# Rice Husk Waste: Impact on Environmental Health and Potential as Biogas

*by* Hashfi Hawali

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# Rice Husk Waste: Impact on Environmental Health and Potential as Biogas

Hashfi Hawali Abdul Matin[1,4*], Syafrudin[2], Suherman[3]

[1]Doctor Program of Environmental Science, School of Post Graduate Studies, Universitas Diponegoro, 50275 Semarang, Indonesia

[2]Department of Environmental Engineering, Faculty of Engineering, Universitas Diponegoro, 50275 Semarang, Indonesia

[3]Department of Chemical Engineering, Faculty of Engineering, Universitas Diponegoro, 50275 Semarang, Indonesia

[4]Department of Environmental Science, Faculty of Mathematics and Natural Science, Universitas Sebelas Maret, 57126 Surakarta, Indonesia

(*Corresponding Author: hawalihashfi@staff.uns.ac.id)

**ABSTRACT:** Indonesia is an agricultural country with dry milled grain production reaching 55.6 million tons in 2022. Besides producing an abundance of rice, milled dry rice also produces waste in the form of rice husks. The handling of rice husk waste is mostly by burning where the smoke from burning is toxic so it has a bad impact on environmental health. In this research, a study was carried out regarding the impact of improper management of rice husks on environmental health and the utilization of rice husks into biogas energy was carried out and a study was carried out regarding its potential in Indonesia. Air quality measurements were carried out in areas that were burning rice husks on the parameters SO2, CO, NO2, and PM10 with reference to the method of the Indonesian National Standard. Anaerobic laboratory scale research was carried out to convert rice husk into biogas. Chemical pretreatment was carried out with 3% NaOH and the C/N ratio was determined to be 25. Condition variations were determined for L-AD with 7% TS and SS-AD with 17% TS. It was found that burning rice husks have a negative impact on environmental health. This is indicated by the $SO_2$ and $PM_{10}$ parameters exceeding the quality standards, namely 167 and 132 $\mu$g/m3 and the $NO_2$ parameter almost reaching the quality standard, namely 178 $\mu$g/m3. Generated rice husk can be converted into renewable energy in the form of biogas with good productivity in SS-AD conditions with biogas production reaching 75.2 mL.gTS-1. Biogas potential from rice husks reaches 1.5 million liters of biogas, it can be used as a support for energy security for Indonesia.

Keywords: Rice husk, environmental health, biogas energy

## 1. Introduction

Indonesia is an agrarian country with the majority of the population working in the agricultural sector. According to the Official Statistical News No. 74/10/Th. XXV which was released on October 17 2022 by the Central Statistics Agency (BPS), the harvested area of rice plants reached 10.6 million hectares with production in the form of dry milled grain (GKG) of 55.6 million tonnes. If converted into rice, rice production is estimated to reach 32.07 million tonnes (Statistik, 2022). Of course this is good news where Indonesia is a country with a staple food in the form of rice so that one of the food sectors can be fulfilled properly. However, it also needs to be understood that GKG does not completely turn into ready-to-cook rice. Rice obtained from GKG is 64.02% and the rest is waste in the form of rice husks. If calculated, in 2022 there will be an estimated generation of rice husk waste of 20 million tons.

Based on (Nugraha et al., 2018; Putri et al., 2019), the utilization of rice husks is currently still relatively low, usually used as a planting medium where some are made into charcoal first and some are left intact in their original form. Other uses are used as fuel for making bricks

and some are used for cooking fuel, as animal feed, and made into briquettes, but the amount is very small. In research conducted by (Ningsih et al., 2012) stated that rice husks can be used as a mixture of cement raw materials where utilization can reach 5%. The research was carried out on a laboratory scale and needs to be scaled up and further developed. Most of the handling of rice husk waste is by burning it. Usually carried out directly by farmers after the main harvest period. Farmers have the notion that burning rice husks can make paddy fields fertile and ready for replanting (Goodman, 2020). However, this is not in accordance with research conducted by (Glushankova et al., 2018)) which stated that burning rice husks can reduce nutrients in the area used to burn the rice husks. Besides having a bad impact on the soil, burning rice husks also causes other problems in the form of air pollution. According to (Bodor et al., 2022; Zorena et al., 2022), the combustion process will release various pollutants such as $SO_2$, $NO_2$, CO, $O_3$, Pb, $PM_{10}$, and $PM_{2.5}$ which can be detrimental to environmental health. Air pollution affects humans, animals, including plants.

Rice husk waste is included in the class of organic waste from agricultural activities (Achinas et al., 2017). Currently, biogas technology is being developed using agricultural waste (biomass) as raw material, where initially biogas technology only used livestock waste (Matin et al., 2020). Of course this trend is very good for an agrarian country like Indonesia where the generation of organic waste from agricultural activities is very high. Biogas is a technology that utilizes microorganisms anaerobically and converts organic waste into methane gas and other gaseous elements. Biogas is also a renewable energy because the production process uses simple raw materials and does not require a long time (Budiyono et al., 2022, 2021; Sumardiono et al., 2022).

In this research, a study was conducted regarding the impact of rice husk waste on environmental health if not managed properly. Furthermore, it is utilized as a renewable energy in the form of biogas and a study is carried out related to the potential of rice husk to become biogas energy in Indonesia.

## 2. Materials and Methods

Measurement of ambient air quality was carried out in Rowosari Village, Tembalang District, Semarang City. Measurements were made twice during the main harvest and many farmers burned rice husks. The measurement method is based on the Indonesian National Standard (SNI) under Government Regulation No. 22 of 2021 concerning the Implementation of Environmental Protection and Management. The parameters tested included: Sulfur Dioxide

($SO_2$) with SNI 7119-7-2017, Carbon Monoxide (CO) with SNI 7119-10-2011, Nitrogen Dioxide ($NO_2$) with SNI 7119-2-2017, and Particulate Matter 10 ($PM_{10}$) with SNI 7119-15-2016. In measuring $SO_2$, CO, and $NO_2$ parameters using Impinger and for $PM_{10}$ parameters using High Volume Air Sampler (HVAS).

The raw material used for biogas production is rice husk taken from the Rice Milling House in Rowosari Village, Tembalang District, Semarang City. Another ingredient used is cow rumen liquid taken from the Penggaron Animal Slaughterhouse. Cow rumen liquid is used as a starter. 3% NaOH was used for chemical pretreatment for 24 hours. The C/N Ratio parameter was determined to be 25 and adjusted by adding technical urea. Total Solid (TS) parameters are set in two conditions, namely Liquid State Anaerobic Digestion (L-AD) and Solid State Anaerobic Digestion (SS-AD). In L-AD with 7% TS and in SS-AD with 17% TS.

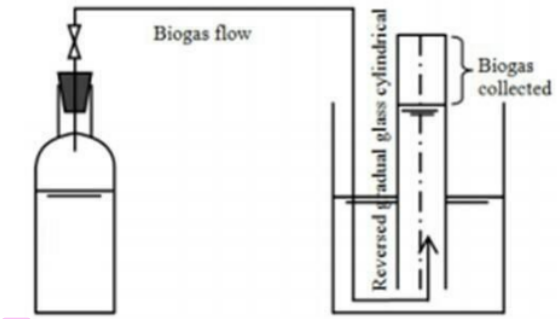


**Figure 1. Series of Research Tools in the Laboratory**

The research was carried out on a laboratory scale. The biogas reactor is assembled from a polyethylene bottle with a volume of 1 liter, with a top made of rubber equipped with a valve that can be opened and closed for the process of measuring biogas production. Biogas measurements were carried out using the water displacement method (Budiyono et al., 2022; Sumardiono et al., 2022) and also carried out every other day for 60 days (biogas was no longer formed significantly). The series of biogas reactors and their measurements can be seen in Figure 1.

## 3. Results and Discussions

### 3.1 Impact of Burning Rice Husk on Environmental Health

Ambient air quality measurements were carried out twice in order to obtain accurate data and also follow the SNI method for each parameter. The results of ambient air quality measurements can be seen in Table 1. There were 2 parameters that exceeded the quality standards, namely $SO_2$ 167 $\mu$g/m3 and $PM_{10}$ 132 $\mu$g/m3. Then the parameters for CO 200

$\mu$g/m3 and $NO_2$ 178 $\mu$g/m3 are still below the quality standard, but for $NO_2$ it is at the upper limit so that it almost reaches the quality standard.

**Table 1. Ambien Air Quality Measurement**

| No | Parameter | Measurement Result ($\mu g/m^3$) | Quality Standard ($\mu g/m^3$) |
|---|---|---|---|
| 1 | Sulfur Dioxide ($SO_2$) | 167 | 150 |
| 2 | Carbon Monoxide (CO) | 200 | 1,000 |
| 3 | Nitrogen Dioxide ($NO_2$) | 178 | 200 |
| 4 | Particulate Matter 10 ($PM_{10}$) | 132 | 75 |

The process of burning rice husks openly and at uncontrolled temperatures is included in incomplete combustion resulting in quite high air pollutants. Perfect combustion then only produces $CO_2$ and $H_2O$ (Oluwoye et al., 2020). Rice husk has a high lignin content so that when it is placed and allowed to stand in an open space, it will retain its shape due to the difficulty of being degraded by microorganisms (Nugraha et al., 2020; Syafrudin et al., 2020). The lignin content in rice husk forms the outermost layer so that the contents in it such as cellulose and hemicellulose are difficult to decompose naturally (Matin and Hadiyanto, 2018). Utilization of rice husks, such as being used for planting media, then used as fuel for making bricks, is still very low and has not been able to reach all of the rice husks, especially during the main harvest. This condition causes many farmers to burn rice husks.

The smoke from burning rice husks is toxic to humans and animals. Air that has been contaminated with pollutants from combustion can cause eye and nose irritation, difficulty breathing, coughing, and headaches. People with heart disease, asthma, emphysema or other respiratory ailments are particularly sensitive to air pollution. Other health problems exacerbated by burning waste include lung infections, pneumonia, bronchiolitis and allergies (Budhy et al., 2021). Exposure to these $SO_2$, CO, $NO_2$ and $PM_{10}$ substances and consuming food contaminated with ash and smoke in the long term has the risk of causing certain types of cancer, liver disorders, immune system disorders, and reproductive system disorders (Hu et al., 2020; Sunarsih et al., 2019).

Burning rice husks in paddy fields which are considered to be able to fertilize paddy fields is also another reason why farmers do this. Whereas according to (Glushankova et al., 2018), rice husks that are burned in rice fields can cause nutrients to be lost, especially in volatile nutrients. Loss of nutrients without being accompanied by the return of these elements

into the soil will result in an imbalance in the balance of nutrients in the soil so that it will reduce the level of soil fertility and lead to a decrease in crop production and productivity.

### 3.2 Potential of Rice Husk as Biogas Energy

In this section, a study is carried out on the effect of L-AD and SS-AD on the production of biogas made from rice husk. In the L-AD variable, biogas appeared starting from the 8th day of 19 mL. This L-AD variable was recorded to produce a maximum daily biogas production of up to 56 mL on the 32nd day. Furthermore, on the SS-AD variable, biogas has appeared since the 2nd day of 25 mL. This SS-AD variable was recorded to produce a maximum daily biogas production reaching 107 mL on the 46th day. Cumulatively, biogas production at L-AD and SS-AD variables for 60 days was 433 mL and 1.278 mL. Cumulative biogas production in detail can be seen in Figure 2.

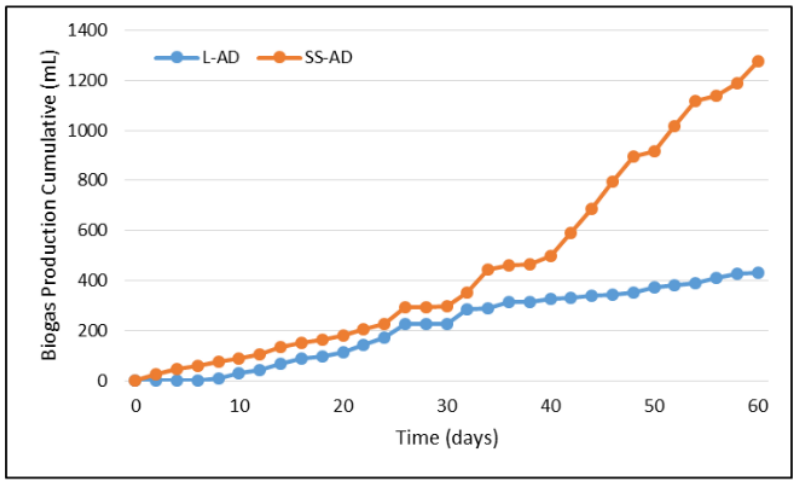


**Figure 2. Biogas Production Cumulative on TS 7% (L-AD) and TS 17% (SS-AD)**

When viewed cumulatively as presented in Figure 2, the SS-AD variable shows very good biogas productivity compared to L-AD, with a biogas difference of up to 845 mL. However, if we examine more deeply the study of calculations per unit-TS, it is found that between L-AD and SS-AD the difference in productivity is not too great. It can be seen in Figure 3, the cumulative biogas production on the L-AD variable is 61.8 mL.gTS$^{-1}$ and on the SS-AD variable is 75.2 mL.gTS$^{-1}$. The difference between the two is only 13.4 mL.gTS$^{-1}$.

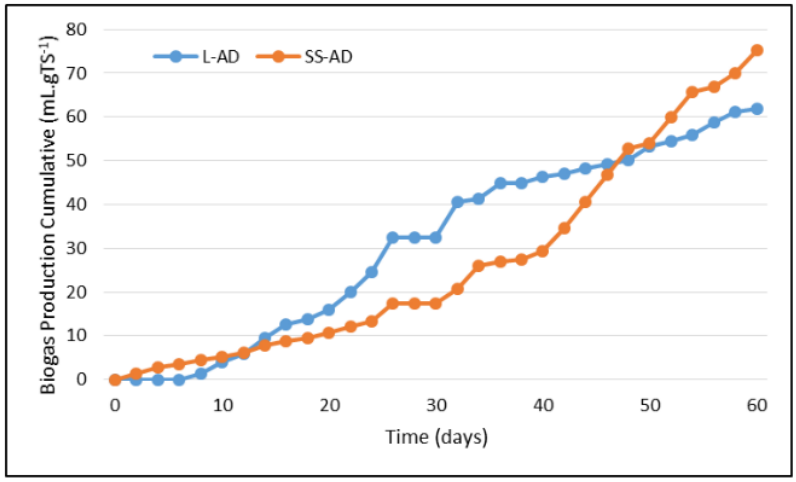


**Figure 3. Biogas Production Cumulative per unit-TS on TS 7% (L-AD) and TS 17% (SS-AD)**

When compared between the two, the difference in biogas production per unit-TS is not significant, but SS-AD has various advantages so that this variable is superior. Based on (Brown et al., 2012; Budiyono et al., 2021; Li et al., 2011; Matin and Hadiyanto, 2018; Yang et al., 2015), SS-AD has better biogas productivity, then in one period of anaerobic fermentation, SS-AD can accommodate more solid waste so it can degrade more organic solid waste, and has a by-product in the form of organic fertilizer which is also more many.

The potential of rice husk waste to be used as renewable energy in the form of biogas is very large, especially in an agricultural country like Indonesia (Nugraha et al., 2020). In Indonesia, in 2022 it will produce 55.6 million tons of dry milled grain (GKG). From the GKG data, 64.02% goes into rice and the rest is rice husk waste. So that it can be calculated that rice husk production in Indonesia in 2022 will reach 20 million tons. This is a big problem if rice husks cannot be handled properly. If all of this waste is burned, what will happen is a massive degradation of health and environmental quality. However, if it is converted into renewable energy in the form of biogas, the potential obtained is 1.5 million liters of biogas. If all generated rice husk waste can be managed properly, it can be used as a support for energy security for Indonesia and on the other hand sources of air pollution originating from agricultural activities, especially burning rice husks can be significantly reduced.

## 4. Conclusion

The results of burning rice husks have a negative impact on environmental health. This is indicated by the $SO_2$ and $PM_{10}$ parameters exceeding the quality standards, namely 167 and 132 $\mu$g/m3 and the $NO_2$ parameter almost reaching the quality standard, namely 178 $\mu$g/m3. Generated rice husk can be converted into renewable energy in the form of biogas with good productivity in SS-AD conditions with biogas production reaching 75.2 mL.gTS$^{-1}$. Rice husk to be used as biogas is very potential and can be done. By utilizing rice husk to become biogas, it can suppress the emergence of air pollutants originating from agricultural activities and can also be a source of energy security support for Indonesia.

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