ISSN 2181-8622

Manufacturing technology problems

Scientific and Technical Journal Namangan Institute of Engineering and Technology

INDEX COPERNICUS INTERNATIONAL

Google Scholar Crossref doi SLIB.UZ Scientific library of Uzbekistan

Volume 9
Issue 1
2024

SPECTROSCOPIC ANALYSIS OF A SORBENT BASED ON UREA, FORMALIN, AND SUCCINIC ACID AND ITS COMPLEXES WITH IONS OF Cu(II), Zn(II), Ni(II)

MUQUMOVA GULVAR

Doctoral student of Termez State University, Termiz, Uzbekistan
Phone: (0890) 226-5668, E-mail: gulvarmuqimova@gmail.com
*Corresponding author.

TURAYEV XAYIT

Professor of Termez State University, Termiz, Uzbekistan
Phone: (0891) 579-0633

MO'MINOVA SHAHNOZA

Lecturer of Termez State University, Termiz, Uzbekistan
Phone: (0899) 744-4012, E-mail: mominovashahnoza24@gmail.com

KASIMOV SHERZOD

Professor of Termez State University, Termiz, Uzbekistan
Phone: (0890) 746-4016, E-mail: qosimovsh@tersu.uz

KARIMOVA NAIMA

Researcher of Termez State University, Termiz, Uzbekistan
Phone: (0899) 045-4944, E-mail: naimakarimova364@gmail.com

Abstract: As a universal solvent, water plays an important role in the existence of all living organisms. Its continuous circulation through the hydrological cycle is essential for maintaining ecosystem balance. Wastewater is distinguished by its pollution and poses a great threat to the environment and all forms of life. Therefore, before discharging polluted water, it is necessary to properly treat it to mitigate its harmful effects. In this work, the sorption of Fe(III), Cu(II), Cd(II), Pb(II) metal ions from separate solutions and mixtures of their components was studied using sorbents obtained from rice husks for wastewater treatment. It is shown that the absorption capacity of sorbents depends on their properties.

In the article, the synthesis of sorbent and the Raman spectra of sorbent obtained on the basis of urea, formalin and succinic acid (KFC) with some 3d-metals were studied. The results of Raman spectroscopic analysis of the metallocomplex formed by KFC sorbent with Cu(II), Zn(II) and Ni(II) ions were analyzed. The obtained spectrum results are presented on the basis of Fig. Absorption frequencies of KFC sorbent and its metallocomplexes for each field (group) were analyzed and included in the table.

Keywords: sorbent, urea, formalin, succinic acid, asymmetric nas vibration, symmetric valence vibrations, deformation d vibrations KFC

Introduction. Targeted synthesis of complex-forming sorbents containing nitrogen, phosphorus, sulfur, study of their physico-chemical and analytical properties, nature of substituents in ligands and acid-base properties of complex compounds formed with metal ions. Research is being conducted on the development of sorption systems that allow the selective separation of metal ions from complex solutions by means of modeling the process of formation of metal-sorbent systems[1]. Water as a universal solvent plays an important role in the existence of all living organisms[2]. Its continuous circulation

through the hydrological cycle is essential for maintaining ecosystem balance. Wastewater is distinguished by its pollution and poses a great threat to the environment and all forms of life. Therefore, before discharging polluted water, it is necessary to properly treat it in order to mitigate its harmful effects [3]. In this article, the sorption of Cd^{2+}, Cu^{2+}, Fe^{2+}, Ni^{2+}, Zn^{2+} ions by polysaccharide biosorbent was studied. The effect of pH on the distribution of metal cations in the heterophase system of an aqueous solution of metal sulfate and a sorbent containing cellulose was determined [4]. The article describes the process of sorption of Cu (II), Ni (II), Fe (III), Cr (VI) ions from model aqueous solutions by production waste (knop) and knop after chemical modification with solutions of organic and mineral acids; sodium sulfide has been studied. [5] In this study, the sorption of Fe (III), Cu (II), Cd (II), Pb (II) metal ions from separate solutions and mixtures of their components was studied using rice husk sorbents. It has been shown that the absorption capacity of sorbents depends on their properties.[6] In this work, the adsorption of metal ions from aqueous solutions by wastes of the woodworking industry was studied under static conditions. The effect of particle size of aspen sawdust on the level of adsorption of Zn^{2+} and Fe^{2+}, Fe^{3+} ions was determined. Adsorption isotherms were obtained and adsorption parameters were calculated using Freundlich and Langmuir equations.[7] The article presents the sorption isotherms of copper (II) ion in a sorbent based on urea, formaldehyde and ethylenediaminetetraacetic acid (EDTA) according to the Langmuir and Freundlich models. [8]. In this research work, the removal of cations from an aqueous solution of wood processing waste-juniper bark sorbent was investigated. It was determined that the dynamic exchange capacity of these sorbents reached 22.52 mg/g at an initial concentration of 52 mg/dm in solution [9][10]. The process of sorption of heavy metals such as Sr, Ni, Zn from surface waters by the natural zeolite (KLT) of the Kholinskoe mine and the organozeolite mineral obtained on its basis was studied. According to the obtained results, internal diffusion coefficients and sorption levels of Sr, Zn, Ni, and Ca are good in pH 6, 7, and 8 [11,12]. Sorption mechanisms with unmodified and modified sorbents have been proposed, including chemisorption, electrochemical, and various variants of donor-acceptor interactions [13,14,15]. Compounds based on N-2-sulfoethyl chitosan of copper (II) and silver (I) ions in the solution were used as sorbents. The sorption selectivity of sorbents based on N-2-sulfoethylchitosan has been shown to increase compared to copper(II) [16,17]. In a number of research works presented below, methods of obtaining sorbents based on various compounds are presented: Dithizone, calmagit[18], ammonium salts of dithiophosphoric acid O,O-diethyl ether[19], 8-hydroxyquinoline[20], 1-(2-pyridylazo) Several complicating agents have been proposed.

Methodology. Synthesis of KFC sorbent. 1.2 g (0.02 mol) of urea was dissolved in 4 ml (0.05 mol) of formalin in a three-necked flask equipped with a reflux condenser and an automatic stirrer for the synthesis of ionite, which forms a complex containing nitrogen and oxygen, and pH=8- Ammonium hydroxide solution was added until 9. The temperature was heated at 70-80℃ until a viscous mass was formed. 1.18 g (0.01 mol) of succinic acid solution in 5 ml of ammonium hydroxide was added dropwise to the

resulting viscous mixture and mixed. When the temperature increased to 110-130℃, a solid or gummy mass was formed. The resulting resinous mass was placed in a porcelain bowl and dried in a drying cabinet at a temperature of 100℃ for 20 hours. After the dried polymer was crushed, the low molecular weight substances were washed first with 5% sodium alkali solution and then several times with distilled water until it became neutral. As a result, a white granular mass consisting of small pores was formed. Product yield was 90%.

Results.

In the Raman spectrum (HORIBA Scientific) of the sorbent based on urea, formalin and succinic acid (KFC) in the 3128.42 cm^{-1} and 1176.01 cm^{-1} regions, valence symmetric ν_s and deformation δ vibrations of the n(NH_2) group and 1116.43 cm^{-1} In area , the valence ν vibration frequency of the n(C-N-) group was observed. Together with this, the frequency of valence asymmetric ν_{as}, valence symmetric ν_s and deformation δ vibrations of the ν(CH_2) group was formed in the fields of 2945.46 cm^{-1}, 2828.42 cm^{-1} and 745.46 cm^{-1}. In the regions of 1725.93 cm^{-1} and 1519.24 cm^{-1}, the valence asymmetric vibration of the ν(C=O) and ν(COO-) group was formed, as well as the deformation δ vibration frequency in the region of 828.42 cm^{-1} . Also, the valence ν vibration frequencies of the ν(COOC) group were observed in the region of 1282.58 cm^{-1}. The obtained spectrum results are presented in picture-1.

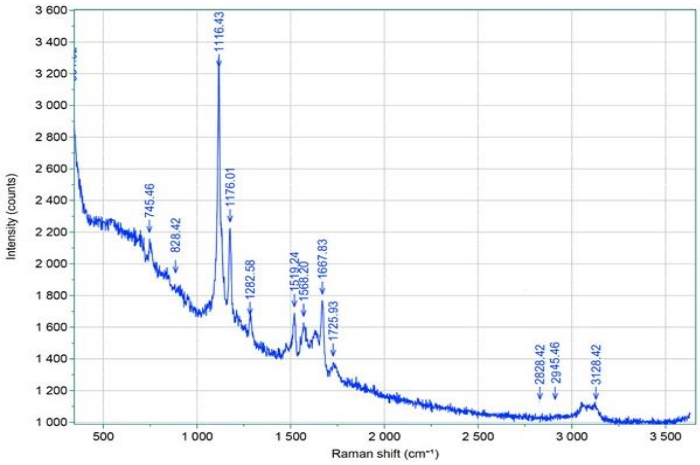

Figure 1. Raman spectrum of KFC sorbent.

The Raman spectrum (HORIBA Scientific) obtained as a result of Cu(II) sorption of KFC sorbent is presented in picture-2, according to the results of the IR spectrum, the valence symmetric ν_s of the ν(NH_2) group at 3195.93 cm^{-1} and 1188.11 cm^{-1} deformation d vibrations and the valence δ vibration frequency of the ν (C-N-) group were observed in the region of 1116.43 cm^{-1}. Together with this, the frequency of valence asymmetric ν_{as}, valence symmetric ν_s and deformation δ vibrations of the ν (CH_2) group was formed in the fields of 2985.31 cm^{-1}, 2895.2998 cm^{-1} and 785.82 cm^{-1}. In the regions of 1765.11 cm^{-1} and 1511.24 cm^{-1}, the valence asymmetric vibration of the ν (C=O) and ν (COO-) group was formed, as well as the deformation δ vibration frequency in the region of 825.93 cm^{-}

[1] . Also, the valence ν vibrational frequencies of the ν(COOC) group were observed in the region of 1231.58 cm^{-1}. The spectrum results are presented in picture-3.2

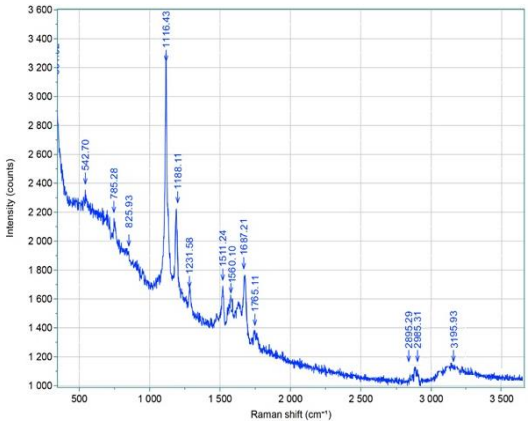

Figure 2. Raman spectrum of the complex formed by Cu(II) with KFC sorbent.

The complex Raman spectrum (HORIBA Scientific) obtained as a result of the sorption of Zn(II) of KFC sorbent is presented in picture-3. According to the results of the IR spectrum, the ν(NH_2) group is valence symmetric in the areas of 3268.94 cm^{-1} and 1192.50 cm^{-1} ν_s and deformation δ vibrations and the valence ν vibration frequency of the ν(C-N-) group were observed in the region of 1182.82 cm^{-1}. Together with this, the freCuency of valence asymmetric ν_{as}, valence symmetric ν_s and deformation δ vibrations of the ν(CH_2) group was formed in the fields of 2935.29 cm^{-1}, 2865.33 cm^{-1} and 765.82 cm^{-1}. In the 1745.94 cm^{-1} and 1516.24 cm^{-1} regions, the valence asymmetric vibration of the ν(C=O) and ν(COO-) group was formed, as well as the deformation δ vibration frequency in the 835.29 cm^{-1} region. Also, the valence n vibrational frequencies of the n(COOC) group were observed in the region of 1233.58 cm^{-1}. The complex Raman spectrum (HORIBA Scientific) obtained as a result of Ni(II) sorption of KFC sorbent is shown in picture-4.

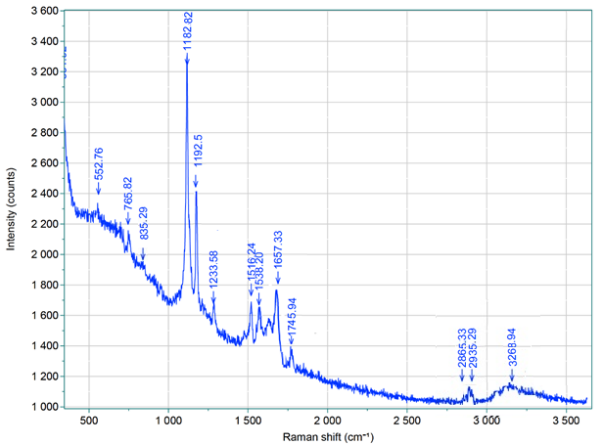

Figure 3. The complex formed by Zn(II) with KFC sorbent

According to the results of the IR spectrum, the ν(NH_2) group is valence symmetric in the fields of 3461.88 cm^{-1} and 1196.91 cm^{-1} ν_s and deformation δ vibrations and the

valence ν vibration frequency of the ν(C-N-) group were observed in the region of 1146.41 cm^{-1}. Together with this, the frequency of valence asymmetric ν_{as}, valence symmetric ν_s and deformation δ vibrations of the ν(CH_2) group was formed in the fields of 2967.81 cm^{-1}, 2861.18 cm^{-1} and 735.55 cm^{-1}.

In the 1738.83 cm^{-1} and 1533.21 cm^{-1} regions, the valence asymmetric vibration of the ν(C=O) and ν(COO-) group was formed, as well as the deformation δ vibration frequency in the 861.87 cm^{-1} region. Also, the valence ν vibrational frequencies of the ν(COOC) group were observed in the region of 1283.64 cm^{-1}.

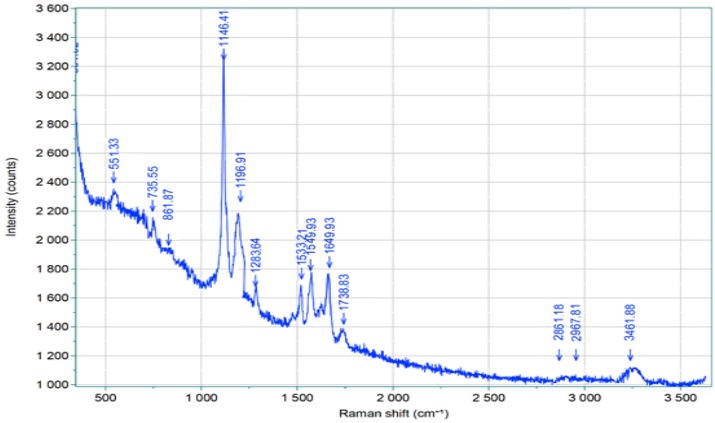

Figure 4. Raman spectrum of Ni(II) complex formed with KFC sorbent.

Table 1

Absorption frequencies in Raman spectra of KFC sorbent and its coordination compounds with Cu(II), Zn(II), Ni(II) ions, cm^{-1}

Vibration classifications	KFC	KFC+Cu(II)	KFC+Zn(II)	KFC+Ni(II)
ν(NH)	3128,42	3195,93	3268,94	3461,88
$\nu_s(CH_2)$	2945,46	2985,31	2935,29	2967,81
$\nu_{as}(CH_2)$	2828,42	2895,29	2865,33	2861,18
ν(C=O)	1725,93	1765,11	1745,94	1738,83
ν(-COC=O)	1282,58	1231,58	1233,58	1283,64
$\nu_{as}(-COO^-)$	1519,24	1511,24	1516,24	1533,21
ν(C-N)	1116,43	1116,43	1182,82	1146,41
δ(NH)	1176,01	1188,11	1192,50	1196,91
$\delta(CH_2)$	745,46	785,28	765,82	735,55
$\delta(-COO^-)$	828,42	825,93	835,29	861,87

sm^{-1}

As can be seen from table-11, the ν(NH) vibration frequency and δ(C=O) vibration frequency in KFC sorbent are relatively shifted to other areas. It can be concluded as follows that the secondary amine and carbonyl groups in the KFC sorbent ensure the coordination of the metal ion and a chelate is formed.

Discussion. Certain scientific and practical results have been achieved in our republic in the production of chemical industry products, in particular, in the selective extraction of non-ferrous and rare metals from the composition of solutions, and in the production of sorbents used for the purification of wastewater from heavy metals. In this article presented by the authors, the problem of pollution and self-cleaning of water

bodies from heavy metal compounds is considered. The process of sorption of heavy metal compounds (Cu (II), Zn (II), Pb (II), Cd (II)) by bottom sediments of different composition was studied. Equilibrium constants and rates of sorption of heavy metals by bottom sediments were obtained during laboratory studies. It was determined that the obtained data are necessary for predicting water quality as a result of pollution of a water body with industrial wastewater.

Conclusion. The article contains a brief annotation of the work, key words. In the introduction, the relevance of the topic and the work of scientists on the topic are analyzed. The absorption spectra of the sorbent based on urea, formalin and succinic acid (KFC) and its complexes with some 3d metals were studied by Raman spectroscopy (HORIBA Scientific). Raman spectroscopic analysis of metal complexes formed by Cu(II), Zn(II) and Ni(II) ions with KFC sorbent was performed. From the results, it can be concluded that the secondary amine and carbonyl groups in KFC sorbent are coordinated with the metal ion and a chelate is formed.

REFERENCES

1.Kasimov Sh.A. Ba'zi d-metallarning tarkibida N,P,S bo'lgan immobillangan ligandlar bilan metallokomplekslari: sintezi, tuzilishi va xossalari.// Doktorlik dissertatsiyasi –T.: 2021. 28-46 b.

2.Астхана М., Кумар А., Шарма Б.С. (2017). Очистки сточных вод. В: Сингх, Р. (ред.) Принципы и применение экологической биотехнологии для устойчивого будущего. Прикладная экология и инженерия для устойчивого будущего. Спрингер, Сингапур. https://doi.org/10.1007/978-981-10-1866-4_6.

3.Адефеми С.О. и Э.Э. Авокунми (2010), Определение физико-химических параметров и тяжелых металлов в пробах воды из района Итаогболу штата Ондо, Нигерия, Африканский журнал экологической науки и технологий, 4 (3), стр. 145-148.

4.Никифорова Т. Е., Козлов В. А. Особенности сорбции ионов тяжелых металлов целлюлозосодержащим сорбентом из водных сред //Журнал прикладной химии. – 2010. – Т. 83. – №. 10. – С. 1642-1645.

5.Нагимуллина Г. Р. Исследование химической модификации отходов валяльно-войлочного производства для повышения сорбционной емкости по отношению к ионам тяжелых металлов //Журнал экологии и промышленной безопасности. – 2010. – №. 1. – С. 49-54.

6.Шевелева И. В. и др. Сорбенты на основе рисовой шелухи для удаления ионов Fe (III), Cu (II), Cd (II), Pb (II) из растворов //Химия растительного сырья. – 2009. – №. 4. – С. 171-176.

7.Сазонова А. В., Голощапова С. Э. Адсорбция ионов металлов отходами деревообрабатывающей промышленности //APRIORI. Серия: Естественные и технические науки. – 2014. – №. 2. – С. 17.

8.Абдувалиева М. Ж., Тураев Х. Х., Касимов Ш. А. Изотермы сорбция иона меди (II) в сорбента на основе карбамида, формальдегида и

этилендиаминтетрауксусной кислотой //Universum: технические науки. – 2023. – №. 8-3 (113). – С. 18-20.

9.Belova T. P. Кинетика сорбции ионов меди, никеля и кобальта при совместном присутствии из водных растворов цеолитами //Сорбционные и хроматографические процессы. – 2018. – Т. 18. – №. 3. – С. 324-331.

10.Семенович А. В. Динамическая сорбция катионов Cu 2+ модифицированной корой Abies sibirica Ledeb //Химия растительного сырья. – 2015. – №. 3. – С. 161-168.

11.Kats E. M., Kuzmina T. G. Кинетика сорбции Sr, Ni, Zn из поверхностной воды методом «тонкого слоя» на природном цеолите КЛТ и органоцеолите ПЭИ–КЛТ //Сорбционные и хроматографические процессы. – 2018. – Т. 18. – №. 4. – С. 505-514.

12.Кропачева Т. Н. и др. Комплексоны как реагенты для деметаллизации загрязненных седиментов //Журнал прикладной химии. – 2014. – Т. 87. – №. 10. – С. 1421-1428.

13.Дударева Г. Н. и др. О механизме сорбции ионов никеля (II) модифицированными углеродными сорбентами //Физикохимия поверхности и защита материалов. – 2015. – Т. 51. – №. 6. – С. 582-582.

14.Ульрих Д. В., Денисов С. Е. Поглощение катионов меди и цинка черноземом обыкновенным //Сорбционные и хроматографические процессы. – 2009. – Т. 9. – №. 5. – С. 722-725.

15.Калюкова Е. Н., Иванская Н. Н. Количественные характеристики процесса сорбции катионов никеля (II) и марганца (II) на природном сорбенте опоке //Башкирский химический журнал. – 2009. – Т. 16. – №. 3. – С. 54-58.

16.Петрова Ю. С. и др. Динамика сорбции меди (II) и серебра (I) материалами на основе N-2-сульфоэтилхитозана с различной степенью сшивки //Журнал физической химии. – 2017. – Т. 91. – №. 4. – С. 720-724.

17.Ярусова С. Б. и др. Влияние температуры на кинетику сорбции ионов со 2+ и ni 2+ сорбентом на основе производного инозиттексафосфорной кислоты //Журнал физической химии. – 2018. – Т. 92. – №. 3. – С. 451-456.

18.Y. P. de Peña, M. Gallego, and M. Valcárcel, J. Anal. At. Spectrom., 1994, 9, 691.

19. H. C. dos Santos, M. G. A. Korn, and S. L. C. Ferreira, Anal. Chim. Acta, 2001, 426, 79.

20. S. P. Cuináia, J. B. B. da Silva, M. C. E. Rollemberg, and A. J. Curtius, Talanta, 2001, 54, 687.

CONTENTS

PRIMARY PROCESSING OF COTTON, TEXTILE AND LIGHT INDUSTRY