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Ljubiša Balanović
Dejan Tanikić

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PREFACE

On behalf of the Organizing Committee, it is a great honor and pleasure to welcome all esteemed participants of the 54th International October Conference on Mining and Metallurgy (IOC 2023), scheduled to take place at the picturesque Bor Lake, Serbia, from October18th to 21st 2023.

The collaborative efforts of the University of Belgrade, the Technical Faculty in Bor, and the Mining and Metallurgy Institute Bor have meticulously organized this year's IOC. Our focus remains unwavering on showcasing the latest research findings and advancements in geology, mining, metallurgy, materials science, technology, environmental protection, and other engineering disciplines. Our primary objective is to foster a dynamic environment where academics, researchers, and industry professionals can come together to share their knowledge, experiences, and innovative ideas while exploring opportunities for collaborative research endeavors.

Our conference agenda is rich and diverse, encompassing plenary sessions, engaging invited lectures, technical presentations, enlightening oral and poster sessions, informative technical tours, a diverse exhibition, and memorable social gatherings. At the heart of this event lies our strong commitment to sustainable development within the mining and metallurgy sector. We are dedicated to exploring ecologically conscious methodologies, responsible resource extraction practices, and cutting-edge technologies that reduce the industry's environmental impact and enhance the well-being of local communities.

The conference proceedings comprise 129 papers authored by individuals from universities, research institutes, and industries in 22 countries. We are proud to welcome participants from Bosnia and Herzegovina, Bulgaria, Canada, China, Croatia, Germany, Greece, India, Iran, Kazakhstan, Libya, North Macedonia, Montenegro, Morocco, Romania, Russia, Slovakia, South Africa, Spain, Turkey, United States, and, of course, Serbia.

We are excited to host the 8th International Student Conference on Technical Sciences (ISC 2023) as part of IOC 2023. This event offers students from Serbia and the wider region a unique chance to showcase their research and discuss the future of their fields with experts.

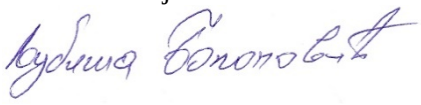
We sincerely thank the Ministry of Science, Technological Development, and Innovation of the Republic of Serbia for their generous financial support. In addition, we express our profound gratitude to all our sponsors, exhibitors, and friends of the Conference for their contributions and unwavering support for playing a pivotal role in ensuring the success of IOC 2023.

We would like to express our heartfelt thanks to all authors, committees, reviewers, speakers, and chairpersons for their invaluable contributions in shaping IOC 2023.

We look forward to welcoming you to the 55th International October Conference on Mining and Metallurgy (IOC 2024), which will be held in October 2024.

On behalf of the 54th IOC Organizing Committee,

Prof. dr Ljubiša Balanović



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ADSORPTION KINETICS FOR COPPER IONS ADSORPTION ONTO ONION PEELS

Milan Gorgievski, Miljan Marković, Nada Štrbac, Vesna Grekulović, Kristina Božinović, Milica Zdravković, Marina Marković

University of Belgrade, Technical Faculty in Bor, V.J. 12, 19210 Bor, Serbia

Abstract

Kinetic analysis of copper ions adsorption onto onion peels is presented in this paper. The experimental kinetic data were analyzed using two kinetic models, namely the pseudo-first order kinetic model and the pseudo-second order kinetic model. The kinetic parameters were calculated from the linearized plots of the corresponding models. The obtained results indicate that the adsorption of copper ions onto onion peels follows the pseudo second-order kinetic model, with a correlation coefficient of $R^2 = 0.994$. This indicates that the chemical interaction between the surface functional groups is the limiting factor of the process rate.

***Keywords**: adsorption, onion peels, copper ions, kinetic models*

1. INTRODUCTION

Environmental pollution, which includes water, air, and soil pollution, is a serious environmental problem. Water contaminated with heavy metals is one of the biggest environmental problems today. Water polluted with heavy metals affects flora and fauna, and through the food chain, also affects human health. After reaching the human body, heavy metals can lead to serious health problems and complications [1].

Heavy metals can be removed from wastewater by well-known industry-applied conventional methods, such as chemical precipitation, cementation, ion exchange, solvent extraction, etc. These methods don't always give satisfactory results in terms of insufficient degree of metal ions removal, formation of significant amounts of sludge that needs further processing, the need for excessive amounts of chemicals consumed in the process, and high costs. Due to the tendency of every industrial process to be more economical and efficient, adsorption using natural adsorbents - biosorption is being investigated as one of the alternatives to conventional technologies for wastewater treatment, especially those with low heavy metal ions content [2,3].

Biosorption is a new process, which, at the laboratory level, has proven to be effective in the treatment of aqueous solutions with a certain content of these metal ions [4].

The main advantages of this method compared to conventional technologies are reflected in the efficiency in removing heavy metal ions, as well as in the availability and price of such adsorbents, with very often minimal or without economic value [5].

The analysis of the experimentally obtained data and the determination of the mechanism of the adsorption process, its speed, as well as the step that determines the overall speed of the adsorption process, can be performed using kinetic models of adsorption. Some of the models used to describe the kinetics of the adsorption process and mostly found in the literature are: the pseudo-first order kinetic model and the pseudo-second order kinetic model [6, 7].

2. EXPERIMENTAL

The biosorption experiments were performed in batch conditions, on a magnetic stirrer. The change in the adsorption capacity of copper ions with time was determined by bringing into contact 50 mL of a solution with an initial Cu concentration of 0.2 g dm^{-3} with 0.5 g of onion peels, for

different process time. Biosorption was terminated after 90 minutes, assuming that this time was long enough to establish equilibrium in the system [3].

3. RESULTS AND DISCUSSION

Figure 1 shows the change in the adsorption capacity with time. It can be seen that at the beginning of the process (first 5 minutes), the adsorption capacity increases rapidly with the contact of the phases. The rapid increase in capacity at the beginning of the process is due to the large number of available active sites in the biosorbent structure where copper ions can be incorporated. Further, with process time, a slight increase in the adsorption capacity is observed, due to a decrease of available active sites, as well as a decrease in the concentration of copper ions in the solution.

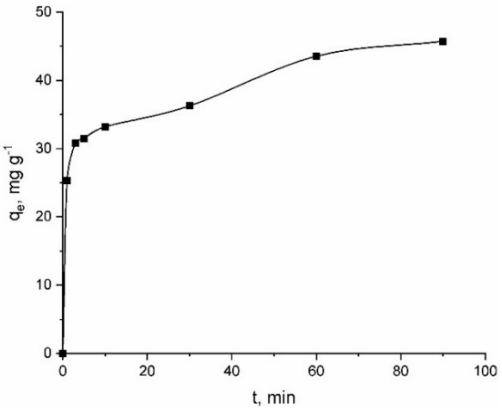

Figure 1 – Change in the adsorption capacity with time

3.1 Pseudo-first order kinetic model

Lagergren showed that the rate of the adsorption of a solute onto an adsorbent is based on the adsorption capacity and follows a pseudo-first-order equation. Lagergren's pseudo-first-order kinetic model can be represented by the following equation [8]:

$$\frac{dq_{(t)}}{dt} = k_1(q_e - q_{(t)}) \tag{3}$$

where: $q_{(t)}$ – adsorption capacity defined as the mass of adsorbed metal per unit mass of adsorbent for time t (mg g^{-1}), q_e – adsorption capacity defined as the mass of adsorbed metal per unit mass of adsorbent at equilibrium (mg g^{-1}), k_1- adsorption rate constant for the pseudo-first order kinetic model (min^{-1}).

A plot of $log(q_e-q_{(t)})$ vs. t (Figure 2) gives a linear dependence, from which the constant k_1 and the equilibrium adsorption capacity q_e can be determined from the slope and intercept, respectively. The kinetic parameters are given in Table 1, together with the correlation coefficient for this model.

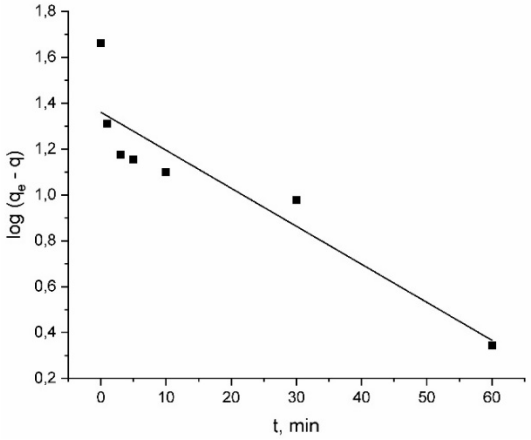

Figure 2 – Pseudo-first order kinetic model for copper ions adsorption onto onion peels

Table 1 – Pseudo-first order kinetic model parameters for copper ions biosorption onto onion peels

Parameter/ion	k_1 (min^{-1})	$q_{e,exp}$ (mg g^{-1})	$q_{e,cal}$ (mg g^{-1})	R^2
Cu^{2+}	0.0382	45.71	22.19	0.845

Based on the value of the correlation coefficient $R^2 = 0.845$ (Table 1), it can be concluded that the functionality of this model is not satisfactory, which it cannot be used to describe the adsorption process of copper ions on onion peels. Also, the obtained values for the parameters $q_{e,exp}$ and $q_{e,cal}$ differ significantly.

3.2 Pseudo-second order kinetic model

The pseudo-second-order kinetic model is based on the assumption that the adsorbate binds to the surface of the adsorbent by chemisorption [9]. This model can be represented by the following equation:

$$\frac{dq_{(t)}}{dt} = k_2(q_e - q_{(t)})^2 \quad (6)$$

where: $q_{(t)}$ – adsorption capacity defined as the mass of adsorbed metal per unit mass of adsorbent for time t (mg g^{-1}), q_e – adsorption capacity defined as the mass of adsorbed metal per unit mass of adsorbent at equilibrium (mg g^{-1}), k_2- adsorption rate constant for the pseudo-second order kinetic model (min^{-1}).

The plot $t/q_{(t)}$ as a function of t (Figure 3) gives a linear dependence from which the equilibrium adsorption capacity q_e and constant k_2 can be calculated from the slope and intercept, respectively. The kinetic parameters are given in Table 2, together with the correlation coefficient for this model.

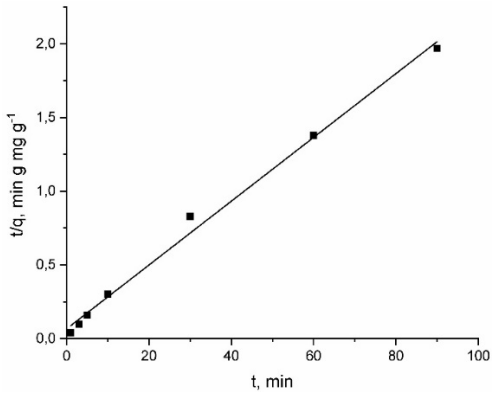

Figure 3 – Pseudo-second order kinetic model for copper ions adsorption onto onion peels

Table 2 – Pseudo-second order kinetic model parameters for copper ions biosorption onto onion peels

Parameter/Ion	k_2 (min^{-1})	$q_{e,exp}$ (mg g^{-1})	$q_{e,cal}$ (mg g^{-1})	R^2
Cu^{2+}	0.007	45.71	46.18	0.994

The correlation coefficient from Table 2 ($R^2 = 0.994$), indicates that the pseudo-second order kinetic model shows an excellent agreement with the analyzed experimental data. This means, that the adsorbate binds to the surface of the adsorbent by the chemisorption. Also, the close values of $q_{e,exp}$ and $q_{e,cal}$ confirm the good functionality of the proposed model.

4. CONCLUSIONS

The kinetic analysis of the adsorption of copper ions onto onion peels is presented in this paper. Two kinetic models, namely the pseudo-first order and the pseudo-second order kinetic model, were used to fit the experimental data. Obtained results show that the pseudo-second order kinetic

model is the best fit for the analyzed data. This leads to the conclusion that chemisorption is a possible way of binding the copper ions to the active sites on the surface of the onion peels.

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