

# Kobalt saqlagan keklarni qayta ishlashning zamonaviy ahvoli va usullari

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**Annotatsiya:** Ushbu maqolada kobalt metalini ishlab chiqarishning zamonaviy ahvoli zahiralarini va ishlab chiqaruvchi yetakchi mamlakatlar haqida ma'lumotlar diagramma va jadvallar ko'rinishida keltirilgan. Bundan tashqari rux ishlab chiqarishda hosil bo'ladigan kobalt saqlagan oraliq mahsulotlarni turlari va ularni kimyoviy tarkiblari, qayta ishlash texnologiyalarining texnologik sxemalari haqida batafsil to'xtalgan. O'zbekistonda ham birlamchi kobalt saqlagan xomashyo zahirasi mavjud emas ammo oraliq mahsulot Co-Ni keki rux ishlab chiqarishda hosil bo'lmoqda va bunda Co miqdori 1 - 2 % atrofida bo'ladi. Bu esa o'z navbatida ushbu xomashyoni qayta ishlab yiliga 1-1,3 tonnaga yaqin qo'shimcha ravishda kobaltni ajratib olish imkonini beradi.

**Kalit so'zlar:** Co-Ni keki, kobalt saqlagan xomashyo, kislotali tanlab eritish, selektiv tanlab eritish, oksidlab - cho'ktirish, sulfat - ammiakli tanlab eritish, ekstraksiya, ajratish, tiklash, elektroliz.

## Modern state and methods of processing cobalt-preserved cakes

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**Abstract:** This article presents the current state of the production of metallic cobalt in the form of diagrams and tables with information on reserves and leading producing countries. In addition, the types of cobalt-containing intermediates in the production of zinc and their chemical composition, technological schemes of processing technologies are considered in detail. Uzbekistan also does not have reserves of primary cobalt-containing raw materials, but an intermediate product is

formed by Co-Ni cake with a Co content of about 1-2% during zinc production. This, in turn, allows processing this raw material and obtaining an additional 1-1.3 tons of cobalt per year. This article presents the current state of the production of metallic cobalt in the form of diagrams and tables with information on reserves and leading producing countries. In addition, the types of cobalt-containing intermediates in the production of zinc and their chemical composition, technological schemes of processing technologies are considered in detail. Uzbekistan also does not have reserves of primary cobalt-containing raw materials, but an intermediate product is formed by Co-Ni cake with a Co content of about 1-2% during zinc production. This, in turn, allows processing this raw material and obtaining an additional 1-1.3 tons of cobalt per year.

**Keywords:** Co-Ni cake, cobalt-containing raw materials, acid selective leaching, selective leaching, oxidation-precipitation, sulfate-ammonia selective leaching, extraction, separation, recovery

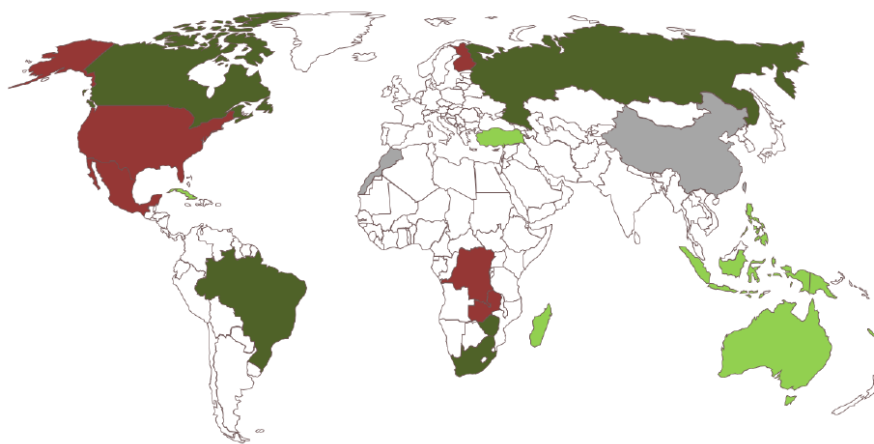
## KIRISH

Kobalt haqidagi dastlabki ma'lumotlar 2600 yil oldin ham ma'lum bo'lib shisha va chinni buyumlarni bo'yashda ishlatilgan. Ushbu bo'yoqlar tarkibida kobaltning ulushi 0,05-0,15 % gacha bo'ladi. Kobalt so'zi Leobenning yilnomalarida 1335-yilda Germaniya hududidagi Shneberg tog'larida yashagan afsonaviy gnomlarga nisbatan ishlatilgan [1]. Kobalt kimyoviy element sifatida 1735-yilda Shved mineralogi Georg Brandt tomonidan ajratib olingan [2].

2021-yilga kelib dunyo bozorida 1,5 mlrd ga yaqin smartfonlar sotilishi aytilmoqda. Elektromobillar ishlab chiqarish esa 2025 yilga kelib 12 mln donani tashkil etadi. Bundan tashqari yetakchi kompaniyalar tomonidan elektrovelosipedlar, elektromototsikllar, noutbuk, planshet, fotoapparatlar hamda telefonlarni quvvatlovchi powerbanklar ham ishlab chiqarilmoqda. Yuqorida nomlari keltirilgan mahsulotlarning barchasi akkumulyatorlar yordamida ishlaydi xususan 1 dona smartfon uchun 5 - 10 gr, noutbuk uchun 30 gr va elektromobillar uchun ea 20 kg gacha kobalt zarur. Hozirgi vaqtga kelib 1 tonna 99,6 - 99,8% tozalikdagi kobalt metalini LME (London metal birjasi)dagi narxi o'rtacha 50,000 - 52,000 AQSH dollarini tashkil etadi [3]. Elektrotexnika sohasini rivojlanib borishi shu asnoda davom etaversa yaqin 10 yilliklarda kobalt metaliga bo'lgan talab yanada ortadi va uning narxi ham oshadi.

## ADABIYOTLAR TAHLILI VA METODLAR

Ma'lumotlarga [4] qaraganda jahonda ishlab chiqarilgan kobaltning 55 % i mis ishlab chiqarishda 29 % i esa nikel ishlab chiqarishda yo'ldosh element sifatida ajratib olingan. Ammo kobaltni asosiy xomashyodan ajratib olish Morokkodagi Bou-Azzer ruda konida amalga oshirilmoqda.



■ - Cu-Co li ruda ■ - Ni-Cu-Co sulfidli rudalar ■ - Ni-Co lateritli ruda ■ - Boshqa turdagi rudalar

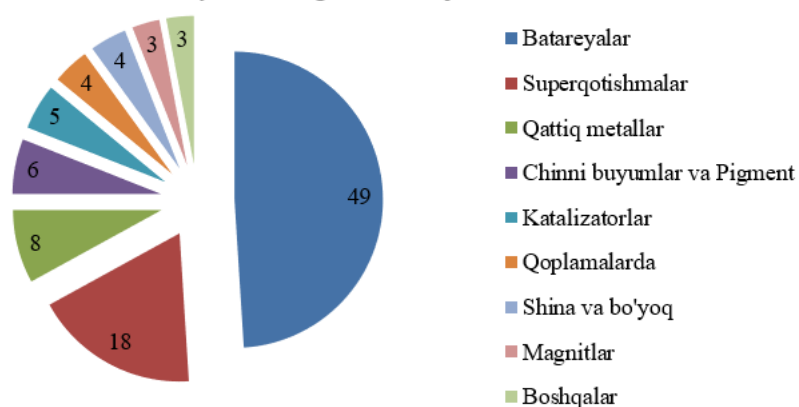
1-rasm. Kobalt ishlab chiqaruvchi va zahiralarga ega bo'lgan davlatlar 2020 yil.

Jadval №1

USGS keltirgan ma'lumotlarga ko'ra (2021) dunyo miqyosida kobaltning tasdiqlangan zahirasi 7,1 mln.t deb baholanmoqda

Mamlakatlar	Zahirasi
Avstraliya	1,400,000
Kanada	220,000
Xitoy	80,000
Kuba	500,000
Kongo demokratik respublikasi	3,600,000
Madagaskar	100,000
Morokko	14,000
Yangi Gvineya va Papua	51,000
Filippin	260,000
Rossiya Federatsiyasi	250,000
Janubiy Afrika	40,000
AQSH	53,000
Boshqalar	560,000
Jami	7,100,000

Umumiy ishlab chiqarilgan kobaltni mahsulotlarga yo'naltirilganlik darajasi. %



## Li ionli batareyalar turlari va ishlatilish sohalari

Akkumlyatorni nomlanishi	Kimyoviy formulasi	Kobaltni ulushi	Ishlatilishi
Li-Co oksidi	$\text{LiCoO}_2$	60 %	Mobil telefonlar, planshetlar, noutbuklar, fotoapparatlar.
Li-Mn oksidi	$\text{LiMn}_2\text{O}_4$	Co yo'q	Elektroinstrumentlar, elektrovlosipedlar, elektromobillar, tibbiy buyumlar.
Li-Fe fosfati	$\text{LiFePO}_4$	Co yo'q	
Li-Ni-Mn-Co oksidi	$\text{LiNiMnCoO}_2$	10-30 %	Elektr quvvatni yig'ib turishda, sanoat miqyosidagi dasturlarda, tibbiy asbob uskunalar.
Li-Ni-Co-Al oksidi	$\text{LiNiCoAlO}_2$	10-15 %	

O'zbekiston sharoitida ushbu metallni tasdiqlangan zahirasi mavjud bo'lmasa ham u Olmaliq KMK AJ ga qarashli rux ishlab chiqarish zavodida oraliq mahsulot hisoblangan Co-Ni keki tarkibida 0,5 - 1,3 % gacha bo'ladi. Taqqoslash uchun ruda tarkibida Co ulushi 0,5 % dan yuqori bo'lsa u boy ruda 0,1 - 0,5 % bo'lsa o'rtacha hamda 0,1 % dan kam bo'lsa kambag'al ruda hisoblanadi. Sanoat ahamiyatiga ega bo'lgan rudalarda esa 0,5 - 1,5 % atrofida bo'ladi. Agarda ushbu Co-Ni keki boyitilsa u holda Co ulushi konsentratda 2,2 -12 % gacha yetishi mumkin. Ko'rib turbmizki kekdagi kobalt ulushi ruda tarkibidan ancha boy.

## MUHOKAMA VA NATIJALAR

Quyidagi jadvalda keltirilgan Co-Ni keki kadmiy ishlab chiqarish bo'limida hosil bo'ladi. Bir oyda ushbu kek 10 - 15 t atrofida hosil bo'ladi ba'zan 20 t gacha ham chiqishi mumkin. Kekda o'rtacha Co – 0,91 % va Ni – 0,45 % atrofida bo'ldi bundan tashqari Zn, Cd, Cu va birqacha qimmatbaho elementlar ham bo'ladi. Hozirda ushbu kek maxsus joyda to'planib velslash jarayoniga yuborilmoqda. Agarda ushbu kek gidrometallurgik usulda qayta ishlansa yiliga 1,2 - 1,3 t gacha qo'shimcha ravishda Co metalini olish imkoni mavjud bo'ladi.



1-rasm. BARC va HZL ishlab chiqarishgan kobaltni kekdan ajratib olish texnologik sxemasi

Yuqorida keltirilgan texnologik sxema orqali kekni qayta ishlaganda kobaltni ajratib olish darajasi 40 % ni tashkil etib olingan kobalt tozaligi 98 - 99 % ni tashkil qilgan.

Kekdan Co ajratib olish bo'yicha dunyoda hozirgi paytda ishlab turgan bir qancha texnologiyalar va qilingan ilmiy ishlar bo'yicha o'rganish ishlari olib borildi bularning bir nechtasi quyida keltirilgan.

DEEPAK BHATNAGAR va A. JANCY ishlarida [5] keltirilishicha (CRDL), Hindustan Zinc Limited (HZL), Udaipur markaziy ilmiy tekshirish laboratoriyasida kekdan kobaltni ajratib olish ishlari olib borilgan. Vizag va Debari zavodlarida yiliga 165,000 tonna rux ishlab chiqarilib, undan hosil bo'lgan kekdan 1,24 tonna kobalt metallik holatda ajratib olingan.

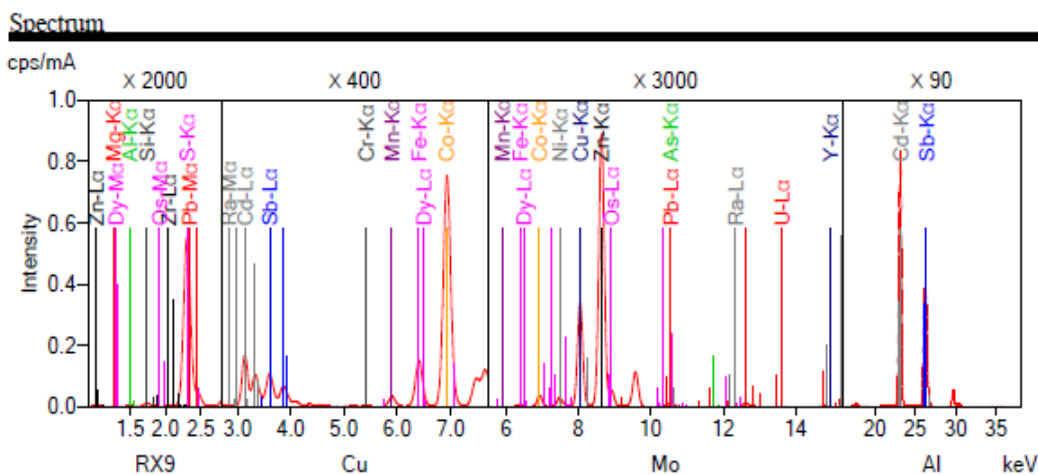
Kekning tarkibi % da : Co – 1 - 2, Zn – 10 - 17, Fe – 2 - 4, Cu – 0,1 - 0,4, Cd – 0,05 - 0,25 va boshqalar.

Jadval № 3

OKMK AJ ga qarashli Rux zavodi Kadmiy sexidan olingan Co-Ni kekining kimyoviy tarkibi

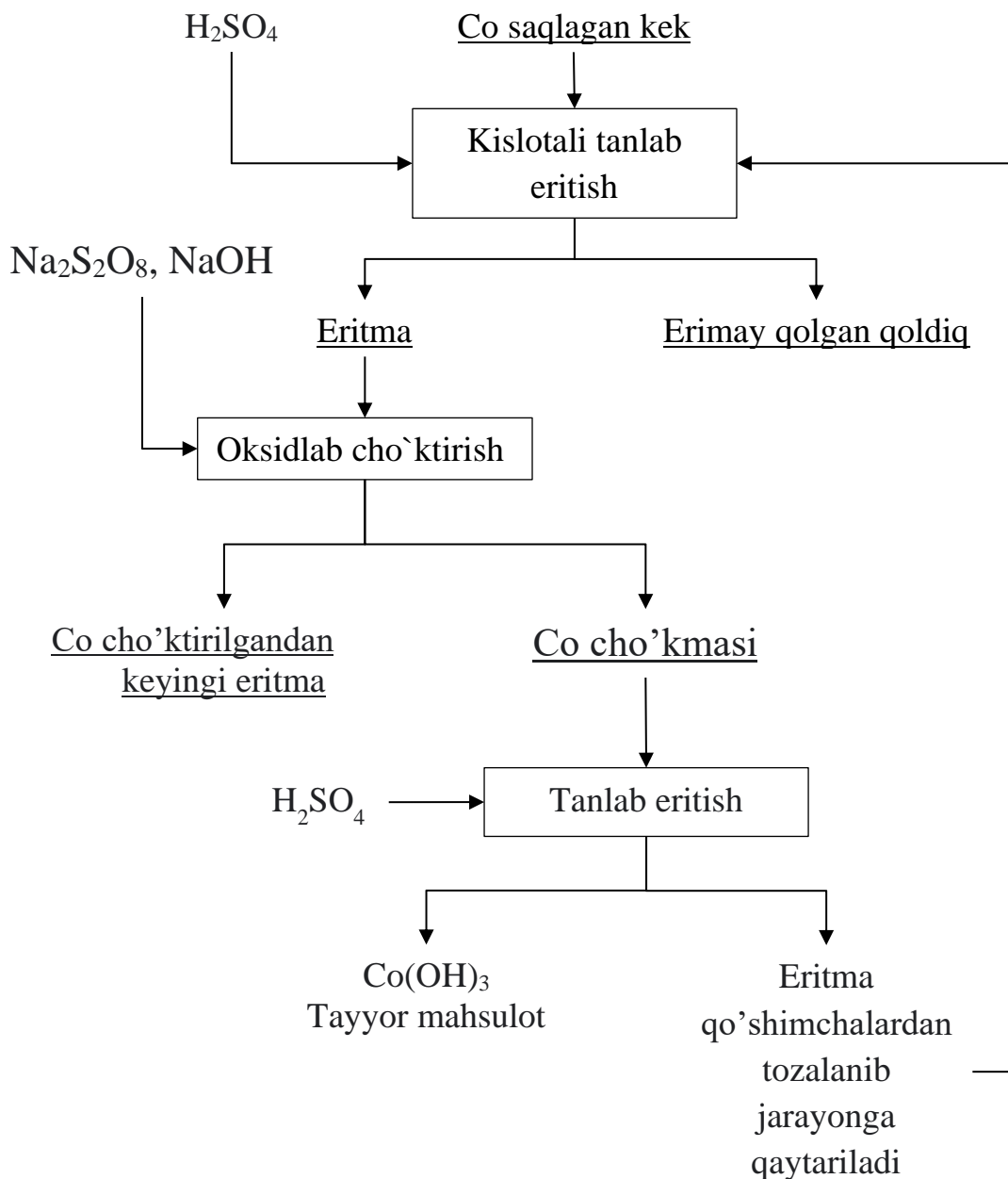
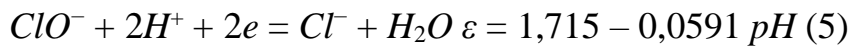
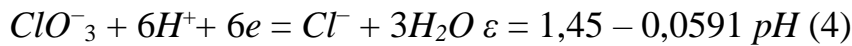
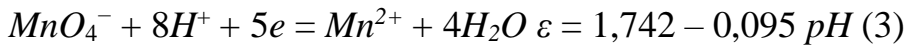
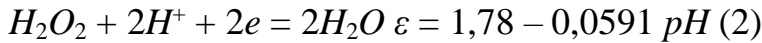
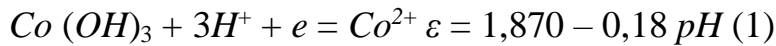
Analyzed result(FP method, Scatter)

No.	Component	Result	Unit	Stat. Err.	LLD	LLQ
1	Ra	0.0231	mass%	0.0013	0.0035	0.0105
2	MgO	0.148	mass%	0.0159	0.0435	0.130
3	Al2O3	0.463	mass%	0.0078	0.0138	0.0415
4	SiO2	1.25	mass%	0.0074	0.0067	0.0202
5	SO3	15.9	mass%	0.0112	0.0068	0.0204
6	Cr2O3	0.0175	mass%	0.0006	0.0011	0.0034
7	MnO	0.149	mass%	0.0035	0.0057	0.0171
8	Fe2O3	0.668	mass%	0.0050	0.0062	0.0186
9	Co2O3	2.25	mass%	0.0061	0.0072	0.0216
10	NiO	1.31	mass%	0.0063	0.0032	0.0097
11	CuO	15.5	mass%	0.0225	0.0059	0.0178
12	ZnO	31.3	mass%	0.0319	0.0159	0.0477
13	As2O3	0.0602	mass%	0.0034	0.0096	0.0288
14	ZrO2	1.18	mass%	0.0081	0.0049	0.0146
15	CdO	18.8	mass%	0.0341	0.0520	0.156
16	Sb2O3	10.0	mass%	0.0267	0.0328	0.0983
17	OsO4	0.240	mass%	0.0096	0.0267	0.0801
18	PbO	0.682	mass%	0.0042	0.0042	0.0127
19	Dy2O3	0.0771	mass%	0.0085	0.0235	0.0704
20	U3O8	0.0729	mass%	0.0011	0.0026	0.0079



Odatda oddiy oksidlovchilarga H<sub>2</sub>O<sub>2</sub>, NaClO, NaClO<sub>3</sub>, KMnO<sub>4</sub>, Na<sub>2</sub>S<sub>2</sub>O<sub>8</sub> va boshqalar kiradi. Ushbu oksidlovchilarni oksidlantirish xususiyatlari va pH Guo, 2000

va Hong 2003 lar tomonidan o'rganilgan. Eritmaning pH i oshib borishi bilan oksidlantiruvchilarning oksidlantirish darajalari tushib ketadi  $S_2O_8^{2-}$  dan tashqari :



4-rasm. Oksidlovchi sifatida  $Na_2S_2O_8$  qo'llanilgan holatdagi kekni oksidlab-cho'ktirishning texnologik sxemasi

Kekni oksidlab - cho'ktirish jarayonida ko'p ilmiy va tajriba ishlarida oksidlovchi sifatida  $Na_2S_2O_8$  ishlatilgani keltirilgan [6]. 4-rasmda Jarayonning texnologik

sxemasi ham keltirilgan. Ushbu texnologiya asosida qayta ishlangan kekdan olingan rux sulfat (kobalt miqdori 1mg/l kam bo'lgan rux sulfati ruxni elektroliz qilishga yuboriladi ) va kobalt (kobalt ulushi 50 % dan ortiq) erimay qolgan qoldiq sifatida olinadi. Bundan tashqari kobaltni ammoniy persulfat yordamida oksidlab cho'ktirish usulini Güler va Seyrankayalar ham o'rganishgan [7]. Ushbu olimlar asosan eritmaning pH muhitini, haroratini va oksidlovchining konsentratsiyalarini o'rganishgan. Olingan natijalarga ko'ra oksidlovchining konsentratsiyasiga bog'liq holda kobaltni ajratib olish darajasi 70 dan 90 % gacha bo'ldi va Kobalt eritmadan CoOOH ionlari holida cho'kdi.

Aytish mumkinki oksidlab - cho'ktirish ikki valentli kobaltni uch valentli kobaltga oksidlab o'tqazish orqali rux va kobaltni bir biridan ajratish uchun samarali usul hisoblanadi.

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## XULOSA

Xulosa qilib aytish mumkinki oksidlab - cho'ktirish ikki valentli kobaltni uch valentli kobaltga oksidlab o'tqazish orqali rux va kobaltni bir biridan ajratish uchun samarali usul hisoblanadi.

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