TRANSLOCATION OF RICE CELL-BASED BIOSORBENT FOR EFFICIENT REMOVAL OF CU^{2+} IONS FROM WATER BODIES

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Abstract: *This study investigated the possibility of removing toxic Cu^{2+} ions from aqueous solutions of the biosorbent obtained by modifying rice husk biomass. Biosorbent absorbed Cu^{2+} ion at 40°C in the amount of 43.18 mg/g. The reaction order between biosorbent and metal ion, isotherm and thermodynamic analyzes are presented. Sorption between biosorbent and metal ion at different temperatures (293-313K) was found to correspond to the pseudo-second order (0.97-0.98) kinetic model. Based on the analysis of the adsorption isotherm, it was concluded that the Freundlich isotherm model (0.97-0.99) is more suitable than the Langmuir isotherm model (0.95-0.98).*

Key words; *kinetics, reaction order, copper ion, sorption, pseudo-first-order kinetic model pseudo-second-order kinetic model*

As a result of the industrial revolution and the rapid increase in the population, environmental pollution with heavy metals has increased dramatically since the beginning of the 20th century, causing environmental and human health problems worldwide [1-2]. Important sources of environmental threats include waste incineration plants, agricultural inputs such as sludge, pesticides and mineral fertilizers. An increase in this amount causes a number of diseases in the human body [3]. It accumulates in the environment as a result of the activities of cleaning and coating baths, paperboard mills, wood pulp production and fertilizer industries. This heavy metal has toxicological properties for living organisms. Therefore, it is necessary to control the Cu^{2+} ion concentration and prevent its spread to the environment. Recently, many researchers have been researching inexpensive adsorbents capable of binding metal ions. In this case, it is effective to use naturally available agricultural waste products. In our study, we studied the possibilities of removing Cu^{2+} ions from aqueous solutions of the biosorbent modified from rice husk biomass with urea. Artificial solutions were prepared to study the sorption of Cu^{2+} ions of biosorbent

obtained by modifying rice husk. In this case, a 0.1 mol/L solution was prepared by taking $CuSO_4 \cdot 5H_2O$ from "t" in the required mass. Solutions of other concentrations were prepared based on the dilution of this solution.

To study the sorption of metal ions (Cu^{2+}) of the biosorbent, solutions with different concentrations were prepared. A biosorbent with a static exchange capacity of 5.08 mg-eq/g for hydrochloric acid was used in the sorption process. Adsorption processes were carried out at temperatures of 293, 303 and 313 K for 4, 8, 12, and 24 hours. The amount of adsorbed ions was calculated from the difference in concentrations found in the UV-spectrophotometer of the initial and post-sorption solutions (1).

$$q_e = \frac{(C_0 - C_e)}{m} \times V \quad (1)$$

where: q_e is the mol/g amount of metal ions absorbed into the biosorbent, initial concentration of C_0 metal ions in mol/L, equilibrium concentration of C_e metal ions in mol/L; V – solution volume L; m-biosorbent mass (g) [4, 5].

Sorption kinetics Pseudo-first order, pseudo-second order and several other methods are used to study the reaction order of the adsorption process. Kinetic models are used to determine the mechanism of the sorption process. That is, these models allow for obtaining important information about the rate of chemical reaction, diffusion process and mass exchange [6, 7]. The following kinetic models were used in the study.

It is represented by equation (2) below.

$$\log(q_e - q_t) = \log q_e - \frac{k_1}{2{,}303} t \quad (2)$$

In this equation: q_t and qe are the amount of sorbent sorbent metals at a certain time and equilibrium (mg/g). k_1 is the speed of the first-order sorption process (min^{-1}), and the angular value of the intersection slope in the linear graph of the log (q_e-q_t) and time t is $k_1/2{,}303$.

Pseudo-Second-Order Kinetic Model. It is representedbyequation (3) below.

$$\frac{t}{q_t} = \frac{1}{k_2 q_e^2} + (\frac{1}{q_e})t \quad (3)$$

The initial sorption rate (t = 0) is found as follows (4).

$$h = k_2 q_e^2 \quad (4)$$

In this equation: k_2– the velocity constant, q_e – the amount of metal absorbed in a sorbent of a certain mass (mg/g), t-time (minutes).

Kinetic results.

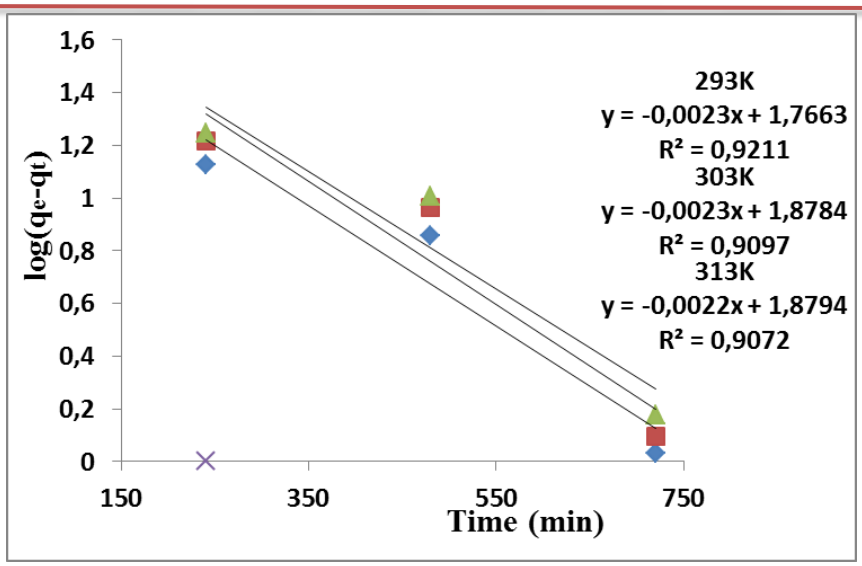

Fig. 1. Pseudo-first-order model of metal ion absorption on biosorbent

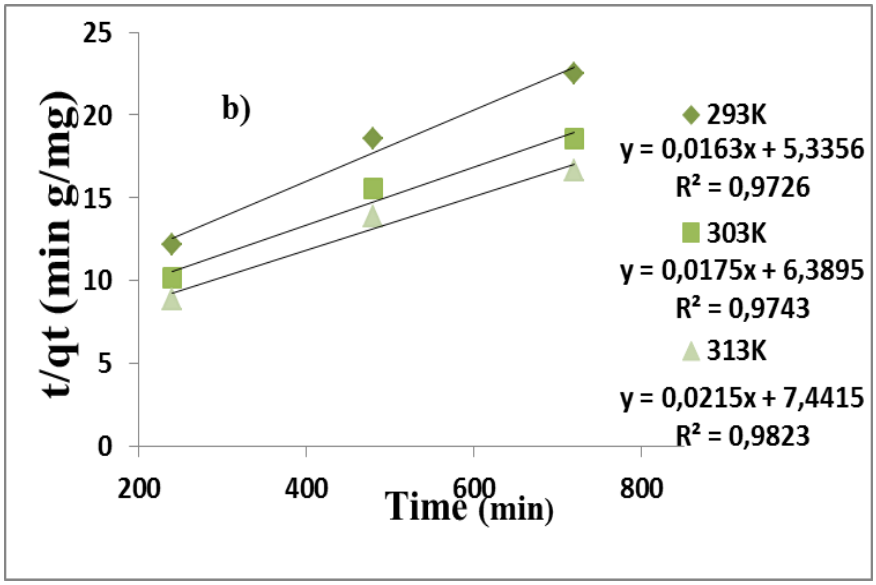

Fig. 2 Pseudo-second-order model of metal ion absorption to biosorbent

Correlation coefficients obtained from the absorption reaction of metal ions to biosorbent are presented in the table below (Table 1).

Table 1

Reaction procedures of absorption of metal ions to biosorbent at different temperatures

T,K	Pseudo-First kinetic model			Pseudo-Second-Order kinetic model		
	q_e	K_1	R^2	q_e	K_2	R^2
293	4,988	-0.0000833	0,92	46,51	0,000679167	0,98
303	6,543	-0.0000958	0,91	57,14	0,000729167	0,97
313	6,549	-0.0000916	0,907	61,34	0,000895833	0,97

From the kinetic constants in table 1, we can see that the sorption of metal ions onto the biosorbent fits the pseudo-second-order kinetic model. That is, it means that the sorption process occurs at the expense of the functional group of the biosorbent and the mobility of metal ions.

CONCLUSION

In short, the secondary hydroxyl groups of rice husk cellulose were altered by modification with urea. As a result, sorption occurred due to the functional groups of the resulting biosorbent.

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