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Adsorption of Lead(II), Cadmium(II) and Copper(II) Ions on Agricultural Byproducts

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Adsorption of Pb^{2+}, Cd^{2+} and Cu^{2+} on different agricultural byproducts has been measured at different temperatures. Adsorption of metal ions follows the order: polymerized orange skin < banana husk for Cd(II) and Pb(II) and orange skin > banana husk for Cu(II). It could also be seen that Cu(II) is a good adsorbing agent as compared to Cd(II) and Pb(II). Thermodynamic parameters have also been evaluated.

Key Words: Adsorption, Agricultural products, Pb(II), Cd(II), Cu(II).

INTRODUCTION

The presence of toxic metal ions in industrial waste has attracted worldwide attention. Several methods such as chemical precipitation, ion exchange, ultrafiltration, electrochemical treatment etc. are suggested for the removal of these metal ions. Few workers have suggested methods for the adsorption of their ions by using inexpensive agricultural byproducts[1], barks[2], peanut skin[3] and agricultural waste materials[4]. Jumle *et al.*[5] have studied adsorption of toxic metal ions like Hg^{2+}, Pb^{2+} and transition metal ion Zn^{2+} on different agricultural byproducts. We thought of using agricultural byproducts in their nature state. The present investigation aims to study adsorption of Cd^{2+}, Pb^{2+} and Cu^{2+} by agricultural products such as orange skin and banana husk.

RESULTS AND DISCUSSION

The data of % adsorption are presented in Tables 1–3. The adsorption of Cu^{2+} as observed on orange is greater than Cd^{2+} and Pb^{2+}. The adsorption of Pb^{2+} and Cd^{2+} is greater than the adsorption of Cu^{2+} in case of banana. It is noted from Tables 1–3 that the order of percentage of adsorption for orange adsorbent is $Cu^{2+} > Cd^{2+} > Pb^{2+}$ except at 0.01 M concentration but for banana adsorbent, the order is $Pb^{2+} > Cd^{2+} > Cu^{2+}$. It is also observed that banana husk is the best adsorbing agent for Pb^{2+} ions.

Some adsorptions were carried out at different temperatures (*i.e.*, 303, 307, 311, 315, 319 and 323 K) and thermodynamic parameters such as ΔG, ΔH and ΔS are evaluated. The data of adsorption systems are presented in Table-4.

TABLE-1
DATA OF % ADSORPTION WITH CONCENTRATION FOR Cu^{2+} IONS

Concentration	Orange skin			Banana husk		
	Ab	Aa	% ΔA	Ab	Aa	% ΔA
0.01	0.05	0.25	20.00	0.04	0.28	24.00
0.02	0.06	0.32	32.00	0.05	0.32	27.00
0.04	0.075	0.40	32.50	0.06	0.38	32.00
0.06	0.08	0.42	34.00	0.08	0.40	32.00
0.08	0.09	0.44	35.00	0.09	0.42	33.00
0.10	0.09	0.46	37.00	0.10	0.42	32.00

TABLE-2
DATA OF % ADSORPTION WITH CONCENTRATION FOR Cd^{2+} IONS

Concentration	Orange skin			Banana husk		
	Ab	Aa	% ΔA	Ab	Aa	% ΔA
0.01	0.02	0.14	12.00	0.03	0.26	23.00
0.02	0.03	0.20	17.00	0.04	0.30	26.00
0.04	0.04	0.28	24.00	0.04	0.34	30.00
0.06	0.05	0.30	25.00	0.05	0.38	33.00
0.08	0.07	0.36	29.00	0.07	0.40	33.00
0.10	0.08	0.39	31.00	0.08	0.44	36.00

TABLE-3
DATA OF % ADSORPTION WITH CONCENTRATION FOR Pb^{2+} IONS

Concentration	Orange skin			Banana husk		
	Ab	Aa	% ΔA	Ab	Aa	% ΔA
0.01	0.06	0.30	24.00	0.04	0.31	27.00
0.02	0.09	0.32	23.00	0.07	0.39	32.00
0.04	0.12	0.36	24.00	0.10	0.43	33.00
0.06	0.13	0.38	25.00	0.12	0.50	38.00
0.08	0.14	0.38	24.00	0.14	0.52	38.00
0.10	0.16	0.42	26.00	0.15	0.54	39.00

where, Aa = Absorption after adsorption, Ab = Absorption before adsorption
ΔA = Difference in absorption.

TABLE-4
ADSORPTION SYSTEMS AT DIFFERENT TEMPERATURES

Temperature (K)	Orange skin			Banana husk		
	% ΔA for Cu^{2+}	% ΔA for Cd^{2+}	% ΔA for Pb^{2+}	% ΔA for Cu^{2+}	% ΔA for Cd^{2+}	% ΔA for Pb^{2+}
303	23	13	24	25	29	26
307	20	12	24	24	23	27
311	19	14	23	22	22	27
315	18	15	22	23	20	25
319	16	15	21	22	21	25
323	16	15	21	24	20	27

It could be seen from Table-4 that % of absorption decreased with increase in the temperature. It means Langmuir's adsorption theory holds good. ΔG, ΔH and ΔS parameters are determined at the above mentioned temperature as shown in Table-5. It is observed from Table-5 that ΔG J/mol is more for Cd^{2+} than Cu^{2+} and Pb^{2+} for both the systems. But ΔS J/mol is found to be greater for Pb^{2+} than Cu^{2+} and Cd^{2+} absorption systems and that showed that the process would be spontaneous.

TABLE-5
THERMODYNAMIC PARAMETERS FOR Cu^{2+}, Cd^{2+} AND Pb^{2+} METAL IONS

Metal ions	Orange skin			Banana husk		
	ΔG J/mole	ΔH J/mole	ΔS J/mole	ΔG J/mole	ΔH J/mole	ΔS J/mole
Cu^{2+}	17.65×10^3	-58.07×10^2	-75.45	6.27×10^3	-37.23×10^2	-32.13
Cd^{2+}	13.36×10^3	-26.77×10^2	-51.56	15.77×10^3	-79.04×10^2	-76.15
Pb^{2+}	9.25×10^3	-12.46×10^2	-33.76	2.71×10^3	-10.64×10^2	-12.14

EXPERIMENTAL

Banana husk and orange skin were collected and exposed to sunlight for one week. Subsequently they were ground, exposed to sunlight for 24 h and were preserved in plastic bottles with airtight corks.The solutions of different concentrations (0.01 M, 0.02 M, . . .) of Cu^{2+}, Cd^{2+} and Pb^{2+} were prepared in 50 mL volume in different conical flasks. 0.5 g each of the adsorbent was weighed and placed in each conical flask. All the conical flasks containing metal ion solution (50 mL) and 0.5 g adsorbent powder were digested at about 3–4 h. The flasks

were corked and shaken in mechanical shaker for 2 h. The solutions were filtered, pH of filtrates were measured and filtrates were preserved in airtight glass bottles. The change in absorption of metal ions before and after adsorption was measured by absorption spectrophotometer (Tables 1–3).

The data obtained of % adsorption along with concentration are presented in Tables 1–3. Adsorption systems are also studied at different temperatures to determine thermodynamic parameters as shown in Table-4.

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