
International Journal of
Science and Environment
IJSE
WWW.IJSENET.COM

Editorial Team

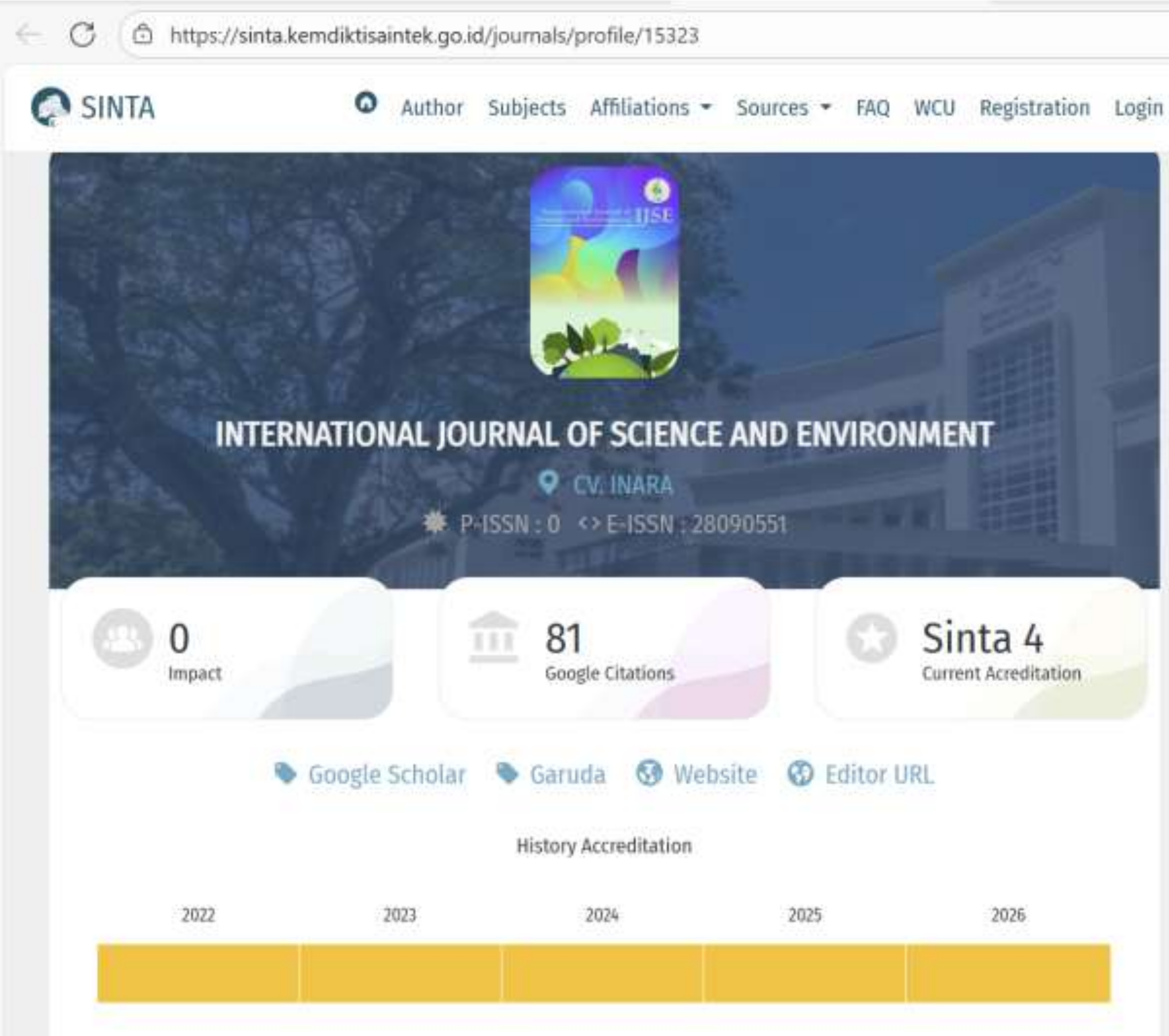
DAFTAR ISI

Laman: Vol. 5 No. 3 (2025): August 2025 | International Journal of Science and Environment (IJSE)

https://ijsenet.com/index.php/IJSE/issue/view/17

PERINGKAT SINTA

Laman: SINTA - Science and Technology Index



Analysis of Rice Husks And Sugarcane Bagasse For Water Treatment Of Formation Water In Oil Fields

Aqlyna Fattahanisa[1*],Listiana Satiawati[2],Lisa Samura[3]

[1,2,3] Petroleum Engineering Study Program, Faculty of Earth and Energy Technology, Universitas Trisakti, Indonesia.

*Correponding Author:

Email: aqlyna@trisakti.ac.id

Abstract.

In the oil and gas production process in the Cepu field, oil, gas, and water are produced. After oil and gas are produced from the reservoir to the surface, the water that is produced will be returned to the environment. In this water, there is a relatively small amount of oil, high total dissolved solids (TDS), and low pH. High TDS can cause hardness in the water to increase, pH that is too acidic and alkaline can cause pollution to the environment, also residual oil in the water can damage the environment because it is difficult to combine and difficult to decompose. Therefore, this problem can be overcome one way by the adsorption process. This research aims to test absorption using an adsorbent in the form of activated carbon. This adsorption uses sugar cane bagasse and rice husks which can be obtained at low prices and also in abundance. Several stages carried out in this research were making activated carbon by drying the bagasse and rice husks, then blending it until smooth, then placing it in a furnace at a temperature of 800°C. Produced water in Cepu has a TDS value of 5100 ppm and a pH of 5. By adding sugarcane bagasse and rice husk adsorbent the pH value becomes 7, then the TDS value becomes 2261 ppm after adding 3 grams of rice husk adsorbent. and the TDS value became 1153 ppm with the addition of 3 grams of sugarcane bagasse adsorbent. The results of this research provide evidence of the effectiveness of sugarcane bagasse and rice husks as adsorbents in reducing TDS values, pH, and absorbing residual oil from produced water so that it complies with the quality standards of Minister of Environment Regulation (PermenLH) Number 19 of 2010.

Keywords: *Adsorption; Total Dissolved Solid; pH; Sugarcane Bagasse and Rice Husk.*

I. INTRODUCTION

Exploitation of oil and gas produces water from rock formations which is called produced water [1–3]. Produced water is water that is a by-product of the processing of petroleum, natural gas, or CBM (Coal Bed Methane) [4,5].Produced water is different from water in general. The differences lie in the dissolved and dispersed oil components, dissolved minerals, chemical compounds, solids, and dissolved gases [6,7].This produced water is wastewater that is dangerous to the environment because it has a high TDS value which can cause mineral deposition, has a low or acidic pH value which can cause corrosion hazards, and also has residual oil which is difficult to decompose [8–10].

Therefore, the TDS and pH values must be adjusted to the quality standard criteria stated in the Minister of Environment Regulation (Permen LH) Indonesia Number 19 of 2010 and also the remaining oil is removed by adsorption [11].Sugarcane bagasse is one of the potential materials to be developed as active carbon because it contains cellulose and lignin. The fiber contained in sugarcane bagasse is not soluble in water because it mostly consists of cellulose, lignin, and pentose [12–16]. Rice husks can be used as adsorbents because cellulose and hemicellulose have considerable potential to be used as adsorbents which have OH groups attached so they can interact with the adsorbate components [16–21]. These two materials also have abundant availability. Based on the reasons above, sugarcane bagasse and rice husks are suitable for lowering TDS, pH values, and also absorbing residual oil contained in produced water.

II. METHODS

This research aims to determine the ability of sugarcane bagasse and rice husks as activated charcoal composite to reduce TDS and pH values. Also removing residual oil contained in produced water, to achieve this goal it is necessary to take several steps as follows:

1. Conduct literature studies on related titles, by conducting studies on previous or related studies.
2. Prepare tools and materials such as bagasse, rice husks, and produced water which have been checked for TDS and pH values from the Cepu field, Indonesia.
3. Making activated carbon from sugar cane bagasse and rice husks by grinding and physically activating them using a furnace [22–26].
4. Mix the produced water with activated carbon and wait until the activated carbon binds the remaining oil in the produced water and forms an emulsion.
5. Filtrate 1 gram of bagasse with contact time (30,35,40,45,50,55,60 minutes) and record the data, filter again for mass variations of 1.5;2;2.5;3 grams , thus getting the values of Co, Ct, Ce, and Qe for sugarcane bagasse.
6. Filter 1 gram of rice husk with contact time (30,35,40,45,50,55,60 minutes) and record the data, filter again for mass variations of 1.5;2;2.5;3 grams , thus getting the values of Co, Ct, Ce, and Qe for rice husks.
7. Calculate the pH, TDS and salinity values of produced water which has been mixed with activated carbon from sugarcane bagasse and rice husks.
8. Use Co, Ct, Ce, and Qe for Freundlich calculations to get a linear regression curve so that the R2 value can be obtained [27–31].

III. RESULTS AND DISCUSSION

The filtration results show that the optimal mass of the two ingredients for absorbing residual oil, reducing TDS and pH is 3 grams. Sugarcane bagasse and rice husk data used for Freundlich calculations are the most effective absorption masses. As supporting evidence for active carbon, SEM testing was also carried out to prove that sugarcane bagasse and rice husks are suitable materials for use as active carbon.

3.1 Surface Area of the Adsorbent

To determine the size of the pores on the adsorbent, the SEM (Scanning Electron Microscope) test is used. The test results can be seen in Figure 1 which shows that the adsorbent material has several heterogeneous pores.

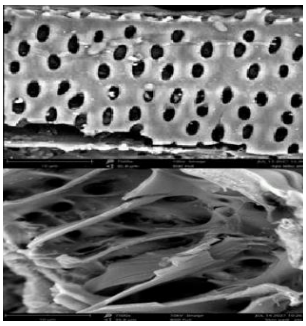


Fig 1. Surface Area of Sugarcane Bagasse (top), and Rice Husk (bottom)

3.2 Effect of Adding Activated Carbon on the pH of Produced Water

The pH contained in produced water before it is mixed with activated carbon is 5, so the produced water must be re-processed to comply with the quality standards of the Minister of Environment and Forestry Regulation. When the formation water is mixed with activated carbon made from sugarcane bagasse and rice husks. In Table 1, the pH value of the formation water can change after adding sugarcane bagasse and rice husk adsorbents, to measure the pH using litmus paper.The initial pH of the Formation Water is 5, after the formation water is mixed with activated carbon made from sugarcane bagasse and rice husks, the pH of the formation water changes due to the reaction of the adsorbent mixing with the adsorbate (oil) with variations in the mass of the adsorbent. With the right adsorbent mass composition, the pH of the formation water can be neutral. These results are in accordance with research (Meunchang et al., 2005 [32]).

Table 1. Addition of Mass Concentration of Active Carbon in Formation Water to the Final pH of Formation Water

Activated Carbon Mass Concentration (g)	Initial pH of Produced Water	Final pH (after adding activated carbon)	
		Rice Husk	Sugarcane Bagasse
1	5	7	7
1,5	5	7	7
2	5	8	7
2,5	5	7	6
3	5	7	7

From Table 1. The initial pH of the Formation Water is 5, after the formation water is mixed with activated carbon made from sugarcane bagasse and rice husks, the pH of the formation water changes due to the reaction of the adsorbent mixing with the adsorbate (oil) with variations in the mass of the adsorbent. With the right adsorbent mass composition, the pH of the formation water can be neutral. These results are in accordance with research Meunchang et al., 2005 [32].

3.3 Effect of Adding Activated Carbon on Total Dissolved Solids (TDS) in Produced Water

The TDS contained in produced water before it is mixed with activated carbon is 5100. So the produced water must be re-processed to comply with the quality standards of the Minister of Environment and Forestry Regulation. In this experiment, we will analyze the changes in the TDS value of the initial formation water to the TDS of the final formation water which has reacted with activated carbon and also compare using a curve between rice husk adsorbent and sugarcane bagasse to the TDS value. For this experiment, the TDS value is measured using a TDS meter equipped can measure dissolved solid particles in formation water that are invisible to the eye without magnification.

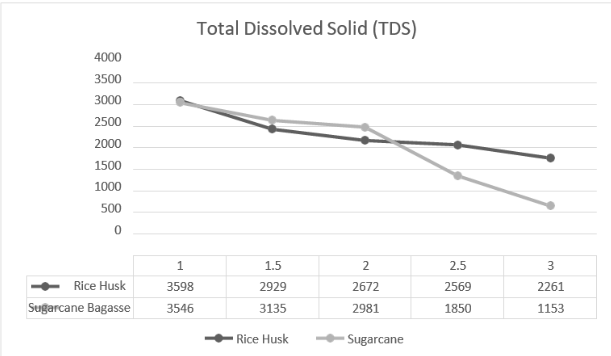


Fig 2. TDS value on sugarcane bagasse and rice husks

The results of measuring the TDS (Total Dissolved Solid) value on rice husks and sugar cane bagasse can be seen in Figure 3. In the rice husk adsorbent the mass variation (g) is 1; 1.5 ; 2 ; 2.5 ; 3 obtained TDS (ppm) values of 2569, 2672, 2929, 2261, 3598.

Meanwhile, measuring the TDS value on sugarcane bagasse adsorbent with mass variations (g), namely 1; 1.5 ; 2 ; 2.5 ; 3 obtained TDS (ppm) values of 1153, 1850, 2981, 3546, 3135.

Based on PP no. 82 of 2001 concerning water quality management and water pollution control, it is stated that the permitted dissolved residue concentration (TDS) is 1000 ppm. Mixing produced water with 3 grams of bagasse can reduce TDS from 5100 to 1153 which is close to 1000. This data shows that adding the composition of bagasse can reduce the TDS value significantly.

3.4 Effect of Adding Activated Carbon on Salinity in Produced Water

In this experiment, we analyzed the salinity and SG (Specific Gravity) values in formation water that had been mixed with activated carbon which had different mass variations. To make a comparison of rice husks and sugarcane bagasse using a curve. Measurement of salinity and SG (Specific Gravity) values using the Warmtone Wt-11 Salinity Meter.It can be seen from Table 2 that the salinity level in the formation water was reduced after adding activated carbon from rice husks and sugar cane bagasse. When the mass concentration is 1 to 3 grams, the salinity of the formation water in rice husks changes until the salinity value becomes 12 ppt with an SG (Specific Gravity) value of 1.008. This also changes the water content of the formation when the mass of bagasse is added to the maximum reduction in salinity at a concentration of 1 to 3 grams of 8 ppt and SG (Specific Gravity) of 1.006. Note that to reduce the salinity value you need the right mass of activated carbon because with the addition of 1 gram of activated carbon the salinity value increases.

Table 2. Salinity and Specific Gravity Values

Sample	Activated Carbon Concentration (g)	Salinity (ppt)	SG
	0	14	1,010
Rice Husk	1	16	1,012
	1,5	14	1,010
	2	14	1,010
	2,5	13	1,008
	3	12	1,008
Sugarcane Bagasse	1	20	1,015
	1,5	14	1,010
	2	12	1,008
	2,5	10	1,006
	3	8	1,006

3.5 Freundlich Isotherm Adsorption on 3 grams of Sugarcane Bagasse and Rice Husk

In this experiment, we looked for calculation variables using the Freundlich method equation using basic materials such as bagasse and rice husks, which can be seen in Table 3 below.In Table 3, this is a determination of the adsorption model contained in the Freundlich model to compare the value of the absorption capacity of the adsorbent, and the final concentration of the formation water so that the comparison of these two adsorbent values will get the logarithmic value for each adsorbent.The terms of the Freundlich adsorption model use the Log ce and Log qe intervals, so these values are used as determining interval values when determining Linear Regression and Correlation Coefficients to determine the flow rate capability during the adsorption process.In this experiment, it is an attempt to make a comparison of adsorbents using the Freundlich model equation, which will be compared is the final concentration log value from the comparison between Rice Husk and Sugarcane Bagasse to formation water with the absorption capacity log value which is known in the adsorption capacity calculation, this can be seen in Figure 3 and Figure 4.

Table 3. Calculation of Freundlich Model Adsorption Values

Adsorbent	Formation Water		qe (mg/g)	Log ce	Log qe
	Initial Concentration	Final Concentration (ce)			
Rice Husk 3 gr	100	73	27	186,332,286	1,431,363,764
	100	75	25	1,875,061,263	1,397,940,009
	100	77	23	1,886,490,725	1,361,727,836
	100	78	22	1,892,094,603	1,342,422,681
	100	79	21	1,897,627,091	1,322,219,295
	100	81	19	1,908,485,019	1,278,753,601
	100	84	16	1,924,279,286	1,204,119,983
Sugarcane Bagasse 3 gr	100	74	26	186,923,172	1,414,973,348
	100	82	18	1,913,813,852	1,255,272,505
	100	83	17	1,919,078,092	1,230,448,921
	100	83	17	1,919,078,092	1,230,448,921
	100	83	17	1,919,078,092	1,230,448,921
	100	84	16	1,924,279,286	1,204,119,983
	100	84	16	1,924,279,286	1,204,119,983

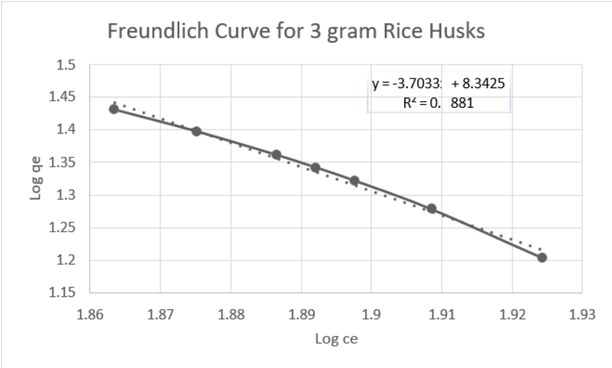


Fig 3. Freundlich Curve for 3-gram Rice Husks

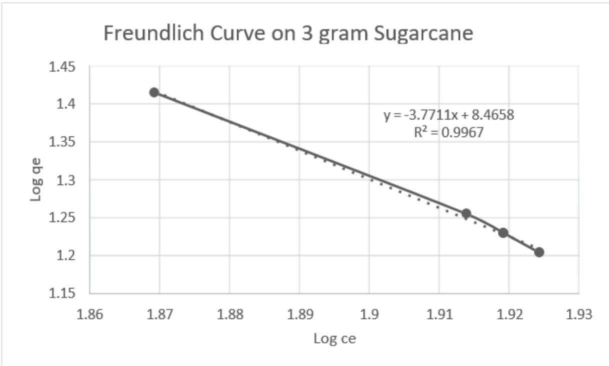


Fig 4. Freundlich curve for 3 grams of sugar cane bagasse

IV. CONCLUSIONS

Based on the results of research and calculations, it can be concluded that:

1. Activated carbon from sugar cane bagasse and rice husks can increase the pH value of produced water from 5 to 7.
2. Activated carbon from sugar cane bagasse and rice husks can reduce the TDS value of produced water. The greater the mass concentration of activated carbon in sugar cane bagasse or the mass of activated carbon in rice husks, the greater the decrease in the TDS value. By adding a mass of 3 grams of activated carbon to rice husks, there was a decrease in the TDS of produced water from 5100 ppm to 2261 ppm, and by adding a mass of 3 grams of activated carbon to 3 grams of sugarcane bagasse, there was a decrease in the TDS of produced water from 5100 ppm to 1153 ppm. Sugarcane Bagasse and Rice Husk Adsorbents can be obtained. reduced the TDS value in produced water from 5100 ppm when the Rice Husk adsorbent was added to 2261 ppm, while when the Sugarcane Bagasse adsorbent was added it became 1153 ppm. There was a decrease in the salinity value when the adsorbent was added to the formation water.
3. To add an active carbon mass concentration of 3 grams of sugarcane bagasse or to add an active carbon mass concentration of 3 grams of rice husks, the longer the contact time, the smaller the adsorption value (qe). When compared between sugarcane bagasse and rice husk, the adsorption value of bagasse is greater than rice husk
4. In the processing of produced water, sugarcane bagasse is a better material than rice husks based on research that has been carried out.
5. Based on the adsorption results in Linear Regression of Sugarcane Bagasse activated carbon, it is more suitable to use the Freundlich equation because the Correlation Coefficient value is close to 1.0

REFERENCES

[1] D. Vasconez, S. Farag, A. Meneses, O. Rodriguez, and W. Pastrana, “Water Source Wells: Challenges to Produce Water. Field Experiences from a Waterflooding Project,” in: Day 4 Thu, July 30, 2020, SPE, 2020. doi:10.2118/199154-MS.

[2] P.E. Korsah, I.S. Ambrose, and W.. Korsah, “The use of Constructed Wetlands in Produce Water Treatment; an Option for the Oil and Gas Industry,” in: Day 3 Thu, June 12, 2014, SPE, 2014. doi:10.2118/169998-MS.

[3] Q. Liu, P. Yang, W. Tu, H. Sun, S. Li, and Y. Zhang, “Lithium recovery from oil and gas produced water: opportunities, challenges, and future outlook,” ***Journal of Water Process Engineering***, **55** 104148 (2023). doi:10.1016/j.jwpe.2023.104148.

[4] M. Al-Saidi, “Produced Water as New Water in the Hydrocarbon Industry,” in: 2022: pp. 489–498. doi:10.1007/978-3-319-95846-0_47.

[5] N.L. Pangestu, N.L. Zahra, A. Sarwono, I. Rahmalia, I.Y. Septiariva, and I.W.K. Suryawan, “Determination of Produced Wastewater Treatment Systems for Reclaim Water in the Oil and Gas Industry,” in: 2023: pp. 1009–1017. doi:10.1007/978-981-16-9348-9_89.

[6] B. Ogbuji, A.G.A. Nnanna, M. Engle, and R. Amesquita, “Compositional analysis of conventional and unconventional permian basin-produced waters: a simple tool for predicting major ion composition,” *SPE Production & Operations*, **37** (*03*) 383–396 (2022). doi:10.2118/209599-PA.

[7] N.. Ghorbani, C.. Yan, P.. Guraieb, R.C. Tomson, D.. Abdallah, A.. Ben Aouda, N.M. Odeh, and T.A. Al Daghar, “Validating Automated Real-Time Produced Water Composition Measurement Device with Field Produced Water Samples: A Pathway to Field Trial,” in: Day 2 Tue, November 14, 2017, SPE, 2017. doi:10.2118/188244-MS.

[8] M. Asthana, A. Kumar, and B.S. Sharma, “Wastewater Treatment,” in: Principles and Applications of Environmental Biotechnology for a Sustainable Future, Springer Singapore, Singapore, 2017: pp. 173–232. doi:10.1007/978-981-10-1866-4_6.

[9] M. Akstinat, “Chemical and physicochemical properties of formation waters of the oil and gas industry,” *J Hydrol (Amst)*, **578** 124011 (2019). doi:10.1016/j.jhydrol.2019.124011.

[10] R.S. Dhamorikar, V.G. Lade, P. V. Kewalramani, and A.B. Bindwal, “Review on integrated advanced oxidation processes for water and wastewater treatment,” ***Journal of Industrial and Engineering Chemistry***, (2024). doi:10.1016/j.jiec.2024.04.037.

[11] Menteri Negara Lingkungan Hidup, “Peraturan Menteri Negara Lingkungan Hidup Nomor 19 Tahun 2010 Tentang Baku Mutu Air Limbah Bagi Usaha Dan/Atau Kegiatan Minyak Dan Gas Serta Panas Bumi,” n.d.

[12] H. Najafi, A. Golrokh Sani, and M.A. Sobati, “A comparative evaluation on the physicochemical properties of sugarcane residues for thermal conversion processes,” *Ind Crops Prod*, **202** 117112 (2023). doi:10.1016/j.indcrop.2023.117112.

[13] S.L. Sunar, R.K. Oruganti, D. Bhattacharyya, D. Shee, and T.K. Panda, “Deep eutectic solvent pretreatment of

sugarcane bagasse for efficient lignin recovery and enhanced enzymatic hydrolysis," ***Journal of Industrial and Engineering Chemistry***, (2024). doi:10.1016/j.jiec.2024.05.030.

[14] Y. Sun, C. Liang, W. Qi, Q. Wang, L. Zhan, J. Tong, J. Jiang, and Z. Yao, "One-pot catalytic hydrolysis of sugarcane bagasse into furfural using a pressurized phosphoric acid/acetone/water system," *Biomass Bioenergy*, **185** 107242 (2024). doi:10.1016/j.biombioe.2024.107242.

[15] N.Y. Nguyen-Thi, C.Q. Nguyen, Q. Le Dang, Q. De Tran, T.N. Do-Thi, and L.H. Vu Thanh, "Extracting lignin from sugarcane bagasse for methylene blue and hexavalent chromium adsorption in textile wastewater: a facile, green, and sustainable approach," *RSC Adv*, **14** (*7*) 4533–4542 (2024). doi:10.1039/D3RA08007B.

[16] S. Awasthi, A. Mishra, and D.B. Pal, "Energy Production from Sugarcane Bagasse and Rice Husk," in: 2024: pp. 157–181. doi:10.1007/978-981-97-0840-6_7.

[17] M. Wanli, S. Suda, and S. Murata, "Effect of Nano-Silica Synthesized from Rice Husk on Low Salinity Water Flooding," in: Day 2 Tue, April 23, 2024, SPE, 2024. doi:10.2118/218244-MS.

[18] S.J. Mane, P. Kumbhare, and A. Pandav, "Experimental study of treatment of kitchen waste water using rice husk ash," *Mater Today Proc*, (2024). doi:10.1016/j.matpr.2024.01.056.

[19] N.H. Shalaby, E.M.M. Ewais, R.M. Elsaadany, and A. Ahmed, "Rice husk templated water treatment sludge as low cost dye and metal adsorbent," ***Egyptian Journal of Petroleum***, **26** (*3*) 661–668 (2017). doi:10.1016/j.ejpe.2016.10.006.

[20] M.S. Masoud, W.M. El-Saraf, A.M. Abdel - Halim, A.E. Ali, E.A. Mohamed, and H.M.I. Hasan, "Rice husk and activated carbon for waste water treatment of el-mex bay, alexandria coast, egypt," ***Arabian Journal of Chemistry***, 9 S1590–S1596 (2016). doi:10.1016/j.arabjc.2012.04.028.

[21] K. Durand, R. Daassi, D. Rodrigue, and T. Stevanovic, "Study of biopolymers and silica recovery from pre-hydrolyzed rice husks," *Biomass Convers Biorefin*, (2024). doi:10.1007/s13399-024-05445-0.

[22] S. Singh Rawat, and A. Sharma, "Sugarcane bagasse ash—the future composite material: a literature review," *Mater Today Proc*, (2023). doi:10.1016/j.matpr.2023.07.272.

[23] Valério Filho, L.V. Tholozan, E.O. da Silva, L. Meili, A.R.F. de Almeida, and G.S. da Rosa, "Perspectives of the reuse of agricultural wastes from the Rio Grande do Sul, Brazil, as new adsorbent materials," in: Biomass-Derived Materials for Environmental Applications, Elsevier, 2022: pp. 243–266. doi:10.1016/B978-0-323-91914-2.00014-3.

[24] J. Jampílek, and K. Kráľová, "Preparation of nanocomposites from agricultural waste and their versatile applications," in: Multifunctional Hybrid Nanomaterials for Sustainable Agri-Food and Ecosystems, Elsevier, 2020: pp. 51–98. doi:10.1016/B978-0-12-821354-4.00004-2.

[25] M.Z. Yameen, S.R. Naqvi, D. Juchelková, and M.N.A. Khan, "Harnessing the power of functionalized biochar: progress, challenges, and future perspectives in energy, water treatment, and environmental sustainability," *Biochar*, **6** (*1*) 25 (2024). doi:10.1007/s42773-024-00316-3.

[26] Bedane, T. Guo, B. Shirani, and H. Xiao, "Textural characteristics of activated carbons prepared from

agricultural residues-review," ***Can J Chem Eng***, **101** (*12*) 6718–6739 (2023). doi:10.1002/cjce.24960.

[27] Nafisifar, A.K. Manshad, and S.R. Shadizadeh, "Primary evaluation of a new green synthesized anionic surfactant, micellar behavior analysis, and flooding in sandstone reservoirs: application in chemical enhanced oil recovery," ***SPE Journal***, **27** (*01*) 771–789 (2022). doi:10.2118/208569-PA.

[28] L.N. Rozanov, "Kinetic equations of non-localized physical adsorption in vacuum for freundlich adsorption isotherm," *Vacuum*, **189** 110267 (2021). doi:10.1016/j.vacuum.2021.110267.

[29] R. Ezzati, "Derivation of pseudo-first-order, pseudo-second-order and modified pseudo-first-order rate equations from langmuir and freundlich isotherms for adsorption," ***Chemical Engineering Journal***, **392** 123705 (2020). doi:10.1016/j.cej.2019.123705.

[30] G.P. Jeppu, and T.P. Clement, "A modified langmuir-freundlich isotherm model for simulating ph-dependent adsorption effects," ***J Contam Hydrol***, **129–130** 46–53 (2012). doi:10.1016/j.jconhyd.2011.12.001.

[31] Ng, J.N. Losso, W.E. Marshall, and R.M. Rao, "Freundlich adsorption isotherms of agricultural by-product-based powdered activated carbons in a geosmin–water system," *Bioresour Technol*, **85** (*2*) 131–135 (2002). doi:10.1016/S0960-8524(02)00093-7.

[32] S. Meunchang, S. Panichsakpatana, and R.W. Weaver, "Co-composting of filter cake and bagasse; by-products from a sugar mill," *Bioresour Technol*, **96** (*4*) 437–442 (2005). doi:10.1016/j.biortech.2004.05.024.

Analysis of Rice Husks and Sugarcane Bagasse

by Aqlyna Fattahanisa FTKE

Submission date: 02-Sep-2025 10:52AM (UTC+0700)
Submission ID: 2277191069
File name: Aqlyna_Fattahanisa..neww.pdf (646.1K)
Word count: 3975
Character count: 19300

Analysis of Rice Husks And Sugarcane Bagasse For Water Treatment Of Formation Water In Oil Fields

Aqlyna Fattahanisa[1*],Listiana Satiawati[2],Lisa Samura[3]

[1,2,3] Petroleum Engineering Study Program, Faculty of Earth and Energy Technology, Universitas Trisakti, Indonesia.

*Correponding Author:

Email: aqlyna@trisakti.ac.id

Abstract*.*

In the oil and gas production process in the Cepu field, oil, gas, and water are produced. After oil and gas are produced from the reservoir to the surface, the water that is produced will be returned to the environment. In this water, there is a relatively small amount of oil, high total dissolved solids (TDS), and low pH. High TDS can cause hardness in the water to increase, pH that is too acidic and alkaline can cause pollution to the environment, also residual oil in the water can damage the environment because it is difficult to combine and difficult to decompose. Therefore, this problem can be overcome one way by the adsorption process. This research aims to test absorption using an adsorbent in the form of activated carbon. This adsorption uses sugar cane bagasse and rice husks which can be obtained at low prices and also in abundance. Several stages carried out in this research were making activated carbon by drying the bagasse and rice husks, then blending it until smooth, then placing it in a furnace at a temperature of 800°C. Produced water in Cepu has a TDS value of 5100 ppm and a pH of 5. By adding sugarcane bagasse and rice husk adsorbent the pH value becomes 7, then the TDS value becomes 2261 ppm after adding 3 grams of rice husk adsorbent. and the TDS value became 1153 ppm with the addition of 3 grams of sugarcane bagasse adsorbent. The results of this research provide evidence of the effectiveness of sugarcane bagasse and rice husks as adsorbents in reducing TDS values, pH, and absorbing residual oil from produced water so that it complies with the quality standards of Minister of Environment Regulation (PermenLH) Number 19 of 2010.

Keywords: *Adsorption; Total Dissolved Solid; pH; Sugarcane Bagasse and Rice Husk.*

I. INTRODUCTION

Exploitation of oil and gas produces water from rock formations which is called produced water [1–3]. Produced water is water that is a by-product of the processing of petroleum, natural gas, or CBM (Coal Bed Methane) [4,5].Produced water is different from water in general. The differences lie in the dissolved and dispersed oil components, dissolved minerals, chemical compounds, solids, and dissolved gases [6,7].This produced water is wastewater that is dangerous to the environment because it has a high TDS value which can cause mineral deposition, has a low or acidic pH value which can cause corrosion hazards, and also has residual oil which is difficult to decompose [8–10].

Therefore, the TDS and pH values must be adjusted to the quality standard criteria stated in the Minister of Environment Regulation (Permen LH) Indonesia Number 19 of 2010 and also the remaining oil is removed by adsorption [11].Sugarcane bagasse is one of the potential materials to be developed as active carbon because it contains cellulose and lignin. The fiber contained in sugarcane bagasse is not soluble in water because it mostly consists of cellulose, lignin, and pentose [12–16]. Rice husks can be used as adsorbents because cellulose and hemicellulose have considerable potential to be used as adsorbents which have OH groups attached so they can interact with the adsorbate components [16-21]. These two materials also have abundant availability. Based on the reasons above, sugarcane bagasse and rice husks are suitable for lowering TDS, pH values, and also absorbing residual oil contained in produced water.

II. METHODS

This research aims to determine the ability of sugarcane bagasse and rice husks as activated charcoal composite to reduce TDS and pH values. Also removing residual oil contained in produced water, to achieve this goal it is necessary to take several steps as follows:

1. Conduct literature studies on related titles, by conducting studies on previous or related studies.
2. Prepare tools and materials such as bagasse, rice husks, and produced water which have been checked for TDS and pH values from the Cepu field, Indonesia.
3. Making activated carbon from sugar cane bagasse and rice husks by grinding and physically activating them using a furnace [22–26].
4. Mix the produced water with activated carbon and wait until the activated carbon binds the remaining oil in the produced water and forms an emulsion.
5. Filtrate 1 gram of bagasse with contact time (30,35,40,45,50,55,60 minutes) and record the data, filter again for mass variations of 1.5;2;2.5;3 grams , thus getting the values of Co, Ct, Ce, and Qe for sugarcane bagasse.
6. Filter 1 gram of rice husk with contact time (30,35,40,45,50,55,60 minutes) and record the data, filter again for mass variations of 1.5;2;2.5;3 grams , thus getting the values of Co, Ct, Ce, and Qe for rice husks.
7. Calculate the pH, TDS and salinity values of produced water which has been mixed with activated carbon from sugarcane bagasse and rice husks.
8. Use Co, Ct, Ce, and Qe for Freundlich calculations to get a linear regression curve so that the R2 value can be obtained [27–31].

III. RESULTS AND DISCUSSION

The filtration results show that the optimal mass of the two ingredients for absorbing residual oil, reducing TDS and pH is 3 grams. Sugarcane bagasse and rice husk data used for Freundlich calculations are the most effective absorption masses. As supporting evidence for active carbon, SEM testing was also carried out to prove that sugarcane bagasse and rice husks are suitable materials for use as active carbon.

3.1 Surface Area of the Adsorbent

To determine the size of the pores on the adsorbent, the SEM (Scanning Electron Microscope) test is used. The test results can be seen in Figure 1 which shows that the adsorbent material has several heterogeneous pores.

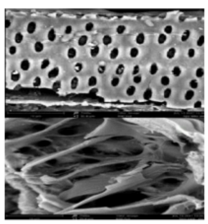


Fig 1. Surface Area of Sugarcane Bagasse (top), and Rice Husk (bottom)

3.2 Effect of Adding Activated Carbon on the pH of Produced Water

The pH contained in produced water before it is mixed with activated carbon is 5, so the produced water must be re-processed to comply with the quality standards of the Minister of Environment and Forestry Regulation. When the formation water is mixed with activated carbon made from sugarcane bagasse and rice husks. In Table 1, the pH value of the formation water can change after adding sugarcane bagasse and rice husk adsorbents, to measure the pH using litmus paper.The initial pH of the Formation Water is 5, after the formation water is mixed with activated carbon made from sugarcane bagasse and rice husks, the pH of the formation water changes due to the reaction of the adsorbent mixing with the adsorbate (oil) with variations in the mass of the adsorbent. With the right adsorbent mass composition, the pH of the formation water can be neutral. These results are in accordance with research (Meunchang et al., 2005 [32]).

Table 1. Addition of Mass Concentration of Active Carbon in Formation Water to the Final pH of Formation Water

Activated Carbon Mass Concentration (g)	Initial pH of Produced Water	Final pH (after adding activated carbon)	
		Rice Husk	Sugarcane Bagasse
1	5	7	7
1,5	5	7	7
2	5	8	7
2,5	5	7	6
3	5	7	7

From Table 1. The initial pH of the Formation Water is 5, after the formation water is mixed with activated carbon made from sugarcane bagasse and rice husks, the pH of the formation water changes due to the reaction of the adsorbent mixing with the adsorbate (oil) with variations in the mass of the adsorbent. With the right adsorbent mass composition, the pH of the formation water can be neutral. These results are in accordance with research Meunchang et al., 2005 [32)].

3.3 Effect of Adding Activated Carbon on Total Dissolved Solids (TDS) in Produced Water

The TDS contained in produced water before it is mixed with activated carbon is 5100. So the produced water must be re-processed to comply with the quality standards of the Minister of Environment and Forestry Regulation. In this experiment, we will analyze the changes in the TDS value of the initial formation water to the TDS of the final formation water which has reacted with activated carbon and also compare using a curve between rice husk adsorbent and sugarcane bagasse to the TDS value. For this experiment, the TDS value is measured using a TDS meter equipped can measure dissolved solid particles in formation water that are invisible to the eye without magnification.

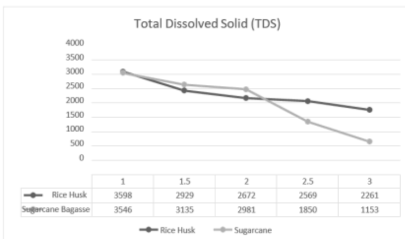


Fig 2. TDS value on sugarcane bagasse and rice husks

The results of measuring the TDS (Total Dissolved Solid) value on rice husks and sugar cane bagasse can be seen in Figure 3. In the rice husk adsorbent the mass variation (g) is 1; 1.5 ; 2 ; 2.5 ; 3 obtained TDS (ppm) values of 2569, 2672, 2929, 2261, 3598.

Meanwhile, measuring the TDS value on sugarcane bagasse adsorbent with mass variations (g), namely 1; 1.5 ; 2 ; 2.5 ; 3 obtained TDS (ppm) values of 1153, 1850, 2981, 3546, 3135.

Based on PP no. 82 of 2001 concerning water quality management and water pollution control, it is stated that the permitted dissolved residue concentration (TDS) is 1000 ppm. Mixing produced water with 3 grams of bagasse can reduce TDS from 5100 to 1153 which is close to 1000. This data shows that adding the composition of bagasse can reduce the TDS value significantly.

3.4 Effect of Adding Activated Carbon on Salinity in Produced Water

In this experiment, we analyzed the salinity and SG (Specific Gravity) values in formation water that had been mixed with activated carbon which had different mass variations. To make a comparison of rice husks and sugarcane bagasse using a curve. Measurement of salinity and SG (Specific Gravity) values using the Warmtone Wt-11 Salinity Meter.It can be seen from Table 2 that the salinity level in the formation water was reduced after adding activated carbon from rice husks and sugar cane bagasse. When the mass concentration is 1 to 3 grams, the salinity of the formation water in rice husks changes until the salinity value becomes 12 ppt with an SG (Specific Gravity) value of 1.008. This also changes the water content of the formation when the mass of bagasse is added to the maximum reduction in salinity at a concentration of 1 to 3 grams of 8 ppt and SG (Specific Gravity) of 1.006. Note that to reduce the salinity value you need the right mass of activated carbon because with the addition of 1 gram of activated carbon the salinity value increases.

Table 2. Salinity and Specific Gravity Values

Sample	Activated Carbon Concentration (g)	Salinity (ppt)	SG
	0	14	1,010
Rice Husk	1	16	1,012
	1,5	14	1,010
	2	14	1,010
	2,5	13	1,008
	3	12	1,008
Sugarcane Bagasse	1	20	1,015
	1,5	14	1,010
	2	12	1,008
	2,5	10	1,006
	3	8	1,006

3.5 Freundlich Isotherm Adsorption on 3 grams of Sugarcane Bagasse and Rice Husk

In this experiment, we looked for calculation variables using the Freundlich method equation using basic materials such as bagasse and rice husks, which can be seen in Table 3 below.In Table 3, this is a determination of the adsorption model contained in the Freundlich model to compare the value of the absorption capacity of the adsorbent, and the final concentration of the formation water so that the comparison of these two adsorbent values will get the logarithmic value for each adsorbent.The terms of the Freundlich adsorption model use the Log ce and Log qe intervals, so these values are used as determining interval values when determining Linear Regression and Correlation Coefficients to determine the flow rate capability during the adsorption process.In this experiment, it is an attempt to make a comparison of adsorbents using the Freundlich model equation, which will be compared is the final concentration log value from the comparison between Rice Husk and Sugarcane Bagasse to formation water with the absorption capacity log value which is known in the adsorption capacity calculation, this can be seen in Figure 3 and Figure 4.

Table 3. Calculation of Freundlich Model Adsorption Values

Adsorbent	Formation Water		qe (mg/g)	Log ce	Log qe
	Initial Concentration	Final Concentration (ce)			
Rice Husk 3 gr	100	73	27	186,332,286	1,431,363,764
	100	75	25	1,875,061,263	1,397,940,009
	100	77	23	1,886,490,725	1,361,727,836
	100	78	22	1,892,094,603	1,342,422,681
	100	79	21	1,897,627,091	1,322,219,295
	100	81	19	1,908,485,019	1,278,753,601
	100	84	16	1,924,279,286	1,204,119,983
Sugarcane Bagasse 3 gr	100	74	26	186,923,172	1,414,973,348
	100	82	18	1,913,813,852	1,255,272,505
	100	83	17	1,919,078,092	1,230,448,921
	100	83	17	1,919,078,092	1,230,448,921
	100	83	17	1,919,078,092	1,230,448,921
	100	84	16	1,924,279,286	1,204,119,983
	100	84	16	1,924,279,286	1,204,119,983

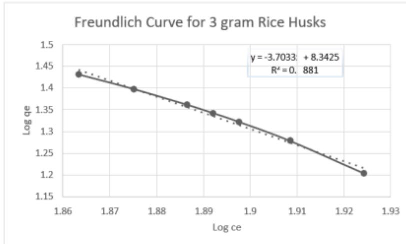


Fig 3. Freundlich Curve for 3-gram Rice Husks

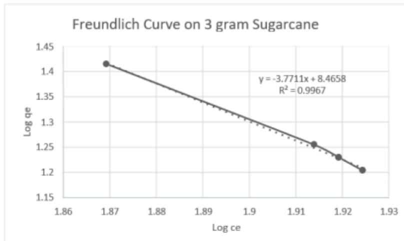


Fig 4. Freundlich curve for 3 grams of sugar cane bagasse

IV. CONCLUSIONS

Based on the results of research and calculations, it can be concluded that:

1. Activated carbon from sugar cane bagasse and rice husks can increase the pH value of produced water from 5 to 7.
2. Activated carbon from sugar cane bagasse and rice husks can reduce the TDS value of produced water. The greater the mass concentration of activated carbon in sugar cane bagasse or the mass of activated carbon in rice husks, the greater the decrease in the TDS value. By adding a mass of 3 grams of activated carbon to rice husks, there was a decrease in the TDS of produced water from 5100 ppm to 2261 ppm, and by adding a mass of 3 grams of activated carbon to 3 grams of sugarcane bagasse, there was a decrease in the TDS of produced water from 5100 ppm to 1153 ppm. Sugarcane Bagasse and Rice Husk Adsorbents can be obtained. reduced the TDS value in produced water from 5100 ppm when the Rice Husk adsorbent was added to 2261 ppm, while when the Sugarcane Bagasse adsorbent was added it became 1153 ppm. There was a decrease in the salinity value when the adsorbent was added to the formation water.
3. To add an active carbon mass concentration of 3 grams of sugarcane bagasse or to add an active carbon mass concentration of 3 grams of rice husks, the longer the contact time, the smaller the adsorption value (qe). When compared between sugarcane bagasse and rice husk, the adsorption value of bagasse is greater than rice husk
4. In the processing of produced water, sugarcane bagasse is a better material than rice husks based on research that has been carried out.
5. Based on the adsorption results in Linear Regression of Sugarcane Bagasse activated carbon, it is more suitable to use the Freundlich equation because the Correlation Coefficient value is close to 1.0

REFERENCES

[1] D. Vasconez, S. Farag, A. Meneses, O. Rodriguez, and W. Pastrana, “Water Source Wells: Challenges to Produce Water. Field Experiences from a Waterflooding Project,” in: Day 4 Thu, July 30, 2020, SPE, 2020. doi:10.2118/199154-MS.

[2] P.E. Korsah, I.S. Ambrose, and W.. Korsah, “The use of Constructed Wetlands in Produce Water Treatment; an Option for the Oil and Gas Industry,” in: Day 3 Thu, June 12, 2014, SPE, 2014. doi:10.2118/169998-MS.

[3] Q. Liu, P. Yang, W. Tu, H. Sun, S. Li, and Y. Zhang, “Lithium recovery from oil and gas produced water: opportunities, challenges, and future outlook,” ***Journal of Water Process Engineering***, **55** 104148 (2023). doi:10.1016/j.jwpe.2023.104148.

[4] M. Al-Saidi, “Produced Water as New Water in the Hydrocarbon Industry,” in: 2022: pp. 489–498. doi:10.1007/978-3-319-95846-0_47.

[5] N.L. Pangestu, N.L. Zahra, A. Sarwono, I. Rahmalia, I.Y. Septiariva, and I.W.K. Suryawan, “Determination of Produced Wastewater Treatment Systems for Reclaim Water in the Oil and Gas Industry,” in: 2023: pp. 1009–1017. doi:10.1007/978-981-16-9348-9_89.

[6] B. Ogbuji, A.G.A. Nnanna, M. Engle, and R. Amesquita, “Compositional analysis of conventional and unconventional permian basin-produced waters: a simple tool for predicting major ion composition,” *SPE Production & Operations*, **37** (*03*) 383–396 (2022). doi:10.2118/209599-PA.

[7] N.. Ghorbani, C.. Yan, P.. Guraieb, R.C. Tomson, D.. Abdallah, A.. Ben Aouda, N.M. Odeh, and T.A. Al Daghar, “Validating Automated Real-Time Produced Water Composition Measurement Device with Field Produced Water Samples: A Pathway to Field Trial,” in: Day 2 Tue, November 14, 2017, SPE, 2017. doi:10.2118/188244-MS.

[8] M. Asthana, A. Kumar, and B.S. Sharma, “Wastewater Treatment,” in: Principles and Applications of Environmental Biotechnology for a Sustainable Future, Springer Singapore, Singapore, 2017: pp. 173–232. doi:10.1007/978-981-10-1866-4_6.

[9] M. Akstinat, “Chemical and physicochemical properties of formation waters of the oil and gas industry,” *J Hydrol (Amst)*, **578** 124011 (2019). doi:10.1016/j.jhydrol.2019.124011.

[10] R.S. Dhamorikar, V.G. Lade, P. V. Kewalramani, and A.B. Bindwal, “Review on integrated advanced oxidation processes for water and wastewater treatment,” ***Journal of Industrial and Engineering Chemistry***, (2024). doi:10.1016/j.jiec.2024.04.037.

[11] Menteri Negara Lingkungan Hidup, “Peraturan Menteri Negara Lingkungan Hidup Nomor 19 Tahun 2010 Tentang Baku Mutu Air Limbah Bagi Usaha Dan/Atau Kegiatan Minyak Dan Gas Serta Panas Bumi,” n.d.

[12] H. Najafi, A. Golrokh Sani, and M.A. Sobati, “A comparative evaluation on the physicochemical properties of sugarcane residues for thermal conversion processes,” *Ind Crops Prod*, **202** 117112 (2023). doi:10.1016/j.indcrop.2023.117112.

[13] S.L. Sunar, R.K. Oruganti, D. Bhattacharyya, D. Shee, and T.K. Panda, “Deep eutectic solvent pretreatment of

sugarcane bagasse for efficient lignin recovery and enhanced enzymatic hydrolysis," ***Journal of Industrial and Engineering Chemistry***, (2024). doi:10.1016/j.jiec.2024.05.030.

[14] Y. Sun, C. Liang, W. Qi, Q. Wang, L. Zhan, J. Tong, J. Jiang, and Z. Yao, "One-pot catalytic hydrolysis of sugarcane bagasse into furfural using a pressurized phosphoric acid/acetone/water system," *Biomass Bioenergy*, **185** 107242 (2024). doi:10.1016/j.biombioe.2024.107242.

[15] N.Y. Nguyen-Thi, C.Q. Nguyen, Q. Le Dang, Q. De Tran, T.N. Do-Thi, and L.H. Vu Thanh, "Extracting lignin from sugarcane bagasse for methylene blue and hexavalent chromium adsorption in textile wastewater: a facile, green, and sustainable approach," *RSC Adv*, **14** (*7*) 4533–4542 (2024). doi:10.1039/D3RA08007B.

[16] S. Awasthi, A. Mishra, and D.B. Pal, "Energy Production from Sugarcane Bagasse and Rice Husk," in: 2024: pp. 157–181. doi:10.1007/978-981-97-0840-6_7.

[17] M. Wanli, S. Suda, and S. Murata, "Effect of Nano-Silica Synthesized from Rice Husk on Low Salinity Water Flooding," in: Day 2 Tue, April 23, 2024, SPE, 2024. doi:10.2118/218244-MS.

[18] S.J. Mane, P. Kumbhare, and A. Pandav, "Experimental study of treatment of kitchen waste water using rice husk ash," *Mater Today Proc*, (2024). doi:10.1016/j.matpr.2024.01.056.

[19] N.H. Shalaby, E.M.M. Ewais, R.M. Elsaadany, and A. Ahmed, "Rice husk templated water treatment sludge as low cost dye and metal adsorbent," ***Egyptian Journal of Petroleum***, **26** (*3*) 661–668 (2017). doi:10.1016/j.ejpe.2016.10.006.

[20] M.S. Masoud, W.M. El-Saraf, A.M. Abdel - Halim, A.E. Ali, E.A. Mohamed, and H.M.I. Hasan, "Rice husk and activated carbon for waste water treatment of el-mex bay, alexandria coast, egypt," ***Arabian Journal of Chemistry***, 9 S1590–S1596 (2016). doi:10.1016/j.arabjc.2012.04.028.

[21] K. Durand, R. Daassi, D. Rodrigue, and T. Stevanovic, "Study of biopolymers and silica recovery from pre-hydrolyzed rice husks," *Biomass Convers Biorefin*, (2024). doi:10.1007/s13399-024-05445-0.

[22] S. Singh Rawat, and A. Sharma, "Sugarcane bagasse ash—the future composite material: a literature review," *Mater Today Proc*, (2023). doi:10.1016/j.matpr.2023.07.272.

[23] Valério Filho, L.V. Tholozan, E.O. da Silva, L. Meili, A.R.F. de Almeida, and G.S. da Rosa, "Perspectives of the reuse of agricultural wastes from the Rio Grande do Sul, Brazil, as new adsorbent materials," in: Biomass-Derived Materials for Environmental Applications, Elsevier, 2022: pp. 243–266. doi:10.1016/B978-0-323-91914-2.00014-3.

[24] J. Jampílek, and K. Kráľová, "Preparation of nanocomposites from agricultural waste and their versatile applications," in: Multifunctional Hybrid Nanomaterials for Sustainable Agri-Food and Ecosystems, Elsevier, 2020: pp. 51–98. doi:10.1016/B978-0-12-821354-4.00004-2.

[25] M.Z. Yameen, S.R. Naqvi, D. Juchelková, and M.N.A. Khan, "Harnessing the power of functionalized biochar: progress, challenges, and future perspectives in energy, water treatment, and environmental sustainability," *Biochar*, **6** (*1*) 25 (2024). doi:10.1007/s42773-024-00316-3.

[26] Bedane, T. Guo, B. Shirani, and H. Xiao, "Textural characteristics of activated carbons prepared from

agricultural residues-review," ***Can J Chem Eng***, **101** (*12*) 6718–6739 (2023). doi:10.1002/cjce.24960.

[27] Nafisifar, A.K. Manshad, and S.R. Shadizadeh, "Primary evaluation of a new green synthesized anionic surfactant, micellar behavior analysis, and flooding in sandstone reservoirs: application in chemical enhanced oil recovery," ***SPE Journal***, **27** (*01*) 771–789 (2022). doi:10.2118/208569-PA.

[28] L.N. Rozanov, "Kinetic equations of non-localized physical adsorption in vacuum for freundlich adsorption isotherm," *Vacuum*, **189** 110267 (2021). doi:10.1016/j.vacuum.2021.110267.

[29] R. Ezzati, "Derivation of pseudo-first-order, pseudo-second-order and modified pseudo-first-order rate equations from langmuir and freundlich isotherms for adsorption," ***Chemical Engineering Journal***, **392** 123705 (2020). doi:10.1016/j.cej.2019.123705.

[30] G.P. Jeppu, and T.P. Clement, "A modified langmuir-freundlich isotherm model for simulating ph-dependent adsorption effects," ***J Contam Hydrol***, **129–130** 46–53 (2012). doi:10.1016/j.jconhyd.2011.12.001.

[31] Ng, J.N. Losso, W.E. Marshall, and R.M. Rao, "Freundlich adsorption isotherms of agricultural by-product-based powdered activated carbons in a geosmin–water system," *Bioresour Technol*, **85** (*2*) 131–135 (2002). doi:10.1016/S0960-8524(02)00093-7.

[32] S. Meunchang, S. Panichsakpatana, and R.W. Weaver, "Co-composting of filter cake and bagasse; by-products from a sugar mill," *Bioresour Technol*, **96** (*4*) 437–442 (2005). doi:10.1016/j.biortech.2004.05.024.

Analysis of Rice Husks and Sugarcane Bagasse

ORIGINALITY REPORT

7%	2%	6%	2%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	Submitted to Universitas Prima Indonesia Student Paper	2%
2	Kalderis, D.. "Production of activated carbon from bagasse and rice husk by a single-stage chemical activation method at low retention times", Bioresource Technology, 200810 Publication	2%
3	R. Iqbal Robbie, Ali Roziqin, Shannaz Mutiara Deniar, Ardik Praharjo, Kenny Roz. "Environmental Issues and Social Inclusion in a Sustainable Era", Routledge, 2023 Publication	1%
4	Havidh Pramadika, Bayu Satiyawira, R. Hari Karyadi Oetomo, Yosia Anaugtuharesto, Rizky Satrio Putra Sunjaya, Malunlana Alamsah. "Bagasse and bamboo charcoal comparison: as adsorbents for waste water to comply with Indonesian environmental quality standards", IOP Conference Series: Earth and Environmental Science, 2023 Publication	1%
5	sloap.org Internet Source	1%
6	Novena Lany Pangestu, Nurulbaiti Listyendah Zahra, Ariyanti Sarwono, Intan Rahmalia et al. "Chapter 89 Determination of Produced Wastewater Treatment Systems for Reclaim	1%

Water in the Oil and Gas Industry", Springer Science and Business Media LLC, 2023
Publication

7	www.scilit.net Internet Source	1 %

Exclude quotes	Off	Exclude matches	< 15 words
Exclude bibliography	On		