

KOMBINIRANI METODI ZA NISKOPROCENTNI NIKLONOSNI LATERITI

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Abstract

A combination of current trends and developments may undermine the sulphides supremacy and might tip the balance in favour of laterites for new investigations or projects. A list of current laterite operations or laterites processing today is following: Ferronickel smelting, Matte smelting, Reduction roasting-ammonia leaching and High pressure sulphuric acid leaching.

Apart from the above mentioned process routes, there have been many attempts to develop processes known as alternative processes, which have included: Nitric acid leaching, Chlorine leaching, Acid pugging and Sulphation roast, especially Segregation Process etc.

In this paper will be shown the investigations of the segregation-flotation-magnetic separation-ammonia leaching of the low - grade nickel bearing laterites and appropriate comparison about obtained recoveries between these processes.

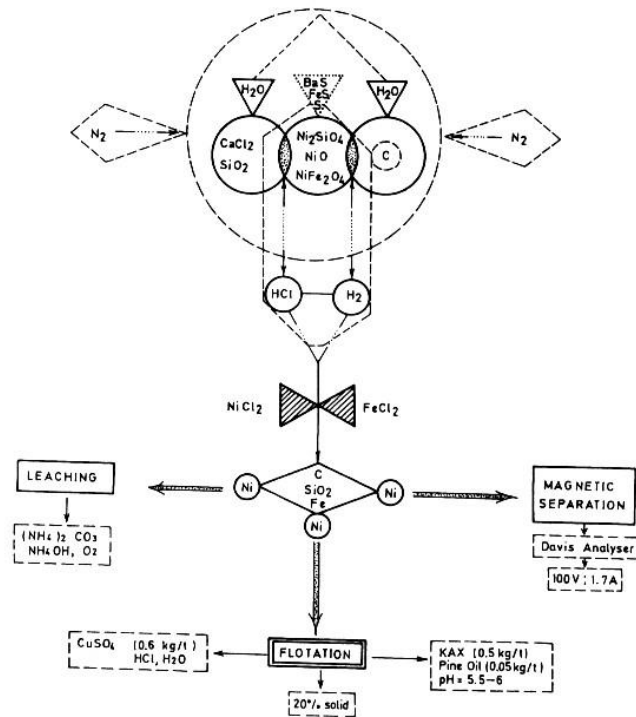
1. Voved

Vo me|uvreme niedna od sovremenite i napredni postapki ne gi premina pragovite na laboratoriski ili poluindustrijski ispituvawa, poradi razni tehni~ki, ekonomski i ekolo{ki faktori ili problemi. Me|utoa, obnoveni ot interes za lateritnite minerali vo 90-tite godini potikna određen broj na novi mo`nosti i nade`ni postapki, a voedno go za`ivea interesot i kon nekoi postari istra`uvani postapki za tretirawe na lateritnite niklonosni rudi.

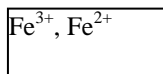
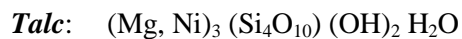
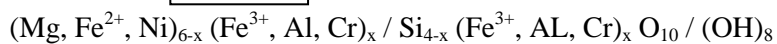
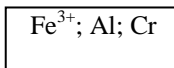
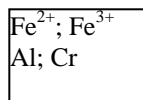
Ist e slu~ajot za interesot i perspektivata za segregaciskio proces. Prethodnite istra`uvawa vo oblata na hloriraweto na metalnite soedinenija, osobeno hloriraweto ili halogenizacija na refraktorni niklonosni minerali: garnierit i nontronit so hlor, HCl, NaCl ili CaCl₂, gi determiniraa pravcite na spomnatite procesi za tretman na niskoprocentni i kompleksni

minerali-lateriti. Principielnata {ema na segregaciski proces e prosleden so klasi~nite koncentraciski metodi - flotacija ili magnetska separacija i hidrometalur{ki tretman - amonija~no lu`ewe, kako {to e prika`ano na slika 1.

Kombinirane metode za obogatuvawe na oksidno-silikatnate nikelonosni rudi se sostoajat vo zagrevawe na rudata vo prisustvo na koks i CaCl_2 na visoka temperatura, pri {to se sozdava metalen nikel vrz prisutniot koks, ili na silikatite koi se sostavni delovi od rudata. Prisutni se slednite ~ekori, soglasno na prika`anaa {ema: sozdavawe na HCl i H_2 ; hlorirawe na Ni-feritite i Ni-silikatite do Ni-hloridi i Fe-hloridi, a pri reakcija na redukcija se sozdava Ni-metal na par~iwata od koks ili na par~iwata od kvarc. Slednite ~ekori se flotacija, magnetska koncentracija ili amonija~no lu`ewe i sozdavawe na Ni-metal.

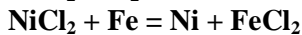
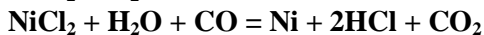
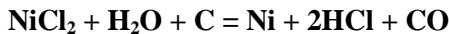
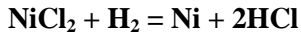
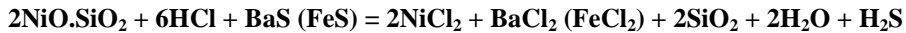
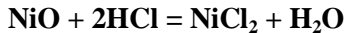
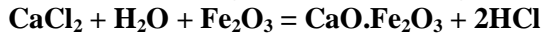
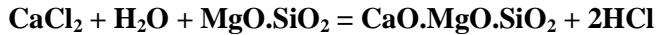
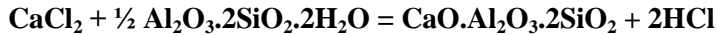
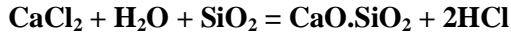
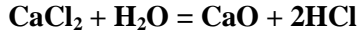


Slika 1. Principielna {ema na segregaciski proces



(Mg, Ni)₃ / Si_{3,75} Al_{0,25} O₁₀ / (OH)₂ H₂O - chlorite (saponit)

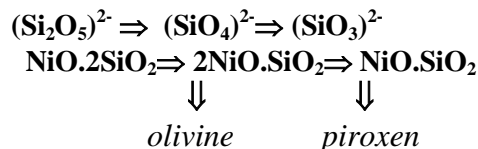
Slednite hemiski reakcii ja objasnuvaat {emata i kompleksniot visokotemperaturen segregaciski proces:



Termodinami~kite karakterisiki na gorespomnatite reakcii se izvedeni soglasno na standardnite izobarni potencijali, dodeka za objasnuvawe na kineti~kite karakteristiki za hlorirawe-segregaciski proces se primeneti ravenki koi ja opi{uvaat reakcijata kontrolirana so tri-dimenzionalno napreduvawe (difuziski-kontrolirani reakcii i reakciski-kontrolirani reakcii).

2. Op{to ponesuvawe na niklonosnite minerali

Za presmetki na Ni vo oksidno-silikatnite minerali, pojavata na nikelot mo`e da se prika`e preku slednata generalna formula ili preku mo`nata transformacija:



amorfna kristalna struktura $\Rightarrow \Rightarrow \Rightarrow$ **stabilna kristalna struktura**

@elezoto vo ovie niklonsni minerali i rudi se pojavuva kako Fe₂O₃·nH₂O i kako nontronit (Fe,Al)₂(Si₄O₁₀)(OH)₂·nH₂O. Oksidno-laterit-nite

rudi se so niska sođrina na nikel. Generalno, nikelot i`elezoto se vo forma na Ni-Fe-limonit (Fe,Ni)O(OH).nH₂O ili vo talk forma.

3. Eksperimentalni istra`uvawa na nikel-sinteti~ki smesi so segregaciski proces

Segregaciskiot proces na nikel-sinteti~ki smesi (NiO, NiO.Fe₂O₃, 2NiO.SiO₂) so jalovi mineralni soedinenija (CaO, MgO, Fe₂O₃, SiO₂) i hlori-rawe so dodavawe na CaCl₂.2H₂O, redukcija so koks pri temperatura od (1023-1223°K) so vreme na zadr`uvawe od (20-120 min) vo atmosfera na N₂.

Tabela 1. Hemiski sostav na sinteti~kite smesi

Soedinenie	Sinteti~ki smesi (%)		
	I	II	III
NiO	1.36	-	-
Ni ₂ SiO ₄	-	1.91	-
NiFe ₂ O ₄	-	-	4.28
Fe ₂ O ₃	20.00	20.00	20.00
SiO ₂	56.00	56.00	56.00
Al ₂ O ₃	5.00	5.00	5.00
CaO	1.00	1.00	1.00
MgO	6.14	5.59	3.22
CaCl ₂	7.50	7.50	7.50
C	1.00	1.00	1.00
BaS	2.00	2.00	2.00
Total	100.00	100.00	100.00
Ni (%)	1.07	1.07	1.07

Tabela 2. Rezultati dobieni so segregacija-flotacija-magnetska koncentracija-amonija~no lu`ewe

Smesa	T (°C)	t (min)	Flotacija	Magnet. sep.	Lu`ewe	
			R _{Ni} (%)	R _{Ni} (%)	R _{Ni} (%)	
I NiO + 2% BaS	750	20	1.62	1.50	1.70	
		40	3.41	3.05	3.65	
		60	3.89	3.20	4.10	
	850	20	8.43	7.80	8.70	
		40	17.66	16.50	18.25	
		60	25.43	21.25	27.10	
	950	120	45.40	42.30	46.50	
		20	28.32	25.10	30.05	
		40	40.78	37.20	42.45	
			60	44.78	40.00	5.75
			120	60.98	56.70	65.10
		750	20	1.90	1.70	2.15
40			3.82	3.25	4.20	
60			5.48	4.85	6.10	
20			14.36	12.10	16.10	

II Ni ₂ SiO ₄ + 2% BaS	850	40	25.17	22.10	27.10
		60	37.40	33.45	40.00
		120	55.60	51.50	56.50
	950	20	36.85	32.40	39.60
		40	47.24	43.70	50.00
		60	58.73	55.10	64.05
		120	76.35	71.35	78.40
III NiFe ₂ O ₄ + 2% BaS	750	20	2.18	1.70	2.55
		40	3.82	3.25	4.20
		60	6.84	5.25	7.65
	850	20	17.55	16.50	18.25
		40	28.40	25.05	30.00
		60	44.65	40.00	46.00
	950	120	58.60	55.00	61.30
		20	33.42	30.15	35.10
		40	50.41	44.10	52.05
		60	59.25	56.00	65.00
		120	80.70	76.40	82.10

4. Eksperimentalni istra`uvawa nas prirodni niklonosni rudi so segregaciski proces

Eksperimentalnite istra`uvawa so dodatok na aktivator 2% (BaS, FeS, S ili BaSO₄) vlijae na tehnolo{kite pokazateli pri kombinirani procesi **segregacija-flotacija-magnetska separacija-amonija~no lu`ewe** kako {to e prika`ano za rudni probi od razni lokaliteti. Parcijalnite hemiski sastavi na rudnite probi (100% - 0,150 mm i 100% - 0,100 mm) se od 0,85% Ni Studena voda, 0,97% Ni R`anovo (dvete od Makedonija), 1,2% Ni i 1,86% Ni Ruxinci I & II (Jugoslavija).

Tabela 3. Rezultati dobieni so segregacija-flotacija na rudni probi (100% -0.150mm)

Rudna proba	BaS (%)	(%), R _{Ni}		
		Flotacija	Magnet. separ.	Lu`ewe
St. Voda	0.0	36.50	34.70	37.20
	2.0	45.45	42.85	46.10
	3.5	60.70	55.60	62.35
R`anovo	0.0	36.85	35.30	37.60
	2.0	47.10	46.60	48.20
	3.5	62.30	60.70	65.10
Ruxinci I	0.0	42.50	40.25	43.10
	2.0	48.60	45.30	50.20
	3.5	65.00	63.20	66.75
Ruxinci II	0,0	46.00	41.75	47.05
	2,0			
	3,5			
		68.00	65.30	70.20
		78.00	73.60	80.30

Tabela 4. Rezultasti dobieni so segregacija- flotacija-magnetska separacija-lu`ewe na rudni robi (100% -0.150mm)

Rudna proba	Dodatok (%)	Flotacija	Iskorist.	
			(%) R _{Ni} Magnet. separac.	Lu`ewe
Studena Voda	2.0% FeS	47.00	44.35	48.35
	3.5% FeS	60.70	56.70	62.75
	2.0% BaS	47.05	44.35	50.10
	3.5% BaS	61.10	57.00	63.25
	2.0% BaSO ₄	45.20	42.30	47.05
	3.5% BaSO ₄	60.10	56.00	64.10
R`anovo	2.0% FeS	49.50	47.20	52.30
	3.5% FeS	61.50	56.35	63.50
	2.0% BaS	50.25	48.10	53.10
	3.5% BaS	60.10	56.00	64.10
	2.0% BaSO ₄	49.80	48.00	51.40
	3.5% BaSO ₄	60.50	56.10	64.00
Ruxinci II	2.0% FeS	79.60	76.30	81.85
	3.5% FeS	80.50	79.10	83.10
	2.0 % BaS	82.40	78.25	85.00
	3.5% BaS	76.50	73.45	80.00
	2.0% BaSO ₄	70.30	65.30	74.00
	3.5% BaSO ₄	76.50	73.45	78.00

5. Zaklu~ok

Kombiniranite procesi **segregacija-flotacija-magnetska separacija- amonija~no lu`ewe** na sinteti~ki smesi i soodvetni rudni probi (so razli~na sodr`ina na nikel vo niv) obezbeduvaat zadovoljitelni rezultati vo odnos na iskoristuvawe na metal. Postoe~kite ekolo{ki problemi }e dovedat do zgolemuvawe na interesot kon kombiniranite metodi ili hidrometalur{kite procesi. Ovi }e vku~at kombinirawe na slednite procesi: **segregacija-flotacija-amonija~no lu`ewe** ili neкои drugi procesi kako {to se oksidacija ili biooksidacija.

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