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AN-31 ANION ALMASHINUVCHI MATERIALGA CU(II) IONLARI SORBSIYASI

СОРБЦИЯ ИОНОВ CU(II) НА АНИОНИТЕ АН-31

SORBRATION OF CU(II) IONS ON AN-31 ANION EXCHANGE MATERIAL

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Annotatsiya

Ushbu ishda sanoatda ishlatiladigan AN-31 nomli tarkibida aminoguruhlari saqlagan anionit suniiy eritmalardan Cu^{2+} ionining adsorbsiya izotermalari, kinetikasi va termodinamikasi o‘rganildi. Buning uchun $CuSO_4 \cdot 5H_2O$ dan foydalanib 0.03M, 0.04M, 0.05M, 0.06M, 0.07M, 0.08M va 0.1M gacha bo‘lgan konsentrasiyali eritmalari tayyorlandi va tayyorlangan sun‘iy eritmalardan metall ionining sorbsiya davomiyligi 1-12 soat oralig‘ida, 293K, 303K, 313K haroratda o‘rganildi. Sorbsiyadan oldingi va keyingi eritmalardagi metall ionlarining konsentrasiya o‘zgarishi spektrofotometr (Shimadzu Corporation. UV-1900i) da o‘rganildi. AN-31 anion almashinuvchi materiallarga Cu^{2+} ioni sorbsiyasining muvozanat jarayonlarini tahlil qilish uchun adsorbsiya izotermalarining Lengmyur va Freyndlix modellari o‘rganildi. AN-31 (Cl^- shaklida) q_e 87.43 mg/g,145.06 mg/g, 205.75mg/g ga teng bo‘ldi. Mis ionlari ionitga qanday bog‘langanligini aniqlash uchun anionit va mis tutgan anionitni Raman spektrlari o‘lchandi.

Аннотация

В данной работе были изучены изотермы, кинетика и термодинамика адсорбции ионов Cu^{2+} из промышленно используемых анионообменных смол, содержащих аминогруппы, называемых АН-31. Для этого были приготовлены растворы с концентрацией 0,03М, 0,04М, 0,05М, 0,06М, 0,07М, 0,08М и 0,1М с использованием CuSO4·5H2O и изучена продолжительность сорбции иона металла из приготовленных искусственных растворов в диапазоне 1–12 часов при температурах 293К, 303К и 313К. Изменение концентрации ионов металлов в растворах до и после сорбции изучали с помощью спектрофотометра (Shimadzu Corporation. UV-1900i). Для анализа равновесных процессов сорбции ионов Cu^{2+} на анионитах АН-31 исследованы модели изотерм адсорбции Ленгмюра и Фрейндлиха. АН-31 (в форме Cl^-) составил 87,43 мг/г, 145,06 мг/г и 205,75 мг/г. Для определения того, как ионы меди связываются с ионитом, были измерены спектры комбинационного рассеяния аниона и медьсодержащего аниона.

Abstract

In this work, the adsorption isotherms, kinetics and thermodynamics of Cu^{2+} ion from artificial solutions of the industrially used anionite containing amino groups, AN-31, were studied. For this, solutions with concentrations of 0.03M, 0.04M, 0.05M, 0.06M, 0.07M, 0.08M and 0.1M were prepared using CuSO4·5H2O, and the sorption duration of the metal ion from the prepared artificial solutions was studied in the range of 1-12 hours at temperatures of 293K, 303K, 313K. The change in the concentration of metal ions in the solutions before and after sorption was studied using a spectrophotometer (Shimadzu Corporation. UV-1900i). To analyze the equilibrium processes of Cu^{2+} ion sorption on AN-31 anion exchange materials, Langmuir and Freundlich models of adsorption isotherms were studied. For AN-31 (in the Cl^- form) qe was 87.43 mg/g, 145.06 mg/g, and 205.75 mg/g. To determine how copper ions are bound to the anion, Raman spectra of the anion and the copper-containing anion were measured.

Kalit so‘zlar: *ion almashinadigan smola, ion almashinuv tizimi, uzoq masofali o‘zaro ta'sir, Cu^{2+} ioni, adsorbsiya*

Ключевые слова: *ионообменная смола, ионообменная система, дальнодействующее взаимодействие, ион Cu^{2+}, адсорбция*

Key words: *ion exchange resin, ion exchange system, long-range interaction, Cu^{2+} ion, adsorption.*

KIRISH

Hozirgi kunda butun dunyo mamlakatlari uchun og‘ir metallarni galvanik zavodlardan chiqayotgan oqava suvlardan ushlab qolish va uni qayta ishlash muammosi dolzarb bo‘lib qolmoqda[1,2]. Mis atrof-muhitda parchalanmaydi va shuning uchun u tuproqda, o‘simlik va

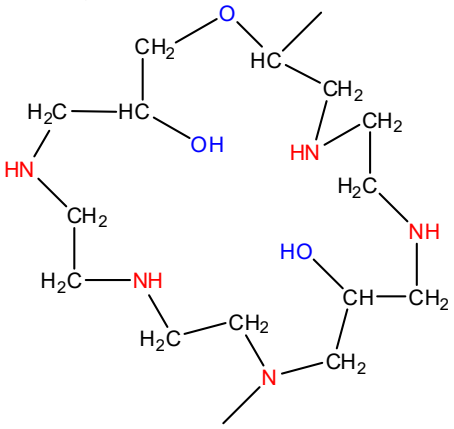
hayvonlar organizmida to‘planishi mumkin. Misga boy tuproqda faqat cheklangan miqdordagi o‘simliklar omon qolish imkoniyatiga ega[3,4,5].

ADABIYOTLAR TAHLILI VA METODOLOGIYASI

Shuning uchun misni utilizatsiya qiluvchi zavodlar yaqinida o‘simliklarning xilma-xilligi unchalik ko‘p emas. Misning yuqori darajasi suv muhitida toksik bo‘lib, baliqlar, umurtqasizlar, o‘simliklar va amfibiyalarga salbiy ta’sir ko‘rsatishi mumkin[6]. Turli xil zararlangan oqava suvlardan og‘ir metall ionlarini olishning eng istiqbolli usullari ion almashinuvi va elektroliz bo‘lib, ular chiqindilarni qayta ishlash uchun past chiqindili jarayonlarini yaratishni ta’minlaydi[7,8,9].

MATERIALLAR VA USULLAR

AN-31 OH shaklidagi ion almashinadigan qatron formulasi 1-sxemada keltirilgan



Sxema 1. AN-31 anionit kimyoviy formulasi.

AN-31 ion almashinadigan qatron (anion almashinuvchi) PAO “Uralximplast” kompaniyasi (PAO “Uralximplast”, Rossiya) tomonidan sintez qilingan.

USKUNALAR

Spektrofotometr - Spektrofotometrning asosiy ishlash printsipi moddalar tomonidan yorug‘likni (yorug‘lik to‘lqin uzunligini) tanlab yutilishiga asoslangan. Turli moddalarning o‘ziga xos assimilyatsiya tasmasi mavjud. Shuning uchun yorug‘likning dispers spektri ma’lum bir eritmadan o‘tganda, ular orasida yorug‘likning ma’lum to‘lqin uzunliklari eritma tomonidan yutiladi.

Ushbu tadqiqotda eritmalar tarkibidagi Cu(II) ionlari kontsentratsion o‘zgarishini aniqlash uchun (Shimadzu Corporation. UV-1900i) (Yaponya) spektrofotometridan foydalanilgan.

NATIJALAR VA MUHOKAMALAR

Ion almashinuvchi tizimlarida muvozanatni ifodalashning keng tarqalgan usuli bu muvozanatdagi qattiq va suyuq fazalar o‘rtasidagi taqsimotni ifodalovchi va bu holda metall ionlari yoki komplekslari va qatronlar o‘rtasidagi o‘zaro ta’sir turini ko‘rsatadigan izoterma tenglamalaridir. Eng muhim adsorbsion izotermalar Lengmyur (bir qatlamli adsorbsiya modeli, tenglama-1) va Frendlix (poli qatlamli adsorbsiya modeli,tenglama-2) adsorbsion modellaridan kelib chiqadi[10,11].

$$q_e = q_{max} \cdot \frac{K_L \cdot C_e}{1 + K_L \cdot C_e} \quad (1)$$

$$q_e = K_F \cdot C_E^{1/n} \quad (2)$$

Lengmyur tenglamasining (1.1) quyida keltirilgan chiziqli ko‘rinishidan foydalanib, q_{max} va K_L qiymatlari topildi va 1-jadvalda keltirildi.

$$\frac{C_e}{q_e} = \frac{1}{q_e K_L} + \frac{1}{q_{max}} \cdot C_e \quad (1.1)$$

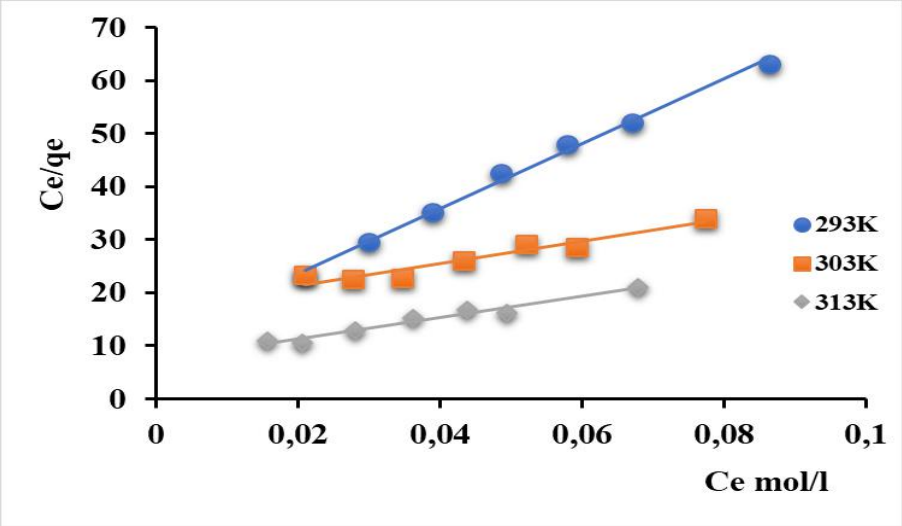
Frendlixning sorbsiya uchun chiziqli tenglamasini quyidagi (2.1) ko‘rinishda ifodalash mumkin.

$$\log q_e = \log K_F + \left(\frac{1}{n}\right) \log C_e$$

Bu yerda: K_F- Frendlix >konstantasi, 1/n-sorbsiya intensivligi[12].

Cu(II) ionlarining AN-31anionitiga sorbsiya izotermalari va kinetikasi

Sorbsiya jarayonini mehanizmini aniqlashda uning izotermalarini tadqiq qilish asosiy usul hisoblanadi 1-rasm.



1-rasm Cu^{2+} ionlarini AN-31anionitiga sorbsiyasini Lengmyur va Frendlix chiziqli tenglamalari koordinatalaridagi ifodasi

1-jadval.

AN-31 anionitiga Cu^{2+} ionlarini adsorbsiya izotermalarining Lengmyur va Frendlix tenglamalari parametrlari

Metall ioni	Ionit	Harorat	Freundlix izotermasi			Lengmyur izotermasi		
			K_F	N	R^2	K_L ($g\ mmol^{-1}$)	q_e (mg/g)	R^2
Cu^{2+}	AN-31	293	2,24	1.45	0,83	12.18	87,43	0,99
		303	2,47	1.87	0,81	27.18	145,06	0,95
		313	7.23	3.45	0,75	53.22	205,75	0,96

1-jadvaldan ko`rinib turibdiki Frendlix parametri $K_F$ ning qiymati harorat ortga sari ortib bormoqda, bu esa harorat ortishi bilan sorbsiya ortayotganligini ko`rsatadi. Lengmyur tenglamasidagi muvozanat kostantasini qiymati(K_L) da ham huddi shu holat kuzatilmoqda. Lengmyur tenglamasi yordamida hisoblangan korrekyatsiya koefitsiyenti R^2 ning qiymati Frendlix tenglamasi yordamida hisoblangan korrelyatsiya qiymatidan yuqori, bu esa tekshirilayotgan sorbsiya jarayoni natijalari Lengmyur tenglamasi orqali yaxshiroq ifodalanishini bildiradi.

Sorbsiya jarayonini tahlil qilish usulidan yana biri uning kinetikasini o`rganish. Olingan kinetik natijalarni pseudo-birinchi va pseudo-ikkinchi tartibli kinetik model yordamida tahlil qilindi.

Pseudo-birinchi va ikkinchi tartibli tenglama koordinatalarida ion almashinuvchi sistema bilan Cu^{2+} ionlarini sorbsiya qilish jarayonining kinetikasi 2-jadvalda keltirilgan.

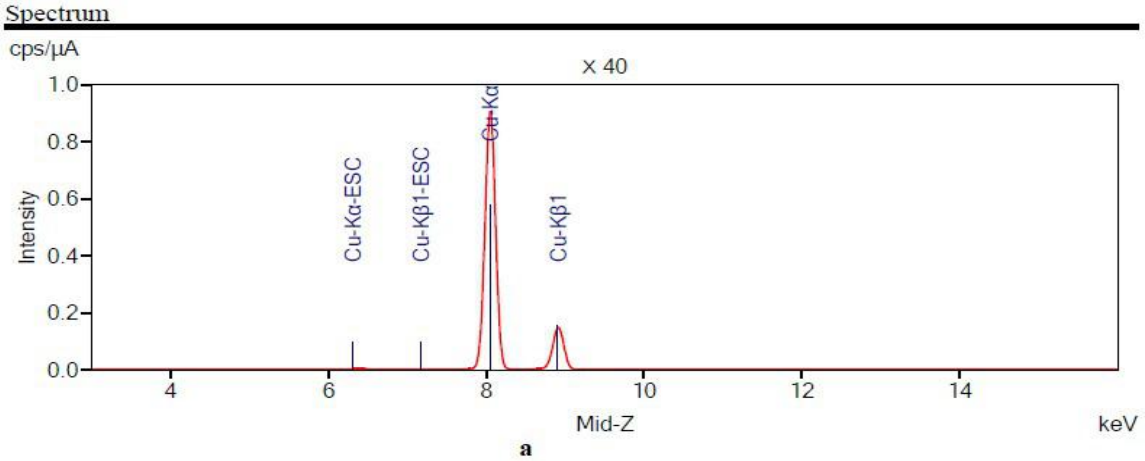
2-jadval

Ionitga Cu^{2+} ionlarini adsorbsiya jarayonlari kinetikasining psevdo-birinchi va psevdo-ikkinchi tenglamalari konstantalari

Metal ioni	**Mis tuzi eritmasini dastlabki kons. (mol/l)**	**Pseudo-birinchi tartibli**			**Pseudo ikkinchi tartibli**		
		Muozanat sorbsiya miqdori q_e(mg g^{-1})	**k_1 (g mg^{-1} min^1)**	**R^2**	**Muozanat sorbsiya Miqdori q_e(mg g^{-1})**	**k_2 10^{-5} (g mg^{-1} min^1)**	**R^2**
Cu^{2+}	**AN-31**						
	0.03	59.32	0.007	0.67	106.01	2.04	0.99
	0.04	67.54	0.009	0.68	109.527	2.09	0.97

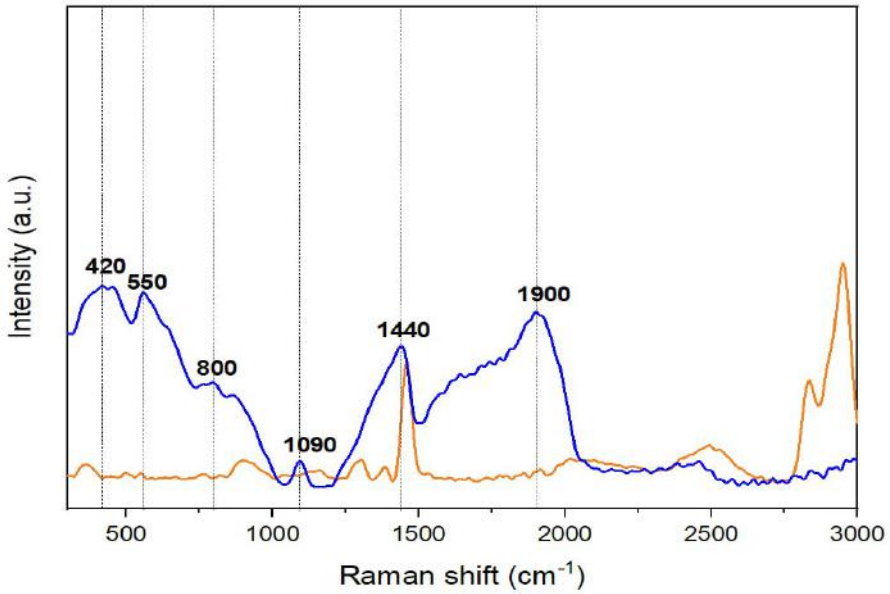
	0.05	73.16	0.008	0.67	112.942	2.16	0.95
	0.06	75.84	0.008	0.72	116.383	2.84	0.98
	0.07	79.45	0.007	0.69	119.167	3.76	0.98
	0.08	86.26	0.008	0.68	121.527	4.31	0.97
	0.1	89.73	0.008	0.68	124.890	4.57	0.98
	O‘rtacha k_1 va k_2		0.078		3.11		

2-jadvaldagi hisoblashlar natijalaridan ko`rinib turibdiki, $R^2$ korrelyatsiya koefitsiyenti qiymati pseudo-birinchi tartibli kinetik modelga qaraganda pseudo-ikkinchi tartibli kinetik modelda yuqori bo`lgan. Bu esa sorbsiya jarayoni pseudo-birinchi tartibli kinetik modelga qaraganda pseudo-ikkinchi tartibli kinetik modelga ko`proq bo`ysunayotganligini ko`rsatadi.



2-rasm. AN-31anionitning Cu^{2+}ionlari sorbsiyasidan keyingi ED-XRF tahlili.

2-rasmdagi ED-XRF spektridan ko`rinib turibdiki. Cu(II) ionlarining sorbent tarkibidagi intensivligi AN-31 anion almashinuvchi uchun 390.848 teng. va Cu(II) ionlarining yutgan deb xulosa qilish mumkin.



3-rasm. AN-31anion almashinuvchi va Cu(II) ionlari tutgan AN-31raman spektrlari.

3-rasmdagi Raman spektroskopik tahlilga ko`ra AN-31 ionit tarkibidagi amino guruhlari bilan Cu(II) ionlarining donor akseptor mehanizm bo‘yicha, bog‘ hosil qilganligini ifodalaydi. Cu-N bog‘iga

tegishli bo‘lgan sohalar 420-550 sm^{-1} da namoyon bo‘ldi va bundan Cu(II) ionlarining anionitga sorbsiya bo‘lganligini ko‘rsatadi.

XULOSA

Olib borilgan sorbsiya natijalaridan shuni xulosa qilib aytish mumkinki, sorbsiya jarayoni Lengmyur va Freundlix izoterma modellari yordamida hisoblanganda korrekyatsiya koefitsiyenti R^2 ning qiymati Lengmyur modelida yuqori qiymatga ega ega bo`ldi, bu esa tekshirilayotgan sorbsiya jarayoni natijalari Lengmyur tenglamasi orqali yaxshiroq ifodalanishini bildiradi. Olingan natijalarni pseudo-birinchi va pseudo-ikkinchi tartibli kinetik model yordamida tahlil qilinganda sorbsiya jarayoni pseudo-birinchi tartibli kinetik modelga qaraganda, pseudo-ikkinchi tartibli kinetik modelga ko`proq bo`ysunayotganligini ko`rsatdi.

Raman spektroskopik tahlilga ko`ra AN-31 ionit tarkibidagi amino guruhlari bilan Cu(II) ionlarining donor akseptor mehanizm bo`yicha bog` hosil qilganligini ifodalaydi. Cu-N bog`iga tegishli bo`lgan sohalar 420-550 sm^{-1} da namoyon bo‘ldi va bundan Cu(II) ionlarining anionitga sorbsiya bo‘lganligini ko‘rsatadi.

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