Journal of Advanced Research in Social Sciences and Humanities
Volume 7, Issue 4 (189-198)
DOI: https://dx.doi.org/10.26500/JARSSH-07-2022-0405

Simple Incinerator Model with Wet Coconut Filters for Mask Waste Treatment in Banjarbaru, South Kalimantan

Sumi Kartika[1*], **Husaini**[2], **Eko Suhartono**[3], **Meitria Syahadatina Noor**[4], **Nelly Al Audhah**[5]
[1,2,3,4,5] Public Health Master Program, Faculty of Medicine, Lambung Mangkurat University, South Kalimantan, Indonesia

Abstract

Aim: Based on data from the 2019 Population Census, the population of Banjarbaru City is 262,719 people; if as many as 50% of the people of Banjarbaru City use masks, approximately 135,200 masks are generated per day, or 4,056,000 masks waste per month. To analyze the effect of the incinerator on CO, CO_2 and NO_2 exhaust gases of mask waste before using wet coconut fiber and after using wet coconut fiber.

Methodology: This research method uses the experimental method. The experimental design in this study is a pre-experimental design by providing treatment and measuring the results of the treatment carried out pretest and post-test. The research was conducted at the Mustika Graha Asri Housing Complex RT 11 RW 01 Loktabat Utara Banjarbaru, South Kalimantan, in April 2022.

Findings: From the results of statistical data processing using the paired *t*-test method, CO exhaust gas was obtained with a significance value of 0.853 ($p > 0.05$), CO_2 with a significance value of 0.002 ($p < 0.05$) and NO_2 with a significance value of 0.801 ($p > 0.05$). The exhaust gas that has a significant difference before and after using the wet coconut fiber filter is CO_2 exhaust gas, while there is no significant difference between CO gas and NO_2 exhaust gas. Many shortcomings still need to be addressed so that the combustion process in this simple incinerator is more optimal.

Implications/Novel Contribution: The present study advances knowledge by comprehensively summarizing mask waste treatment using wet coconut filters. Additionally, this research offers useful information on the entire installation procedure and necessary tools.

Keywords: Incinerators, mask waste, coconut fiber, exhaust gas.

Received: 15 August 2022 / **Accepted:** 3 October 2022 / **Published:** 23 December 2022

INTRODUCTION

Corona Virus Disease (COVID-19) was first discovered in Wuhan, China, on December 13, 2019. In humans, it usually causes respiratory tract infections, ranging from the common cold to serious diseases such as Middle East Respiratory Syndrome (MERS) and Severe Acute Respiratory Syndrome. Syndrome (SARS). COVID-19 has spread widely and quickly in several countries (Axmalia & Sinanto, 2020).

Based on WHO recommendations and considering disease development in Indonesia, the Indonesian government implements health protocols, including using masks when leaving the house. Masks are a must, so the volume of mask waste in the community is very high. Indonesia and other Asian countries ranked first in terms of the use of masks during the pandemic. Recent studies estimate that humans now use 129 billion masks every month worldwide.

Based on the 2019 Population Census data, the population of Banjarbaru City is 262,719 people; if as many as 50% of the people of Banjarbaru city use masks, approximately 135,200 masks waste is generated per day or 4,056,000 masks waste per month. Another study with review results stated that 75.9% of household respondents in Padang, West Sumatra, disposed of medical masks and mixed them with other waste, 6.02% of respondents disposed of masks in a separate place, and 18.07% of respondents cut masks first before throwing them away (Krah, Harahap, et al., 2019; Laelasari, 2021; Qin, Liu, Richman, & Moncur, 2005).

The use of masks during the COVID-19 pandemic can reduce the risk of contracting, but there is a potential problem with the help of masks, namely the waste caused by the environment. Disposable masks are made of

*Corresponding author: Sumi Kartika
†Email: sumikartika89@gmail.com

polypropylene or one type of plastic. Plastics take hundreds of years to decompose.

Based on the guidelines regarding the management of mask waste in the community issued by the government, masks are not classified as medical waste. Thus, the management is the same as domestic household waste following Law 18 of 2008 concerning waste management. However, in a pandemic like today, mask waste is a factor in the spread of the virus because it contains virus droplets that can potentially infect others if not appropriately managed (Ferreira et al., 2018; Sujiono, Zabrian, Zharvan, Humairah, et al., 2022; Sangkham, 2020).

An incinerator is a combustion furnace to treat solid waste, which converts solid waste into gaseous matter, and ash (bottom ash and fly ash). Incinerator with the incineration process is a reliable waste treatment process by burning at a temperature of more than 800^{o}C to reduce combustible until it cannot be recycled and to kill bacteria, viruses, and toxic chemicals from the waste (de Oliveira Cruz, Gomes, Tonetti, & Figueiredo, 2019; Shahbaz, Jam, Bibi, & Loganathan, 2016; Latief, 2010).

Several studies on incinerators have been carried out. Research reveals that simple incinerators can be made using drums and air conditioning blowers. The incineration process's advantage causes the waste volume to be reduced significantly (> 65%). Incinerator technology is a waste destruction device carried out by burning at high temperatures and is integrated; the operation is easy and safe because the emission output produced is environmentally friendly. However, in this study, the emissions resulting from combustion have not been measured (Apolonio, 2020; Dewi, Hadinata, Yulindasari, & Aminuddin, 2020; Li, Wang, Liu, Wang, & Song, 2022).

Another study stated that reducing motor vehicle air pollution could use a filter made from coconut fiber to develop a Diesel Particulate Filter (DPF) filtering system to capture particles as emissions. This situation can be caused because the fiber bonds from the coconut coir can block the particles trapped in the filter and cause the particle concentration to be lower (Lolo, 2014; Shahbaz, Tiwari, Jam, & Ozturk, 2014). Coconut fiber contains 43.44% cellulose. A filter from coconut fiber can reduce particle emissions in mainstream smoke (Faslah, Ponco, & Widodo, 2013).

Thus, the researchers studied the "Simple Incinerator Model with Wet Coconut Coir Filter for Mask Waste Treatment in Banjarbaru, South Kalimantan", as an alternative for safer processing of mask waste in the community and environmentally friendly.

Research Objectives

The purpose of this study was to analyze the effectiveness of the incinerator against CO, CO_2 and NO_2 exhaust gases from mask waste before using wet coconut fiber and after using wet coconut fiber.

Research Methods

This type of research uses quantitative research with experimental methods. The experimental design in this study is a pre-experimental design by providing treatment and measuring the results of the treatment or treatment carried out before and after (pretest-posttest). In this study, a simple incinerator design model will be carried out to treat household mask waste by adding a wet coconut fiber filter used during the incineration process. According to Adiputra, Giriantari, and Kumara (2019), The incinerator is said to be efficient if it has an efficiency of 99.5%.

This research was conducted at the Mustika Graha Asri Housing Complex RT 11 RW 01 Loktabat Utara Banjarbaru, South Kalimantan, in April 2022. The determination of the sample size in this study used the Slovin formula:

$n = \frac{N}{1+(N \times e^2)}$ Information:

n = Minimum number of samples

N = Population

e = Error margin

The stages in the experimental research of a simple incinerator model with a wet coconut fiber filter for mask waste treatment in Banjarbaru, South Kalimantan, are as follows:

1. Prepare tools and materials for the manufacture of incinerators. The experimental research stages of a simple incinerator model with a wet coconut fiber filter for mask waste treatment in Banjarbaru, South Kalimantan, are as follows.

a. The used drum capacity of 200 litres of iron material as a kiln

Figure 1. Incinerator Manufacturing Process

b. Electric welding is used to connect the kiln to the chimney.

Figure 2. Chimney Manufacturing and Installation

c. The iron plate with a thickness of 4 cm is used as a filter material in the combustion chamber to filter ash and

d. Ashes from the rest of the mask waste combustion.

Figure 3. Iron Plate In the Combustion Chamber

e. Coconut husk will be used as an exhaust gas filter. 100 grams of coconut fiber were weighed and then soaked in water for 30 minutes.

Figure 4. Wet Coconut Coir Filter

2. Create an incinerator design model

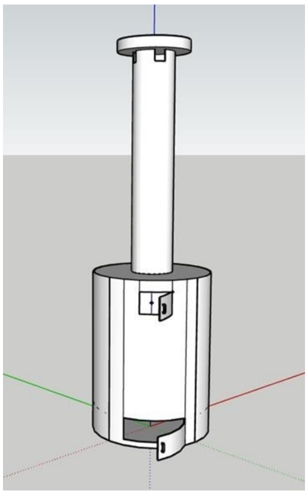

Figure 5. Simple Incinerator Model

The wet coconut coir filter is placed at the top of the chimney. Like the following picture

Figure 6. Coir Filter in the Incinerator Chimney

3. Research the treatment of waste masks with incinerators carried out before using a wet coconut fiber filter and after adding a wet coconut fiber filter.

Figure 7. Measurement of Exhaust Gas

The Research and Industrial Standardization Center (Baristand) carries out the measurement. The tool used is the E Instruments analyzer model E 4500-S CE S/N which is used as a sensor for CO, CO_2 and NO_2 exhaust gases from the incineration process.

RESEARCH RESULTS

Mask waste collected from 170 families in the Mustika Graha Asri Housing Complex RT 11 RW 01 North Loktabat Banjarbaru, South Kalimantan, amounted to 200 grams. The type of mask waste used is medical masks or disposable surgical masks. Based on the test results, the combustion rate and the incinerator's efficiency can be seen in the following table.

Table 1: Incinerator Effectiveness Parameter Test Results

No	Parameter	Test Result	Unit
1	Initial mask waste mass	200	Gram
2	Total burning time	5	Minute
3	The mass of charcoal produced	10	Gram
4	The mass of ash produced	0	Gram

Based on Table 1, data processing was conducted to determine the effectiveness of burning disposable mask waste using a simple incinerator model.

a. Combustion Rate in Simple Model Incinerator

$B_{bt} = \frac{m}{t}$

$B_{bt} = \frac{200gr}{5mint}$

$B_{bt} = \frac{40gr}{mint}$

With a disposable mask waste of 200 grams and a burning time of 5 minutes, the incinerator burning rate is 40 grams/minute.

b. Charcoal Yield in Simple Model Incinerator

$\text{Rendemen Arang } (\%) = \frac{\text{massa arang (gr)}}{\text{massa limbah masker (gr)}} \times 100\%$

$\text{Rendemen Arang } (\ \%) = \frac{10(\text{gr})}{200(\text{gr})} \times 100\%$

$\text{Rendemen Arang } (\%) = 5\%$

c. Ash yield

$\text{Rendemen Abu}(\%) = \frac{\text{massa abu (gr)}}{\text{massa limbah masker (gr)}} \times 100\%$

Rendemen Abu$(\%) = \frac{0(\mathrm{gr})}{200(\mathrm{gr})} \times 100\%$

Rendemen Abu $(\%) = 0\%$

d. Incinerator Efficiency

Efisiensi alat insenerator $(\%) = 100\% - (A(\%) + B(\%))$

Efisiensi alat insenerator $(\%) = 100\% - (5\% + 0\%)$

Efisiensi alat insenerator $(\%) = 95\%$

With a charcoal yield value of 5% and an ash yield value of 0%, the efficiency value of a simple incinerator model in reducing the amount of disposable mask waste is 95%.

Combustion through incinerators will produce flue gas that has or does not have the potential as a pollutant element. The results of the exhaust gas testing from the combustion of mask waste are as follows.

a. CO Exhaust Test Data

Based on the test results, the difference in CO exhaust gas before and after using a wet coconut fiber filter can be seen in the following table and figure:

Table 2: CO. Exhaust Test Results

Testing Time (Minutes)	CO Exhaust Test Parameters (ppm)	
	No Filter	With Filter
1	12.340	9.350
2	15.060	17.880
3	15.800	16.700
4	15.060	19.660
5	19.830	12.358

Table 2 shows that in the 2nd to 4th minute, the concentration of CO exhaust gas using a wet coconut fiber filter is higher than without using a filter. Based on the normality test, it is known that the sig. Value (2-tailed) of 0,200 ($p > 0.05$), so it can be concluded that the residual value is usually distributed.

Furthermore, the results of the statistically paired *t*-test on the CO exhaust gas test results with the scheme without and using a wet coconut fiber filter obtained a significance value of 0.853 ($p > 0.05$), and it was concluded that the provision of coconut coir did not affect the level of CO exhaust gas.

b. CO_2 Exhaust Gas Test Data

Based on the test results data, the difference in CO_2 exhaust gas before and after using a wet coconut fiber filter can be seen in the following table.

Table 3: CO_2 Exhaust Gas Test Results

Testing Time (Minutes)	CO_2 Exhaust Test Parameters (%)	
	No Filter	With Filter
1	9,8	3,6
2	13,1	4,1
3	14,5	5,8
4	4,8	6,7
5	5,5	5,7

From the 1st to the 3rd minute, the CO_2 exhaust gas produced using a wet coconut fiber filter is much lower than without a filter. However, in the 4th and 5th minutes, the CO_2 exhaust gas produced by a wet coconut fiber filter is relatively higher than without a filter.

Based on the normality test, it is known that the sig (2-tailed) value is 0.200, where the value is > 0.05, so it can be concluded that the residual value is normally distributed. From the results of the statistically paired *t*-test on the CO_2 exhaust gas test results with the scheme without and using a wet coconut fiber filter, a significance value of 0.002 ($p < 0.05$) was obtained, and it was concluded that the provision of coconut fiber affected the level of CO_2 exhaust gas.

c. NO_2 Exhaust Gas Testing Data

Based on the test results data, the difference in CO exhaust gas before and after using a wet coconut fiber filter can be seen in the following table.

Table 4: NO_2 Exhaust Gas Test Results

Testing Time (Minutes)	NO_2 Exhaust Gas Test Parameters (ppm)	
	No Filter	With Filter
1	176	12
2	192	37
3	194	268
4	192	362
5	68	93

From the 1st to the 2nd minute, the NO_2 exhaust gas produced by a wet coconut fiber filter is lower than without a filter. In the 3rd to 5th minute, the exhaust gas NO_2 produced by a wet coconut fiber filter is higher than without a filter.

Based on the normality test results, it is known that the sig (2-tailed) value is 0.200, where the value is > 0.05, so it can be concluded that the residual value is normally distributed. From the results of the statistical paired t-test on the results of the NO_2 exhaust gas test with the scheme without and using a wet coconut fiber filter, a significance value of 0.801 ($p > 0.05$) was obtained, and it was concluded that the provision of coconut husk did not affect the level of exhaust gas NO_2.

DISCUSSION

1. Simple Model Incinerator Efficiency

Efficiency is a measure of success that is judged by the size of the source and output. In other words, efficiency is done concerning the size in comparing input and output with optimal results in the process. Based on the calculation of the efficiency of this simple model incinerator, it is 95%.

Adiputra et al. (2019) states that the technical requirements for incinerators are combustion efficiency of at least 99.5%. Thus, this simple incinerator is inefficient in treating mask waste because it is less than 99.5%, and the temperature can cause this during incineration. This study's highest temperature during incineration is 325^0C, less than 8000C, a technical requirement in licensing an incinerator.

2. Effect of Wet Coir Filter on CO Exhaust Gas Quality

From the 2nd to the 4th minute, the concentration of CO exhaust gas using a wet coconut fiber filter is higher than without a filter. This is possible due to the lack of air access in the incinerator, which causes the airflow to be lower so that the amount of oxygen in the combustion becomes insufficient in burning disposable mask waste so that the incomplete combustion process produces CO gas occurs.

In the 1st and 5th minutes, the CO exhaust gas produced using a wet coconut fiber filter is lower than without a filter. The 1st minute is the initial phase of the mask waste combustion process, so the amount of oxygen for combustion is still relatively sufficient. The 5th minute is the final phase in the combustion process, so the amount of mask waste in the incinerator is relatively reduced compared to the previous combustion time. The results of CO exhaust gas with a scheme without and using a wet coconut fiber filter obtained a significance value of 0.853 ($p > 0.05$), and it was concluded that the provision of coconut coir did not affect the level of CO exhaust gas.

3. Effect of Wet Coconut Coir Filter on CO_2 Exhaust Gas

From the 1st to the 3rd minute, the CO_2 exhaust gas produced by a wet coconut fiber filter is much lower than without a filter. This indicates that the wet coconut coir filter media effectively reduces CO_2 exhaust gases from burning disposable mask waste. This aligns with the results of statistical data processing with the paired t-test method.

In the 4th and 5th minutes, the CO_2 exhaust gas produced using a wet coconut fiber filter is relatively higher than without a filter. This is possible because burning disposable mask waste without a filter is faster and more complete due to a smoother oxygen supply. The results of CO_2 exhaust gas with the scheme without and using a wet coconut fiber filter obtained a significance value of 0.002 ($p < 0.05$), and it was concluded that the provision of coconut fiber affected the level of CO_2 exhaust gas.

4. Effect of Wet Coconut Coir Filter on Exhaust Gas NO_2

From the 1st to the 2nd minute, the NO_2 exhaust gas produced by a wet coconut fiber filter is lower than without a filter. This indicates that the initial phase of burning wet coconut coir filter media is still quite effective in reducing NO_2 exhaust gases produced by burning disposable mask waste.

In the 3rd to 5th minute, the exhaust gas NO_2 produced using a wet coconut fiber filter is higher than without a filter. As previously mentioned, NO_2 exhaust gases can form at high temperatures. Installing a wet coconut husk filter inhibits the flow of flue gas so that the temperature generated from the combustion process of disposable mask waste does not flow out of the incinerator smoothly, which has an impact on increasing the temperature in the incinerator combustion chamber.

Pinandari, Fitriana, Nugraha, and Suhartono (2011) said that at high temperatures, oxygen and nitrogen gas react very quickly to produce nitrogen oxides. The NO_2 exhaust gas produced will increase in the incinerator combustion chamber with the increasing temperature. The results of NO_2 exhaust gas with a scheme without and using a wet coconut fiber filter obtained a significance value of 0.801 ($p > 0.05$). It was concluded that adding coconut fiber did not affect exhaust gas NO_2.

5. Medical Waste Incinerator Exhaust Gas Standards in Indonesia

Some standards for medical waste incineration exhaust gases in Indonesia, according to Marosin (2004), are as follows

Table 5: Comparison of Medical Waste Incinerator Exhaust Gas Standards

No	Exhaust Gas Components	Indonesian Standard Marosin (2004)	Produced Exhaust Gas Parameters
1	CO	3687 ppm	0,853 ppm
2	CO_2	6,57%	0,002 %
3	NO_2	46,5 ppm	0,801 ppm

Based on the table above, when compared with the flue gas standard in Indonesia for the flue gas produced from this simple incinerator study, the results are still within the standard limits.

CONCLUSION

Based on the results of the study, it can be concluded that:

1. This simple model incinerator that was developed can reduce the amount of mask waste from 200 grams to 10 grams from the remaining combustion products in the form of melted plastic and small wires. The treatment of mask waste with this simple incinerator has not yet reached the efficient standard because it has not entered the technical requirements for an incinerator with a combustion efficiency that must be met, which is 99.5%.

2. There is no significant difference from the installation of a wet coconut husk filter in the incinerator to the CO exhaust gas, with a significant value of statistical data processing results using the paired *t*-test method of 0.853.

3. There is a significant difference in the installation of wet coconut husk filters in the incinerator on CO_2 exhaust gas results with a significant value of statistical data processing results using the paired *t*-test method of 0.002.

4. There is no significant difference from the installation of a wet coconut coir filter on the incinerator to the exhaust gas NO_2 with a significant value of statistical data processing results using the paired *t*-test method of 0.801.

SUGGESTIONS

1. The simple incinerator model can then be carried out using other variations of filter media or with variations in the mass of the coconut fiber filter media, which are denser, so they are better in the exhaust gas filtering process.

2. A simple incinerator with a wet coconut coir filter still has many shortcomings that must be addressed. One of the main weaknesses that can be observed is the lack of air supply from the incinerator, which aims to

optimize the combustion process in the incinerator.

3. An incinerator with a wet coconut husk filter is used to treat mask waste, which can be carried out by meeting the standard incinerator technical requirements.

REFERENCES

Adiputra, I., Giriantari, I., & Kumara, I. (2019). A study on the use of incinerators to manage solid medical waste in denpasar. *Electrical Technology Scientific Magazine*, *18*(3), 369–376. doi:https://doi.org/10.24843/MITE.2019.v18i03.P10

Apolonio, R. A. (2020). Behavioral and demographic antecedents to household food waste. *International Journal of Humanities, Arts and Social Sciences*, *6*(1), 32-43. doi:https://dx.doi.org/10.20469/ijhss.6.20004-1

Axmalia, A., & Sinanto, R. A. (2020). Handling household infectious waste during the COVID-19 outbreak. *Jurnal Kesehatan Komunitas*, *7*(1), 70-76.

de Oliveira Cruz, L. M., Gomes, B. G. L. A., Tonetti, A. L., & Figueiredo, I. C. S. (2019). Using coconut husks in a full-scale decentralized wastewater treatment system: the influence of an anaerobic filter on maintenance and operational conditions of a sand filter. *Ecological engineering*, *127*, 454–459. doi:https://doi.org/10.1016/j.ecoleng.2018.12.021

Dewi, R., Hadinata, F., Yulindasari, Y., & Aminuddin, K. (2020). Sistem pengolahan sampah domestik dengan menggunakan incinerator drum bekas. Applicable Innovation of Engineering and Science Research (AVoER), *Palembang, Indonesia*.

Faslah, F., Ponco, A. Y., & Widodo, C. S. (2013). *The effect of using coconut fiber filters on utrafine particle emissions from mainstream cigarette smoke*. Unpublished doctoral dissertation, Brawijaya University, Malang, Indonesia.

Ferreira, R., Silva, E., Canevesi, R., Ferreira, E., Taddei, M., Palmieri, M., ... Marumo, J. (2018). Application of the coconut fiber in radioactive liquid waste treatment. *International Journal of Environmental Science and Technology*, *15*, 1629–1640. doi:https://doi.org/10.1007/s13762-017-1541-6

Krah, C. Y., Harahap, I. S., et al. (2019). Use of liquid smoke for sustainable food preservation and postharvest loss and waste reduction (a review). *Journal of Applied and Physical Sciences*, *5*(2), 37–47. doi:https://doi.org/10.20474/japs-5.2.1

Laelasari, E. (2021). Management of household medical waste in the era of the Covid-19 pandemic in Indonesia: Narrative literature. *Prosiding Penelitian Pendidikan dan Pengabdian 2021*, *1*(1), 447–458.

Latief, A. S. (2010). Benefits and impacts of using incinerator on the environment. *Jurnal Rekayasa Mesin*, *5*(1), 20–24.

Li, M., Wang, Y., Liu, Y., Wang, H., & Song, H. (2022). Preparation of active carbon through one-step NaOH activation of coconut shell biomass for phenolic wastewater treatment. *Research on Chemical Intermediates*, *48*(4), 1665–1684. doi:https://doi.org/10.1007/s11164-021-04650-0

Lolo, D. P. (2014). Analysis of the use of incenerator in waste treatment in Merauke city. *Jurnal Ilmiah Mustek Anim Ha Vol*, *3*(3), 1-12.

Marosin, R. (2004). Characteristics of medical incinerator exhaust emission at Dadi Mental Hospital Makassar South Sulawesi. *Jurnal Teknologi Lingkungan*, *5*(1). doi:https://doi.org/10.29122/jtl.v5i1.290

Pinandari, A. W., Fitriana, D. N., Nugraha, A., & Suhartono, E. (2011). Effectiveness and efficiency test of biomass filter using coconut coir (Cocos Nucifera) as bioremoval to reduce metal content (Cd, Fe, Cu), Total Suspended Solids (TSS) and increase pH in coal mine acid wastewater. *Prestasi Journal*, *1*(1), 1–12.

Qin, G., Liu, C. C., Richman, N. H., & Moncur, J. E. (2005). Aquaculture wastewater treatment and reuse by wind-driven reverse osmosis membrane technology: A pilot study on Coconut Island, Hawaii. *Aquacultural Engineering*, *32*(3-4), 365–378. doi:https://doi.org/10.1016/j.aquaeng.2004.09.002

Sangkham, S. (2020). Face mask and medical waste disposal during the novel COVID-19 pandemic in Asia. *Case Studies in Chemical and Environmental Engineering*, *2*, 1-9. doi:https://doi.org/10.1016/j.cscee.2020.100052

Shahbaz, M., Jam, F. A., Bibi, S., & Loganathan, N. (2016). Multivariate granger causality between co2 emissions, energy intensity and economic growth in Portugal: Evidence from cointegration and causality analysis. *Technological and Economic Development of Economy*, *22*(1), 47-74. doi:https://doi.org/10.3846/20294913.2014.989932

Shahbaz, M., Tiwari, A. K., Jam, F. A., & Ozturk, I. (2014). Are fluctuations in coal consumption per capita temporary? Evidence from developed and developing economies. *Renewable and Sustainable Energy Reviews*, *33*, 96–101. doi:https://doi.org/10.1016/j.rser.2014.01.086

Sujiono, E., Zabrian, D., Zharvan, V., Humairah, N., et al. (2022). Fabrication and characterization of coconut shell activated carbon using variation chemical activation for wastewater treatment application. *Results in Chemistry*, *4*, 100291. doi:https://doi.org/10.1016/j.rechem.2022.100291