Proceeding Paper

Compare the Levels of Use of Activated Carbons for Water Treatment and Biogas Purification as Well as Their Reactive Abilities [†]

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[†] Presented at Innovations-Sustainability-Modernity-Openness Conference (ISMO'21), Białystok, Poland, 14 May 2020.

Abstract: The conducted research concerned a comparison of the levels of use of activated carbons purifying water and biogas, and their reactivation capacity. The process of reactivation of both activated carbons was carried out using laboratory kiln. Reactivation was carried out in identical conditions for both tested samples. The obtained results proved that both activated carbons can be regenerated although they differ significantly in degree of use. It was proven that the technological process, the degree of contamination, and the contact time of activated carbon with the medium have a significant impact on the quality, speed, and success of the reactivation process.

Keywords: activated carbon; water treatment; biogas production; regeneration; reactivation; iodine number; mechanical strength; surface area; environmental engineering

Citation: Winconeł, Ł.; Ignatowicz, K. Compare the Levels of Use of Activated Carbons for Water Treatment and Biogas Purification as Well as Their Reactive Abilities. *Environ. Sci. Proc.* **2021**, *9*, 8. <https://doi.org/10.3390/environsciproc2021009008>

Academic Editors: Dorota Anna Krawczyk, Iwona Skoczko, Antonio Rodero Serrano and Ewa Szatyłowicz

Published: 14 October 2021

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1. Introduction

Activated carbon (AC) is a porous material with a large specific surface area and increased pore volume. The activated carbon structure is a disordered pore system with a diameter of less than one to several hundred nanometers. AC has a large specific surface area (up to 1200 m²/g) and a significant pore volume (even above 1 cm³/g) [1–6]. They are made on the basis of various raw materials, such as coal, charcoal, peat, anthracite, coconut shells, beet molasses, and palatinose and can take various forms: dusty, granular, and formed [3–8]. AC is used in many industries, for example dietary supplementation, pharmaceutical industry, synthesis, electroplating industry, water treatment, exhaust gas, and waste gas treatment [1,3,9–11].

2. Material and Methods

We collected three samples of activated carbon (WG-12(W), WG-12(S), and NG-II). The first and the second one was used in the water treatment process for four years (in various water treatment plants, where (S)—Szczecin, (W)—Warsaw), the third in the purification of biogas from siloxanes for two months (Krzywa—biogas plant). Samples differed essentially from two components: grain size and time of work in the process. Other components such as the origin of raw materials, production technology, and physicochemical parameters were comparable. The parameters of three active carbons are presented in Table 1.

Table 1. The parameters of new activated carbon (WG-12 and NG-II).

Activated Carbon	Iodine Number [mg/g]	Surface Area [m ² /g]	Mechanical Strength [%]	Bulk Density [g/L]	Ash Content [%]	Volatile Parts Content [%]
WG-12 (W)	1058	1001	97.8	454	14.3	7.4
WG-12 (S)	1072	1012	97.7	442	14.1	8.1
NG-II	1024	952	99.9	467	14.6	8.8

Activated carbons was dried and analyzed to determine the degree of use. The results are presented in Table 2.

Table 2. The parameters of used activated carbon (WG-12—water treatment, NG-II—biogas).

Activated Carbon	Iodine Number [mg/g]	Surface Area [m ² /g]	Mechanical Strength [%]	Bulk Density [g/L]	Ash Content [%]	Volatile Parts Content [%]
WG-12 (W)	346	267	97.1	583	13.7	22.8
WG-12 (S)	523	451	96.1	501	10.2	14.9
NG-II	32	1	99.9	655	13.6	41.3

The research involved reactivating three activated carbon samples using the same process conditions. The test stand consisted of a stationary dryer and a laboratory kiln. Prepared and standardized tests in the amount of 0.1 dm³ were mounted in a pipe made of steel wire with a mesh of 0.5 mm and subjected to the reactivation process at 850 °C for 20 min [12]. The experiment was replicated three times to reach reliable results.

3. Results and Discussion

Table 3 presents obtained results of re-activated carbons.

Table 3. The parameters of re-activated carbon (WG-12—water treatment, NG-II—biogas).

Activated Carbon	Iodine Number [mg/g]	Surface Area [m ² /g]	Mechanical Strength [%]	Bulk Density [g/L]	Ash Content [%]	Volatile Parts Content [%]
WG-12 (W)	587	505	96.1	511	17.6	7.2
WG-12 (S)	841	776	93.7	427	11.6	4.2
NG-II	914	847	99.6	504	17.4	5.7

The results obtained show the reactivity of each sample tested. The obtained results showed that both activated carbons can be regenerated, although they differ significantly in the degree of elaboration. The highest reactivation rate was obtained for NG-II carbon, while the lowest for WG-12 (W). It was noted that the degree of regeneration is different for the same sorbent operating under different conditions. It has been shown that the technological process, the degree of contamination and the contact time of activated carbon with the purified medium have a significant impact on the quality, speed, and success of the reactivation process. There was no significant effect of the reactivation process on the mechanical strength of the tested activated carbons. The efficiency of processes differed significantly from each other.

4. Conclusions

1. The highest reactivation rate was obtained for NG-II carbon, while the lowest for WG-12 (W).
2. It was noted that the regeneration capacity is different for the same type of activated carbon operating under different conditions.
3. The efficiency of the regeneration process largely depends on the degree of use of activated carbon.

Author Contributions: Ł.W. and K.I. conceived and designed the experiments; Ł.W. performed the experiments; Ł.W. and K.I. analyzed the data; Ł.W. contributed materials; Ł.W. wrote the paper. All authors have read and agreed to the published version of the manuscript.

Institutional Review Board Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

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