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SANOAT ANIONITIGA SUNIY ERITMALARDAN Cr(VI) IONLARINING SORBSIYA KINETIKASINI TADQIQ QILISH**ИССЛЕДОВАНИЕ КИНЕТИКИ СОБСЦИИ ИОНОВ Cr(VI) ИЗ ИСКУССТВЕННЫХ РАСТВОРОВ НА ПРОМЫШЛЕННОМ АНИОНТЕ****INVESTIGATION OF THE KINETICS OF Cr(VI) ION SORPTION FROM ARTIFICIAL SOLUTIONS ON INDUSTRIAL ANIONITE****Botirov Sunnatjon Xudoyberdi o'g'li¹** ¹Mirzo Ulug'bek nomidagi O'zbekiston milliy universiteti, Kimyo fakulteti polimerlar kimyosi kafedrasida tayanch doktoranti,**Eshtursunov Davron Abdisamatovich²** ²Mirzo Ulug'bek nomidagi O'zbekiston milliy universiteti, Kimyo fakulteti polimerlar kimyosi kafedrasida tayanch doktoranti,**Fayzullayev Yusuf Sayfullayevich³** ³Mirzo Ulug'bek nomidagi O'zbekiston milliy universiteti, Kimyo fakulteti polimerlar kimyosi kafedrasida PhD doktoranti,**Bekchanov Davronbek Jumazarovich⁴** ⁴Mirzo Ulug'bek nomidagi O'zbekiston milliy universiteti, Kimyo fakulteti polimerlar kimyosi kafedrasida k.f.d., prof.**Muxamediyev Muxtarjan Ganievich⁵** ⁵Mirzo Ulug'bek nomidagi O'zbekiston milliy universiteti, Kimyo fakulteti polimerlar kimyosi kafedrasida k.f.d., prof.**Annotatsiya**

Sanoat oqava suvlarida Cr (VI) ionlarini olib tashlash dolzarb muammo hisoblanadi. Cr (VI) ionlari juda toksik bo'lib, ular atrof-muhitga va inson salomatligiga zarar keltiradi. sun'iy eritmalardan Cr (VI) ionlarini sanoat miqyosida ishlatiladigan AN-31 anionitiga sorbsiya kinetikasi o'rganildi. Sorbsiya kinetikasi va adsorbsiya mexanizmini baholash uchun psevdobirinchi va psevdodikkinchi tartibli kinetik modellardan foydalanildi. AN-31 anionitiga Cr(VI) ionlarining sorbsiya kinetikasi psevdodikkinchi tartibli modelga, adsorbsiya qobiliyati esa 5,60 mg-ekv/g ni tashkil etdi.

Аннотация

Удаление ионов Cr(VI) из промышленных сточных вод является актуальной проблемой. Ионы Cr(VI) очень токсичны, наносят вред окружающей среде и здоровью человека. Изучена кинетика сорбции ионов Cr(VI) из искусственных растворов анионитом AN-31, который используется в промышленных масштабах. Оценка кинетики сорбции и механизма адсорбции основывалась на кинетических моделях псевдопервого и псевдovторого порядка. Кинетика сорбции ионов Cr(VI) анионитом AN-31 представляла собой модель псевдovторого порядка, адсорбционная емкость составляла 5,60 мг-экв/г.

Abstract

Removing Cr (VI) ions in industrial wastewater is an urgent problem. Cr (VI) ions are very toxic, they harm the environment and human health. The kinetics of sorption of Cr (VI) ions from artificial solutions to AN-31 anionite, which is used on an industrial scale, was studied. The evaluation of sorption kinetics and adsorption mechanism was based on pseudo-first and pseudo-second-order kinetic models. The sorption kinetics of Cr(VI) ions to AN-31 anionite was a pseudo-second-order model, and the adsorption capacity was 5.60 mg-eq/g.

Kalit so'zlar: anion almashinuvchi material, AN-31, sorbsiya, kaliy dixromat, xrom(VI) ionlari.**Ключевые слова:** анионообменник, AN-31, сорбция, dixromat калия, ионы хрома(VI).**Key words:** anion exchanger, AN-31, sorption, potassium dichromate, chromium (VI) ions.

KIRISH

Sanoat korxonalaridan chiqayotgan oqava suvlar tarkibida turli xil zaharli metal ionlari ko'p miqdorda mavjud bo'lib, bu og'ir va zaharli metal ionlarining tabiiy suvga tarqalishi natijasida suvning ifloslanish yuzaga kelmoqda. Bu esa oxir oqibat oqava suvlariga chiqadigan rangli, og'ir va zaharli metall ionlarining miqdori ortib ketishiga olib kelmoqda. Sanoat oqava suvlari tarkibida korxonalaridan chiqayotgan qo'rg'oshin, simob, kadmiy, arsen, xrom va ko'plab zaharli metal ionlari inson tanasiga saraton, yurak-qon tomir kasalliklari, buyrak, jigar, asab tizimi kasalliklari hamda boshqa ko'plab kasalliklarning paydo bo'lishiga olib kelmoqda.

ADABIYOTLAR TAHLILI VA METODOLOGIYA

Kimyo sanoati chiqindilari havo, suv va tuproqni ifloslantiradi. Bu ifloslanish inson sog'lig'iga va ekologik muvozanatga salbiy ta'sir ko'rsatadi. Sanoat oqava suvlari tarkibida chiqayotgan bir qancha og'ir metall ionlari atrof-muhit, o'simlik va hayvonot dunyosi, ayniqsa insonlar salomatligi uchun salbiy ta'sir ko'rsatmay qolmaydi[1].

Turli chiqindilar bilan ifloslangan oqova suvlar dastlab tegishli usullar bilan analiz qilinadi, keyin esa moddalar va zararli ionlardan tozalanadi [2]. Chiqindi suvlarni tozalash, oqava suvlarni iste'molga tayyorlash uchun ko'plab texnologiyalar ishlab chiqilgan bo'lib, ular orasida fizik-kimyoviy ishlov berish asosidagi distillash, erituvchida ajratish, oksidlanish-qaytarilish, dializ, elektrodializ, elektrolitik ekstraksiya, teskari osmos, ion almashinish, bug'latish, adsorbsiya, suyultirish, flokulyatsiya, cho'ktirish kabi ko'plab usullar qo'llaniladi [3], biroq yuqoridagi tozalash usullarini amalga oshirish uchun uchun ko'p energiya sarf bo'ladi hamda ular ortidan katta miqdorda chiqindilar hosil bo'ladi [4].

Ionitlarning va ion almashinish jarayonlarining qo'llanish sohalari uzluksiz ravishda kengayib bormoqda. Ion almashinuv texnologiyasi suvni tuzsizlantirishda, oziq-ovqat sanoati, farmatsevtika sanoati, elektr energiyasi ishlab chiqarish va boshqa ko'plab sohalarda keng foydalaniladi [5]. Hususan hozirgi kunda sintetik, polimerlar asosida sintez qilingan granulalangan, tolasimon, kukunsimon, membranali ion almashinuvchi materiallar kimyo sanoatida ishlatiladigan suvlarni tuzsizlantirishda, oqava suvlarini turli zararli ionlardan tozalashda hamda gidrometallurgiya sohalarida texnologik eritmalar tarkibidan rangli, noyob va qimmatbaho metall ionlarini ajratib olishda, konsentrlashda ishlatiladi. Qimmatbaho, noyob va rangli metall ionlarini selektiv ajratib olishda tarkibida azot va oltingugurt tutgan granulalangan ion almashinuvchi sorbentlar ishlatiladi [6-10]. Ion almashinuvchi materiallar yuqori sorbsion xosasiga ega bo'lib, kimyoviy barqarorligi yuqori, haroratning o'zgarishiga chidamli, arzon hamda ko'p marta qo'llanilib, texnologik, ekologik va iqtisodiy jihatdan talablarga javob beradi [11].

Ko'plab ilmiy tadqiqotchilar tomonidan oqava suvlar tarkibidan zaharli metal Cr (VI) ionlarini ion almashinadigan materiallar yordamida olib tashlash bo'yicha bir qancha ilmiy izlanishlar olib borgan. [12-17]. Kuchsiz amino guruh tutgan anionitlar yordamida kislotali muhitdan suv tarkibidan xromat ionlarini olib tashlash uchun ishlatiladi [13]. Tadqiqotchilar tomonidan Cr (VI) ionlarini oqava suvdan olib tashlash uchun IRA 400 anion almashinadigan materialidan foydalanganlar [14], natijalar asosida, pH 2 kuchli kislotali muhitda IRA 400 Cr (VI) ionlarini samarali sorbsiya qilishgan. Keyingi tadqiqot ishida D301, D314 va kuchsiz amino guruh tutgan anionitlar ishlatilgan. pH muhitni 1-5 gacha o'zgartirganda, oqava suvlar tarkibida Cr^{+6} ni yo'qotish darajasi sezilarli darajada o'zgarmagan. pH > 7 da eritmadan Cr^{+6} ning adsorbsiyasi pH darajasining ortib borishi bilan keskin kamayadi [15]. Kuchli asosli polistirollardan Amberlite IRA 402 va Amberlite IRA 900 hamda poliakrilat ionitlaridan Amberlite IRA 458 va Amberlite IRA 958 ion almashinadigan materiallarga stastik sharoitda suvli eritmalaridan Cr (VI) hamda As (V) ionlarining sorbsiyasini o'rgandilar. Amberlite IRA 900 anionitiga zaharli metal ionlaridan Cr (VI) va As(V) ionlarining maksimal yutilish qiymatlari mos ravishda 77,972 mg/g va 10,9478 mg/g ga tengligi o'rganilgan [16]. Shuningdek, ko'plab tadqiqotchilar tomonidan tarkibida kuchli amino guruh tutgan gelsimon ko'rinishda bo'lgan Purolite A-400 (stiroil-vinilbenzol matritsasi) hamda Purolite A-850 (akril matritsa) ionitlaridan foydalangan holda ko'plab ionlarni sorbsiyasini o'rgangan[17].

Olib borilgan ushbu tadqiqot ishida ham sanoat miqyosida keng qo'llaniladigan tarkibida amino guruh saqlagan AN-31 anion almashinadigan materialiga kaliy dixromat ($K_2Cr_2O_7$) tuzining sun'iy eritmalaridagi Cr (VI) ionlarining sorbsiya kinetikasi o'rganilgan. Anion almashinadigan

smolada Cr (VI) ionlarini sorbsiyalash jarayonini tavsiflash uchun psevdobirinchi tartibli va psevdodikinchi tartibli kinetik modellari qo'llanildi.

NATIJA VA MUHOKAMALAR

AN-31 anionitiga sorbsion jarayonlarini o'rganishda kaliy dixromat tuzi ($K_2Cr_2O_7$) ishlatilgan; Konsentratsiyasi 0,125 mol/l; 0,1 mol/l; 0,075 mol/l; 0,05 mol/l; 0,025 mol/l; 0,01 mol/l bo'lgan sun'iy eritmalar tayyorlab olindi. Tayyorlangan sun'iy eritmalaridan anionitga xrom ionlarining sorbsiyalanish davomiyligi 2-12 soat vaqt 303, 313, 323 K harorat oralig'ida olib borildi. Sorbsiya jarayoni olib borishda HCl bo'yicha statik almashinish sig'imi 2,60 mg-ekv/g bo'lgan anionitdan foydalanildi. Hajmi 250 ml bo'lgan konussimon kolbalarga analitik tarozida o'lchab olingan 0.3 g dan quruq anionit hamda 100 ml dan $K_2Cr_2O_7$ ning turli xil konsentratsiyadagi eritmalar solindi. Dixromat ionlarining sorbsiya miqdorini hisoblashda Cr (VI) ionlarining sorbsiyadan oldingi va keyingi eritmalaridagi konsentratsiyasining o'zgarishini spektrofotometr (Shimadzu Corporation. UV-1900i) (Yaponiya) dan foydalanilgan holda hisoblab topildi (Cr (VI) ionlarining spektrofotometrda to'lqin uzunligi 540 nm).

Quyida keltirilgan tenglama yordamida anionitga yutilgan xrom(VI) ionlarining sorbsiya miqdori hisoblanadi.

$$q_e \frac{C_0 - C_e}{m} * V$$

Bunda: q_e – ionitga yutilgan metall ioni miqdori mol/g, C_0 – metall ionlarining dastlabki konsentratsiya mol/g, C_p – metall ionlarining muvozanat konsentratsiyasi mol/l; V – eritma hajmi l; m – quruq sorbent massasi(g) [18].

Adsorbsiya kinetikanisini o'rganish

Kinetik modellar sorbsiya jarayonining mexanizmini aniqlash uchun ishlatiladi (masalan, kimyoviy reaksiya tezligi, diffuziyani boshqarish va massa almashinuvi). So'nggi yillarda turli xil kinetik modellar keng qo'llanilmoqda jumladan, psevdobirinchi va psevdodikinchi tartibli kinetik modellar [19].

Ushbu tadqiqotda quyidagi kinetik modellardan foydalanilgan

Psevdobirinchi tartibli kinetik model

Psevdobirinchi tartibli kinetik model (2) tenglama bilan ifodalanadi:

$$\log(q_e - q_t) = \log q_e \left(\frac{k_1}{2.303} \right) t \quad (2)$$

Bu tenglamada: ma'lum vaqt (q_t) va muvozanat (q_e) holatidagi Cr(VI) anion almashinuvchi ionlarining miqdori(mg/g). k_1 - birinchi tartibli sorbsiya jarayonining tezligi (min^{-1}) va (2) tenglama bo'yicha bog'liqlik grafigining burchak qiymati absissa o'qiga teng bo'ladi ($k_1/2.303$) [20].

Psevdodikinchi tartibli kinetik model

Psevdodikinchi tartibli kinetik model (3) tenglama bilan ifodalanadi:

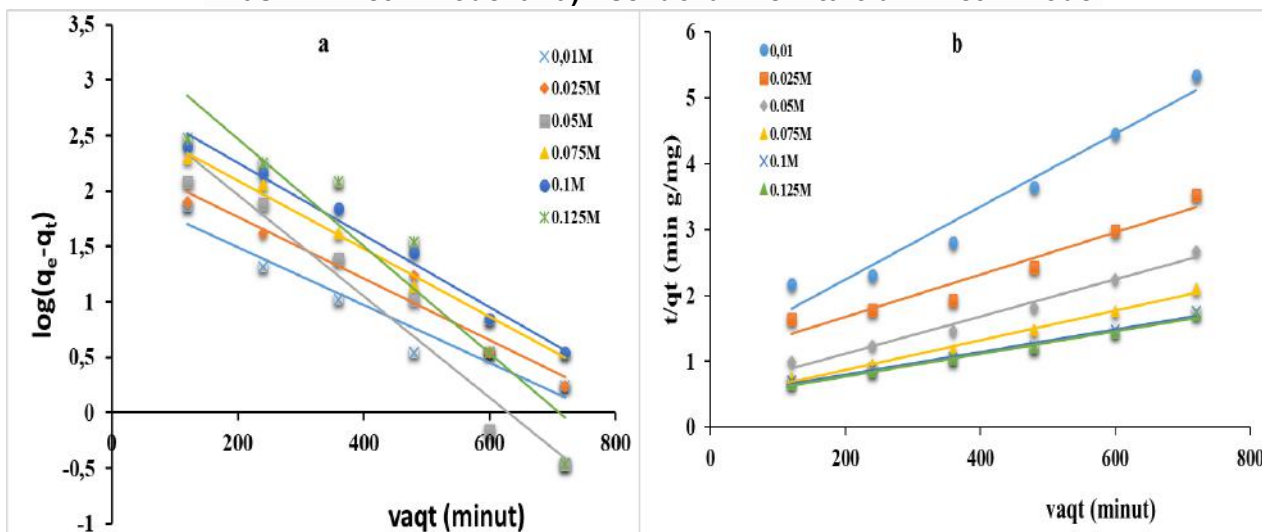
$$\frac{t}{q_t} = \frac{1}{k_2 q_e^2} + \frac{t}{q_e} \quad (3)$$

Bu tenglamada: k_2 - tezlik konstantasi, q_e - ma'lum massadagi anionitga yutilgan olti valentli xrom ionlari miqdori (mg/g), t - vaqt (minut)[21]

Adsorbsiya kinetikasi

Quyida keltirilgan 1 (a va b) rasm AN-31anionitiga Cr (VI) ionlari sorbsiyasi psevdobirinchi va psevdodikinchi tartibli kinetik modellarni ko'rsatadi. Keltirilgan grafiklar yordamida kinetik parametrlar hisoblab chiqilgan. Psevdobirinchi va psevdodikinchi tartibli kinetik modellarning hisoblangan kinetik parametrlari 1-jadvalda keltirilgan.

1-rasm: Kinetik modellar a) Psevdo-birinchi tartibli kinetik model



b) Psevdo-ikkinchi tartibli kinetik model

1-jadval

AN-31 ionitiga yutilgan xrom (VI) ionlarining kinetik parametrlarini taqqoslash

Sorbent	Metall ionlari	Dastlabki kons. (mol)	Psevdo-birinchi tartibliy			Psevdo-ikkinchi tartibliy		
			Muvozanat adsorbsiya miqdori q_e (mg g ⁻¹)	k_1 (g mg ⁻¹ min ⁻¹)	R^2	Muvozanat adsorbsiya miqdori q_e (mg g ⁻¹)	k_2 (g mg ⁻¹ min ⁻¹)	R^2
AN-31	Cr ₂ O ₇ ²⁻	0.01	202,8	0,00944	0,9902	202,8	0,000018075	0,9588
		0.025	306,8	0,00944	0,9639	306,8	0,000006429	0,9359
		0.05	405,6	0,00967	0,9666	405,6	0,000009681	0,9828
		0.075	514,8	0,00990	0,9414	514,8	0,000008073	0,9905
		0.1	624	0,00760	0,9819	624	0,000003948	0,9891
		0.125	634,4	0,01013	0,8908	634,4	0,000004280	0,9951
		O'rtach k_1 va k_2	0,06931			0,000050682		

Psevdo-birinchi va psevdo-ikkinchi tartibli kinetik modularning korrelyatsiya koeffitsientlari mos ravishda $R^2=0.9511-0.9716$ ga tengligi hisoblab topildi. Yuqoridagi 1-jadvalda keltirilgan kinetik parametrlarning qiymatlari shuni ko'rsatadiki, AN-31 anionitiga yutilgan Cr (VI) ionlari psevdo-ikkinchi tartibli adsorbsiya kinetikasiga mos kelgan. Demak, AN-31 anionitiga Cr(VI) ionlarining sorbsiya bo'lishida nafaqat xrom (VI) ionlarning tabiati, balki anionit tarkibidagi amino guruhlar ham ta'sir ko'rsatadi.

XULOSA

AN-31 anion almashinadigan materialiga Cr (VI) ionlarining adsorbsiya kinetikasi psevdo-birinchi tartibli modelga nisbatan psevdo-ikkinchi tartibli modelga yaqin. Psevdo-ikkinchi tartibli kinetik model parametrlari natijalari asosida shuni xulosa qilish mumkinki, anionit sirtida Cr (VI) ionlarining sorbsiyasi dastlab juda tez bo'lib, so'ngra bu ko'rsatgich kamaya boshlagan. Bu jarayonni quyidagicha izohlash mumkin, avval adsorbent yuzasida ma'lum miqdorda metall ionlari to'plangan va vaqt o'tishi bilan sorbent hamda ionlar o'rtasida muvozanat paydo bo'lgan. ishi bilan izohlash mumkin.

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