Activity Of Heterogeneous Base Of Banana Stem Ash And Fly Ash On Production Of Biodiesel Byultrasonic

Marlinda, Ramli, Muh. Irwan

**Abstract**: The use of heterogeneous catalysts in the production of biodiesel provides many advantages due to heterogeneous catalysts can be easily separated from the product so that it can be reused. This research using heterogeneous catalysts derived from natural materials, namely banana stem ash and coal fly ash containing alkali and alkaline earth elements. The preparation of catalyst from banana stem ash and coal fly ash used activator KOH 1.9 N and impregnation with $KNO_3$ 15 % and then heated to a temperature of 550 $^0$C for 3 hours. Results of preparation, banana stem ash contains potassium of 36.52 % and surface area of 41.901 $m^2$/g. This work presents the effect of ultrasonic assisted of waste cooking oil with methanol as solvent using banana stem ash and coal fly ash as catalyst. The diameter of catalyst particles of banana stem ash and coal fly ash varied at 50, 100, 150, 200 and 250 mesh. The transesterification reaction was performed in the presence of ultrasonic operating frequency constant at 40 kHz, methanol molar ratio to oil of 9 : 1 and reaction time of 30 minutes. The methyl ester (biodiesel) content of product was 93.26 % of banana stems *ash* and 57 % of *coal* fly ash respectively. The physical property was compared with the National Indonesia Standard (SNI) 2006 with a density, viscosity, cloud point, flash point and cetane number.

**Keywords:** Biodiesel, Banana stem ash, catalyst, coal, fly ash, heterogeneous, transesterification, ultrasonic.

## 1 INTRODUCTION

In the agriculture sector, production of banana stems of the region East Kalimantan Province, Indonesia is 112,98 tons/years [3].Bananas can be grown in tropical region in both lowland and highland with an altitude of no more 1,600 m above sea level. Banana stem containsa lot of carbohydrates (11,6%)as well asmineralandvitamincontent. Banana stem also containspotassiumbasedashof33,4%, so it can be used as a source of catalysts[10]. Many coal used as fuel industry. Burning of coal produces around 5% solid pollutants in the form of ash where the ashis10-20% and80-90% bottom ash, the fly isgenerated[5].Coal fly ash generally disposed or arranged soon lyinan industrial area. Coal fly as haccumulation is problematic for the environment. Various studies on the use ofcoalfly ash is being done to improve its economic value and reduce its adverse effects onthe environment. Banana stemashand coal fly ashcan be used ash eterogeneouscatalysts which can be used for the production of biodiesel lfrom organic waste has potassium and silica. The use of heterogeneous catalysts in the production of biodiesel has many advantages because of this catalyst can be easily separated from the products by filtration, reusable, non-side products as the soap when reacted with free fatty acid (FFA), more environmentally friendly, cheaper and less corrosive[4]. Traditional production of biodiesel through transesterification of triglycerides with alcohol such as methanol in batch reactor. The objective of this work was to investigate the catalyticactivity between banana stem ash compared coal fly ash in the production of biodiesel using the new methods such as ultrasonication.


- *Marlinda : Chemical Engineering Department, State Polytechnic of Samarinda, Indonesia, E-mail: lin_syam@yahoo.co.id*
- *Ramli : Chemical Engineering Department, State Polytechnic of Samarinda, Indonesia, E-mail: ramli_polismd@yahoo.co.id*
- *Muh. Irwan : Chemical Engineering Department, State Polytechnic of Samarinda, Indonesia, E-mail: m_wandi99@yahoo.com*


## 2 MATERIAL AND METHODS

### 2.1Materials

The waste cooking oil used in this study was collected from KFC restaurant around the Samarinda City in East Kalimantan Province, Indonesia. Methanol used is analytical grade while the KOH used was also an analytical grade. The raw materialused is banana stem ashand coal flyash from the electric power company, TanjungBatu, KutaiKartanegara regency, East Kalimantan Province, Indonesia. Other major materials used include separating funnels, thermometer, beaker glass, etc.

### 2.2Preparation of catalyst

The hetero generous catalyst production of banana stemas hand coal fly ash is activated with 1.9NKOHsolutionanda catalystimpregnationwith$KNO_3$15% and then burned in afurnaceat a temperature of550 $^0$C. The spesific surface area of catalyst was determined by the BET method and potassium using AAS.

### 2.3 Transesterification

The transesterification process is conducted with waste cooking oil with a free fatty acid content of about 1%, reacted with methanolin the molar ratio to oil of1 :9, reaction time of30 minutes and ambient temperature(30$^0$C). Production of biodieselis done atultrasonic reactor, 2.5 L capacity, with frequency of40kHz.

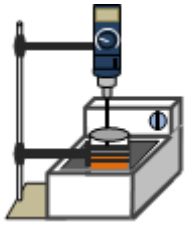

***Fig.1*** *Experimental set-up*

Variation of diameter banana stem ash and coal fly ash catalyst in the transesterification process is carried outto determine the effectdiametercatalyst forbiodieselproductionin terms ofcatalystactivity. The products were filtered and the filtrates were analyzed with GC-MS. Results of analysiscompared withbiodieselstandard such as National Indonesia Standard (SNI).

## 3RESULTS AND DISCUSSION

### 3.1 Environmental Friendly Catalyst

The catalyst prepared from organic waste of banana stem and coal fly ash. This waste can be a catalysts well as having a large surface area, the composition of the compounds present in the waste can be used as the base catalyst contains alkali and alkaline earth. The catalyst is activated before hand with KOH solution of 1.9 N and then impregnated with a $KNO_3$ solution with a concentration of 15% and burned on the temperature of 550 $^0$C for 3 hours. The following are the data of the result of organic waste catalyst preparation of the catalyst in Table below:

***Table 1*** *: Characterization of catalyst Banana Stem Ash and Fly ash*

| Substance | Composition | |
|---|---|---|
| Banana Stem Ash | Silica | 16.5 % |
| | Kalium | 23.3 % |
| | Magnecium | 30.8 % |
| | Other Compound (%) | 29.4 |
| | Surface Width | 41.9 $m^2$/g |
| Fly Ash | Silica | 32.1% |
| | Other Compound (%) | 64.7 |
| | Surface Width | 24.3 $m^2$/g |

The results in Table 1 shows that the level of potassium in the banana stem ash and alkali and alkaline earth compounds as the active catalyst is more abundant in the banana stem ash catalyst than coal fly ash as well as of the surface area of the catalyst. This is what will affect the catalytic activity of organic waste in the production of biodiesel.

### 3.2 Activity of Catalyst Banana Stem Ash and Fly Ash

Catalytic activity performed in the production of biodiesel through transesterification process of waste cooking oil and methanol using the banana stems ash and coal fly ash as catalyst. Transesterification process was done by using an ultrasonic at the constant frequency of 40 kHz with molar ratio of 1 : 9 within 30 minutes reaction times. The result of the catalyst activation at the variation of particle sizes can be shown in Figure 2. below :

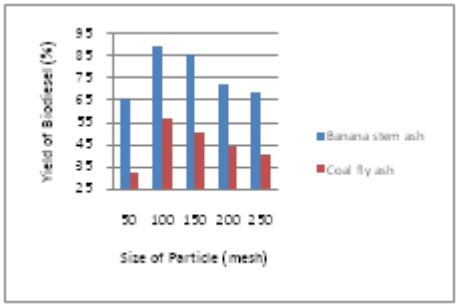


***Fig 2.*** *The correlation of particle size and biodiesel yield*

Figure 2 show the activity of the catalyst particle diameter variation. The banana stem ash and coal fly ash catalysts are heterogeneous base catalyst. Therefore, they are not in the same phase as the reactants. It is shown from the graph that the greater the mesh is, the smaller particle size gets which in turn will result in the smaller amount of the biodiesel yields. The particle size of 100 mesh produces the maximum possible yield of biodiesel and the larger the particle size is much as >100 mesh it will produce smaller biodiesel yield. Meaning that the smaller the particle diameter gets, the less catalytic activity results in will give. The catalytic activity is them seam from the levels of methyl esters produced from the transesterification reaction between the waste cooking oil and methanol as solvent. Level of methyl ester at the transesterification process of waste cooking oil with banana stem ash and coal fly ash catalyst can be seem in Figure 3. below:

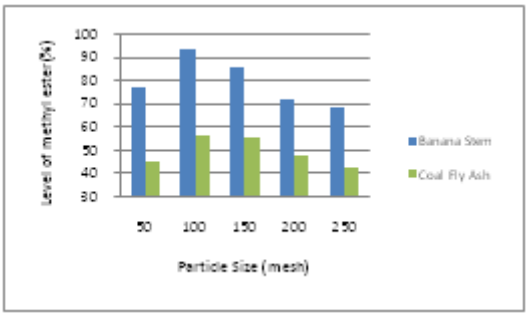


***Fig 3.*** *The correlation between the level of methyl ester and the catalyst particle size*

Figure 2 and 3 show that the use of a heterogeneous catalyst from banana stem ash and coal fly ash at the particle size of >100 mesh produces biodiesel yield and the level of methyl esters decrease. This is due to the use of an agitataor (mixer) and ultrasonic waves in the reactor, therefore the catalyst, which has a smaller particle size causes collisions between catalyst particle occur more quickly so that the catalyst is easy to clash or stuck in the wall of the column. The catalyst which is retained in the column wall can reduce the number of reactants adsorbed on the active surface of the catalyst. Decreasing the amount of adsorbed reactants reduces the chances of triglycerides transesterification reaction with mrthanol, causing a decline in the value of the yield of

biodiesel and biodiesel methyl ester levels. In addition, the effect of ultrasonic waves in solid-liquid heterogeneous systems the occurrence of cavitation as results of the presence of ultrasonic waves on the surface of the catalyst particles will lead to the formation of liquid jets. The liquid jets can expand the catalyst surface and increase the mass transfer of reactant to the catalyst surface [6]. Heterogeneous base catalytic activity in banana stem ash and coal fly ash has the same activity profile, but the banana stem ash has a better catalyst activity due to production of yield and levels of methyl ester biodiesel which are greater than coal fly ash. This can be due to the banana stem ash catalyst has more catalyst active side. It can be seen because of the abundant alkali and alkaline earth compounds in the composition of banana stem ash compared with fly ash (XRD analysis). So is the surface area of the banana stem ash catalyst which is larger than coal fly ash so that the nature of absorbing the reactants is much larger than the fly ash so that the reaction between triglycerides and methanol is the surface of the catalyst and catalyst in the banana stem is much more than fly ash that the product created are the yield of biodiesel and biodiesel methyl ester content is greater than coal fly ash catayst. catalitic activity of banana stem ash and coal fly ash on the transesterificationof waste cooking oil and methanol can be used as heterogeneous base catalyst. But the catalytic activity of banana stem ash has a higher level of activity than coal fly ash. The structure of coal fly ash is similar to zeolites, the structure of fly ash has many advantages but its catalytic activity in the transesterification reaction is relatively low. This is mainly due to the limited diffusion of the triglycerides reactants in to the micro porous structure of fly ash [12].The catalyst banana stem ash is more reactive to the transesterification process than the catalysts fly ash because, trigeliseridadiameter larger than the poredimeter fly ash so that the reaction occurs only on the surface of the catalystal one, in addition to the fly ash has a high acid content that requires modification of better catalysts again because the activecatalystin the fly ash is still not sufficient for reactivity in the transesterification reaction. Production of biodiesel produced in the coal fly ash catalysis much smaller than the banana stem ash. Fly ash turns the reactant into catalyst only on the surface of the catalyst so that the course of the raction only on an external crystal of the fly ash. Fly ash catalyst requires much more reactants to the same conditions than the banana stem ash. The characteristics of biodiesel produced with the use of organic waste catalyst shown in the Table2.as follows:

***Table 2:*** *Characteristics of Biodiesel*

| **Properties** | **SNI Standard** | **Biodiesel** |
|---|---|---|
| Density (kg/m$^3$) | 850 – 890 | 878.5 |
| KinematicViscosity, mm$^2$/s | 2.3 – 6.0 | 5.13 |
| Cetane Number | Min.51 | 52 |
| Flash point ($^o$C) | Min.100 | 129.4 |
| Cloud point ($^o$C) | 18 max | 12 |
| Water Content (%-v) | 0.05 max | 0.0293 |
| Alkyl ester levels (%-m) | 96.5 min | 97 |
| Acid number (mg KOH/g) | 0.8 max | 0.4837 |

Tabel2 shows that the characteristics of biodiesel meet the Indonesian National Standard (SNI), so the quality of the biodiesel is good. The utilization of organic waste catalyst from the banana stem ash and coal fly ash can be used as a heterogeneous base catalyst to production of biodiesel. The characteristics required to determine the feasibility of biodiesel in its application to diesel engine as fuel so that the fuel must meet the safety characteristics of the diesel engine.

## 4 CONCLUSION

Catalyst banana stem ash and coal fly ash can be used as heterogeneous catalyst in production of biodiesel using feedstock of waste cooking oil. Catalyst particle size can affect the production of biodiesel. A particle size of 100 mesh produce maximum biodiesel yield in banana stem ash by 89% compared 63% of coal fly ash catalyst. Catalytic activity banana stem ash is better than coal fly ash with the same ratio of reactants. Banana stem ash and fly ash can be used the base catalyst by means of amodified heterogeneous catalyst with impregnation and activation catalyst so that more activity catalyst in biodiesel production process.Reactivity catalyst banana stem ash larger than the coal fly ash because the banana stem ash have a greather alkaline composition while the fly ash has a silica content greater.

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## REFERENCES

[1] Anshary IM, OktaviaDamayant., Rosyadi A. Biodiesel from Palm Cooking Oil with Double Conection Catalysts and Fixed Bed Reactor, POMITS Engineering Journal, Vol 1, 1-4, 2012.

[2] Atkins P.W. Chemical Phisic. University Lecturer and Fellow Of Lincoln College, Oxford. Jakarta.1990.

[3] Ediati., R., D. Prasetyoko and Samik., Effect of Catalyst Surface Basicity and Activity Against Bases Heterogeneous Catalysts for Biodiesel Production. 1- 6, 2012.

[4] Eka, G.P., Shukri and Zulhajri. Synthesis and Characterization of Catalyst Cobalt And Copper Immobilization And Testing At mesoporous silica catalyst activity In Palm Oil Transesterification Reaction. 23-27, 2012.

[5] Marlinda, Ramli, Muh, Halim. 2013 Effect of Activators Against Performance Heterogeneous Catalysts Bases TKKS On Making Biodiesel Assisted By Ultrasonic. The IRWNS Proceeding, 250 - 254, 2013.

[6] Mohapatra D, Misha S and Sutar N., Banana Productions and its utilization by an overview. Journal of Scientific And Industrial Research, vol 69, 323-329. 2010.

[7] Ridlo, R., Optimization of Biodiesel Production Process from Palm Oil and Jatropha with Potassium Oxide Using Heterogeneous Catalysts.

[8] ISO., Indonesian National Standard Biodiesel. Jakarta: The National Standardization Agency.

[9] Siska, EK, Pujirahayu, A, and Widodo, H., Modification of waste fly ash as adsorbent CongoRed Textile Dyes Environmentally Friendly Industrial Pollution in Efforts to Overcome In Surakarta batik., 2010.

[10] Soerawidjaja, TH, Scientific Foundations and Technicality of Biodiesel Technology. National Conference Energy Alternative. 2010.

[11] Widayat and Agam, DKW. 2013 Biodiesel Production Process Technology. EF Digimedia Press. Semarang.