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TECHNICAL FACULTY BOR

52nd International October Conference on Mining and Metallurgy

PROCEEDINGS

Edited by

Saša Stojadinović

and

Dejan Petrović

November 29th – 30th 2021

Bor, Serbia

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pH AND CONDUCTIVITYCHANGE DURING THE RINSING AND ADSORPTION OF COPPER IONS ONTO WALNUT SHELLS

Miljan Marković[1], Milan Gorgievski[1], Nada Štrbac[1], Vesna Grekulović[1], Aleksandra Mitovski[1], Kristina Božinović[1], Milica Zdravković[1]

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Abstract

The change in pH and conductivity values during the rinsing of the walnut shells as well as during the adsorption of copper ions wasinvestigated in this study. The pH value increases during the rinsing of the adsorbent, reaching a constant value after the passing of 100 ml of distilled water. The increase in the pH value during the rinsing of the adsorbent occurs as a result of the transfer of H^+ ions from the aqueous phase into the molecular structure of the adsorbent, where they are exchanged with alkali and alkaline-earth metal ions. As for conductivity change, a sudden increase in conductivity occurs after passing the first 50 ml of distilled water, followed by a decrease in conductivity with further rinsing. The increase in conductivity is most likely caused by the increase in the concentration of alkali and alkaline earth metal ions in the solution, which are being transferred from the adsorbent structure into the aqueous phase. During the adsorption process, the pH value rapidly increases for the first few minutes, after which starts to decline. The release of H^+ ions from the adsorbent structure into the aqueous phase causes a rapid decrease in pH value as a result of the deprotonation of functional groups in the adsorbent molecular structure. The conductivity increases during the adsorption process. This increase is due to an increase in the concentration of alkali and alkaline earth metal ions in the solution, which are exchanged with copper ions during the adsorption process.

***Keywords**: Adsorption, copper ions, walnut shells, pH, conductivity.*

1. INTRODUCTION

The growing development of the mining and metal processing industry in the 21st century, which aims to process ores, metals, minerals, and other raw materials as efficiently as possible, has led to the creation of a huge amount of wastewater [1]. For an industry to be able to operate smoothly, it is necessary to comply with legal laws that require efficient wastewater treatment systems [2].During the last two decades, there has been an increase in environmental awareness in the world, which has contributed to the development of new, efficient, ecological, and economically acceptable technologies for wastewater treatment.Removal of heavy metals from wastewaters can be achieved by already existing conventional technologies such as: chemical precipitation, coagulation and flocculation, adsorption, ion exchange, solvent extraction, electrochemical methods, cementation, and various membrane processes [3].A new potential method of wastewater treatment, especially wastewaters with low content of pollutants, is adsorption using natural adsorbents–biosorption [4]. The main advantages of the biosorption process, compared to the conventional technologies, are: high efficiency in treating very dilute effluents, low operating costs, natural adsorbents are often with low or without economic value, and minimizationof obtained sludge [5].

In this paper, walnut shells were used as an adsorbent for copper ions adsorption from aqueous solutions. The pH and conductivity values were monitored during the rinsing of the adsorbent as well as during the adsorption process.

2. EXPERIMENTAL

The adsorption experiments were performed by bringing into contact 0.5 g of walnut shells with 50 ml of a synthetic copper ions solution of initial concentration 0.2 g dm^{-3}. Prior the experiments, walnut shells were firstly ground, then sieved through a set of laboratory sieves, and the sieve fraction (-1+0.4) mmwas used for the experiments.All the sampleswere rinsed with 200 ml of distilled water before the adsorption experiments.

3. RESULTS AND DISCUSSION

3.1 Change of pH value during the rinsing of walnut shells with distilled water

The change in pH value during the rinsing of walnut shells is shown in Figure 1. It can be seen that the pH value rises quickly at the beginning of the adsorption process, reaching a near-constant value after passing 100 ml of distilled water. The increase in pH value most likely occurs due to the transfer of H^+ ions from the aqueous phase into the structure of the walnut shells, where they are exchanged with the alkali and alkaline earth metal ions from the walnut shells structure.

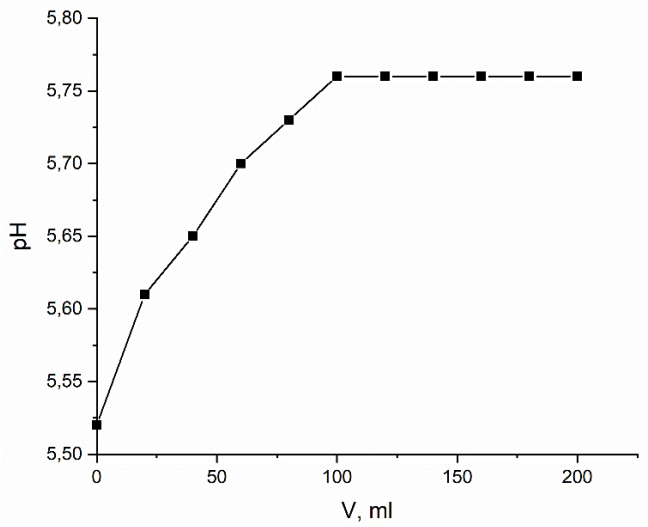

Figure 1. Change in pH value of the solution during the rinsing of the walnut shells

3.2 Change in conductivity of the solution during the rinsing of walnut shells with distilled water

The change in conductivity of the solution during the rinsing of walnut shells with distilled water is shown in Figure 2. It can be seen, that the conductivity first rises up to around 50 ml of distilled water passed, where it reaches its maximum value. After that, with further rinsing, a decrease in the conductivity of the solution is noted. The increase in the conductivity occurs due to the increase in the concentration of alkali and alkaline earth metal ions in the solution, which are transferred from the walnut shells structure into the aqueous phase. With further rinsing, the conductivity decreases as a result of a decrease in the concentration of these ions due to the dilution of the solution.

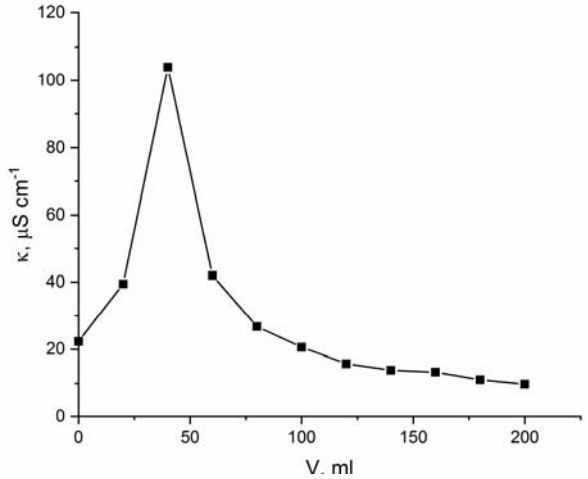

Figure 2. Change in conductivity of the solution during the rinsing of walnut shells with distilled water

3.3 Change of pH value during the adsorption of copper ions onto walnut shells

Quite a different change in pH value was noted during the adsorption process, opposed to the rinsing of the adsorbent. The change in pH value of the solution during the adsorption of copper ions onto walnut shells is shown in Figure 3. As can be seen from Figure 3, the pH value sharply increasesin the first few minutes of the process, after whichdecreases,reaching almost a constant value after 30 minutes of the adsorption process. The decrease in pH value occurs due to the deprotonation of functional groups existing in the structure of the walnut shells, and the transfer of H^+ ions into the solution, where they are exchanged with copper ions.

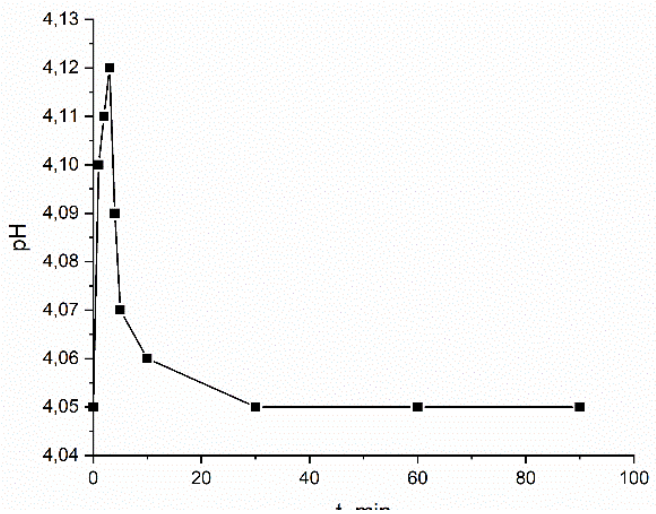

Figure 3. Change in pH value of the solution during the adsorption of copper ions onto walnut shells

3.4 Change in conductivity of the solution during the adsorption of copper ions onto walnut shells

The change in conductivity of the solution during the adsorption of copper ions onto walnut shells is shown in Figure 4. As can be seen from Figure 4 the conductivity of the solution increases during the adsorption process. Thisincrease in conductivity occurs due to the increase in the concentration of alkali and alkaline earth metal ions in the solution, which are being exchanged with copper ions during the adsorption process.

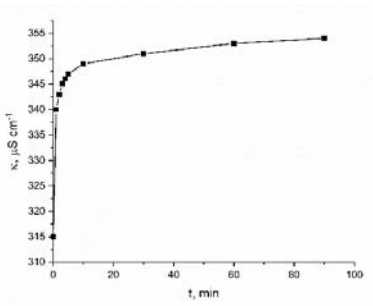

Figure 4. Change in conductivity of the solution during the adsorption of copper ions onto walnut shells

4. CONCLUSIONS

During the rinsing of the adsorbent, the pH value of the solution increases due to the transfer of H^+ ions from the aqueous phase into the structure of the walnut shells. The conductivityof the solution first rises up to around50 ml of distilled water passed, where it reaches its maximum value. After that, with further rinsing, a decrease in the conductivity of the solution is noted. The increase in the conductivity occurs due to the increase in the concentration of alkali and alkaline earth metal ions in the solution, which are transferred from the walnut shells structure to the aqueous phase. With further rinsing, the conductivity decreases as a result of a decrease in the concentration of these ions due to the dilution of the solution. For the adsorption experiments,the pH value sharply increases in the first few minutes of the process, after which decreases, reaching almost a constant value after 30 minutes of the adsorption process. The decrease in pH value occurs due to the deprotonation of functional groups existing in the structure of the walnut shells, and the transfer of H^+ ions into the solution, where they are exchanged with copper ions. The conductivity of the solution increases during the adsorption process. This increase occurs due to the increase in the concentration of alkali and alkaline earth metal ions in the solution, which are being exchanged with copper ions during the adsorption process.

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