AKTET **ISSN 2073-2244**
Journal of Institute Alb-Shkenca **www.alb-shkenca.org**
Revistë Shkencore e Institutit Alb-Shkenca

PROCESSING OF NICKEL OXIDE ORES IN THE ROTARY KILN WITHOUT LIMESTONE IN "FERRONIKELI I RI" IN DRENAS
TRAJTIMI I XEHEVE OKSIDE TË NIKELIT NË FURRËN RROTULLUESE PA GUR GËLQEROR NË "FERRONIKELIN E RI" TË DRENASIT

SHEFIK IMERI[1], NAIM TAHIRAJ[1], MUSA RIZAJ[2]
[1]Ferronikeli i ri Drenas, Kosovë
[2]Fakulteti i Xehetarisë dhe Metalurgjisë, Universiteti i Prishtinës, KOSOVE
Email: shefik.imeri@kosovo-nickel.com

AKTET IV, 2: 261-265, 2011

PERMBLEDHJE
Procesi i përfitimit të ferronikelit karakterizohet më vështirësi të mëdha tekniko-teknologjike dhe ekonomike. Në vazhdën e përmirësimit të procesit metalurgjik të shkrirjes elektrike të sharzhës për përfitimin e ferronikelit është arritur që të eliminohet nga procesi në tërësi shtimi i sasisë së gurit gëlqeror në sharzhën e furrës rrotulluese. Efektet pozitive që janë arritur në procesin e fërgimit në furrë rrotulluese janë: zvogëlimi i konsumit të mazutit, zvogëlimi i ngjitjeve të fërgesës në zonën e fërgimit, rritja e temperaturës së materialit të fërguar, rritja e koeficientit të shfrytëzimit të Ni, rritja e shkallës së para-reduksionit të materialit të fërguar dhe rritja e kapacitetit të furrës rrotulluese. Krahas përmirësimit të procesit metalurgjik të prodhimit të Fe-Ni, është arritur edhe zvogëlimi i shkallës së ndotjes së mjedisit, duke ulur sasinë e prodhuar të CO_2 në furra rrotulluese dhe furra elektrike.
Fjalët kyçe: disocim, para-reduktim, fërgesa, Fe-Ni i pa-përpunuar.

SUMMARY
Process of obtaining Fe-Ni is characterized with lot of technical-technological and economical difficulty. In order to improve metallurgical process of obtaining Fe-Ni, was achieved, to be eliminated at all the adding of quantity of Limstone in charge of rotary kiln. Positive effects, which have been achieved in calcinations process of rotary kiln are: reducing of mazut consumption, reducing of sticking material in calcinations area, increasing of temperature of calcine, increasing of recovery of Ni, increasing of pre-reduction of calcine and increasing of rotary kiln capacity. Except improvement to the metallurgical process of obtaining Fe-Ni, has been decreased the pollution of environment as well, producing less CO_2 in rotary kilns and electro-reduction furnaces.
Key words: Crude Fe-Ni, dissociation, pre-reduction, calcine

1. INTRODUCTION

The aim of this investigation was to improve the metallurgical process of obtaining Fe-Ni and to increase the quantity and quality of produced calcine in rotary kiln, in order to increase production capacity of obtaining Fe-Ni. It was achieved eliminating at all the adding of Limstone in charge of rotary kiln.

2. TREATMENT OF NICKEL OXIDE ORES IN ROTARY KILN

In industrial way was approved that nickel oxide ores can be treated without problem in rotary kiln with out Limstone (sterile material). Since 5.02.2010 the rotary kilns are operating with out adding of Limstone in the charge. Under way, we can give an example of operations of rotary kiln nr. 2.

Date on 14.07.2010. Rotary kiln nr 2 was operating as follow:
Average capacity 102t/hr
Lignite 10.5 %
Ore composition (%): Gllavica ore: 51.7%
Cikatova ore: 17.25 %
Albanian ore – Aren: 6.9%
Albanian ore –Yzo: 3.45 %
Indonesian ore: 20.7 %
ε = 100 %

Charge composition (t): Gllavica ore: 52.73 t
Cikatova ore: 17.59 t
Albanian ore – Aren: 7.038 t
Albanian ore – Yzo: 3.519 t
Indonesian ore: 21.115 t
Lignite 10.71 t
Quantity of charge: ε = 112.71 t

Chemical composition of ore, calcine, temperature of calcine and gases are given in table: 1, 2 and 3.

Ni %	Fe %	Co %	Cr_2O_3 %	CaO %	MgO %	Al_2O_3 %	SiO_2 %	Fe_2O_3 %	H.P %	Humidity %
1.11	19.9	0,03	1,06	2.55	10.80	3.2	43.83	28.48		23.47

Table 1. Average Chemical composition of ore.

Ni %	$Fe_{tot.}$ %	Co %	Cr_2O_3%	CaO%	MgO%	Al_2O_3%	SiO_2%	C_{fix}%	$Fe_{met.}$%	FeO %	Fe_2O_3 %
1,26	17,6	0,04	1,43	2.71	15.65	2,8	46.65	3.32	0.16	9.24	14.87

Table 2. Average Chemical composition of calcine

Temp. of calcine. OP	M8 °C	M7 °C	M6 °C	M5 °C	M4 °C	M3 °C	M2 °C	M1 °C	G7 °C	G6 °C	G5 °C	G4 °C	G3 °C	G2 °C	G1° C	G0 °C
715	613		826		483	376	250	197			870	704	666	433	287	229
670	644		706		322	314	227	186			827	638	576	486	264	246
720	604		758		350	423	263	176			876	703	661	538	261	250

OP – Optical Pyrometer.

Table 3. Temperature of material and gases inside Rotary Kiln

For capacity of rotary kiln of 102t/hr, in the charge was added 7.038 t Albanian ore Aren and 3.519 t Albanian ore Yzo.
Additional quantity of Fe_{total} from Albanian ore Aren:
7.038 t /hr X 23.19 % Fe_{total} = 1.63 t Fe_{tota}/hr.
Additional quantity of Fe_{total} from Albanian ore Yzo:
3.519 t /hr X 38.37 % Fe_{total} = 1.35 t Fe_{tota}/hr.
Total additional quantity of Fe_{total} = 1.35 t Fe_{tota}/hr + 1.63 t Fe_{tota}/hr = 2.98 t Fe_{tota}/hr .

The quantity of reducing of $CaCO_3$ due to adding Albanian ores is 10% of the overall charge, or Rotary Kiln capacity of 102 t / hr: 102 t/hr X 10 % $CaCO_3$ = 10.2 t $CaCO_3$/hr, or considering the moisture of $CaCO_3$ from 0.85%, then:
10.2 t $CaCO_3$/hr X 0,9915 = 10.11t $CaCO_3$/hr.
The practical results proved that ≈ 60% of $CaCO_3$ dissociated in rotary kiln under reaction:

$$CaCO_3 \rightarrow CaO + CO_2$$

10110 kg$CaCO_3$/hr x 60% = 6066 kg$CaCO_3$ x 44/100 = 2669.04 kgCO_2/hr,
Or 2669.04 kg CO_2/hr x 22,4/44 = 1358.78 m^3NCO_2/hr.

Which means that for the capacity of 102 t/hr of the rotary kiln, has been produced less 1358.78 m^3 NCO_2 / hr.
Or for 1t dry ore has been produced less CO_2:
1358.78 m^3NCO_2/78.06 t DO = 17.41 m^3NCO_2/ t DO.

3. TREATMENT OF NICKEL OXIDE ORES IN ELECTRIC FURNACE

$CaCO_3 \rightarrow CaO + CO_2$

10110 kg $CaCO_3$ /hr x 40% = 4044 kg $CaCO_3$/hr x 44/100 = 1779.36 kg $C0_2$/hr,

or 1779.36 kgCO_2/hr x 22,4/44 = 905.856 m^3NCO_2/hr.
Which means that for the capacity of 102 t/hr of the rotary kiln inside the electrical furnace has been produced less 905. 856 m^3 N CO_2 / hr.

For 1t dry ore has been produced less CO_2:
905.856 m^3NCO_2/ 78.06 t DO = 11.605 m^3NCO_2/ t DO.
Chemical composition of electric furnace slag with increasing of Fe_{total} by 3.89 % is given in table 4, while with less Fe_{total} by 3.89 % is given in table 5.

Ni %	SiO2 %	Fe %	FeO%	CaO %	MgO %	Al_2O_3%
0,09	60.96	12.09	15.60	2.75	18.43	2,23

Table 4. Chemical composition of electric furnace slag with increasing quantity by 3.89 % F_{total}

Ni %	SiO2 %	Fe %	FeO%	CaO %	MgO %
0,09	64.19	8.2	10.58	2.89	19.4

Table 5. Chemical composition of electric furnace slag with less of 3.89 %Fe_{total}

4. RESULTS AND DISCUSSION

Increased quantity of Fe $_{total}$ /t DO:
0.038t Fe_{total} /t DO.
Fe_{total}/tDO:$0{,}0479tFe_{total}/tDO$.
$0{,}0479tFe_{total}/tDO$Decreasing quantity of CO_2 in rotary kiln gases: 17.41 m^3NCO_2/t DO.
$13{,}7m^3NCO_2/tDO$.Decreasing quantity of CO_2 in electric furnaces gases: 11.605 m^3NCO_2/t DO. $9{,}13m^3NCO_2/tDO$.Increased quantity of Ni:
0.0011t Ni/t DO. $0{,}207kgNi/tDO$.
Increased quantity of Fe_{total} in electric furnace slag: 3.89 % $Fe_{total.}$ $5{,}43\%Fe_{total}$.
Decreasing of production cost:
80 US $/ t Ni.
From three components diagram (fig.1) we can compare the liquid temperature of electric furnace slag for 2 examples, depending from chemical composition of slag

Chemical composition of main components of electric furnace slag

a). Slag with albanian ores:
SiO_2 = 60.96 %;
MgO + CaO = 18.43 + 2.75 = 21.18 %;
FeO = 15.60 %;
FeO+ MgO + CaO = 36.78 %.
Tl ≈ 1630°C

b). Slag with out albanians ores:
SiO_2 = 64.19 %
MgO + CaO = 19.4 + 2.89 = 22.29 %;
FeO = 10.58 %;
FeO + MgO + CaO = 32.87 %.
Tl ≈ 1690°C.

In rotary kiln is improved roasting process of calcine and is reduced quantity of sticking calcine for 50 – 60 %. Is increased quantity and quality of calcine, producing more calcine, with temperature around 700 C, rate of pre-reduction 40% and is reduced sufficiently consumption of mazut up to 42 kg mazut/t calcine (July 2010)..
Total elimination of $CaCO_3$ in metallurgical process , has been increased capacity of rotary

kiln by 10% and quantity of Ni by 0.0011 t Ni / t DO, decreasing production cost of Ni by 80.3 US $ / t Ni. Has been decreased realising of CO_2 in gases of rotary kiln by 17.41 m^3NCO_2/t DO and CO_2 in gases of electric furnace by 11.605 m^3NCO_2/t DO.

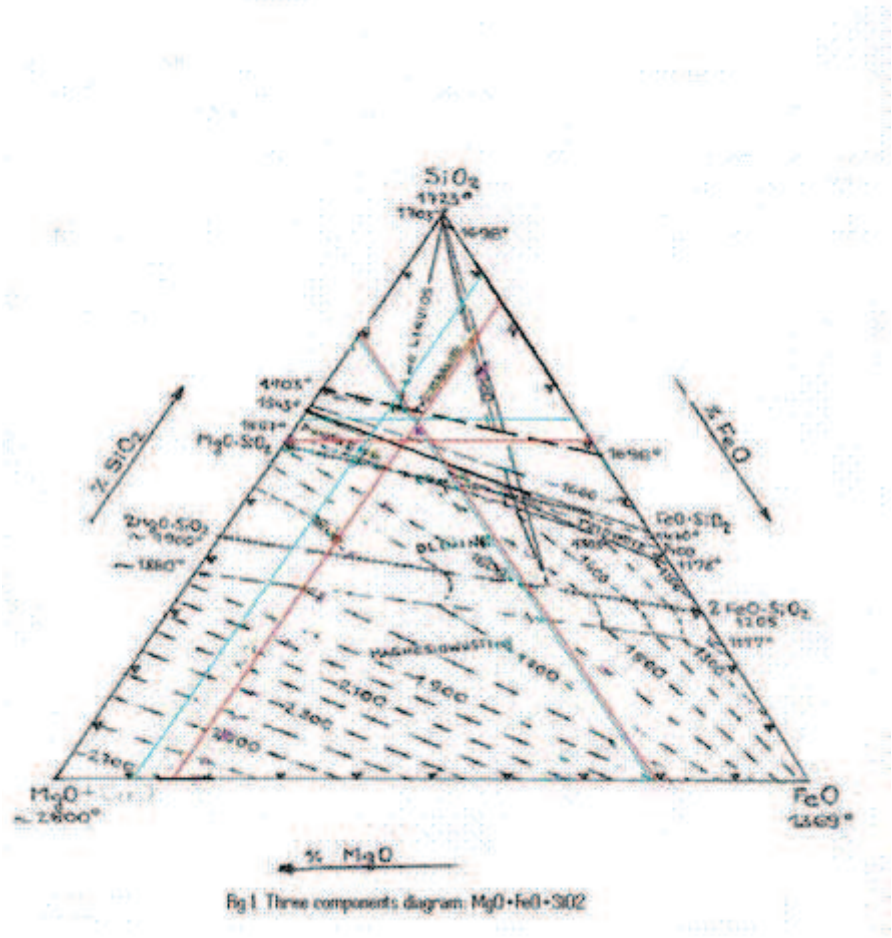

Fig 1 Three components diagram MgO-FeO-SiO2

Increasing quantity of Fe_{total} in electric furnace slag by 3.89%, have been created satisfactory condition, that by decreasing of acidity of electric furnace slag , to decrease the smelting point of it and in such case to have a technological process so equilibrium in electric furnace, with continuous flow of slag (approximately is preserved condition :

FeO + MgO + CaO = 36.78 %.

If we would operate without Albanian ores, we would have these parameters:

FeO + MgO + CaO = 32.87 % .

The recovery of Ni has been reached 88% in July 2010.

5. CONCLUSIONS

Industrial investigation has been done at smelting complex of Newco Ferroniceli Complex in Drenas. By industrial experiments has been proved, that nickel oxide ores could be treated without difficulty in metallurgical process of obtaining Fe-Ni, with out Limstone, by adding of Albanian ores, increasing remarkably production capacity of Fe-Ni and decreasing of production cost as well. Adding of Albanian ores in smelting

process of obtaining Fe-Ni, except improvement of metallurgical process, has been indicated positively in decreasing of pollution of environment as well.

6. REFERENCES

1. Elaboration of electric smelting process experience, Elkem, Osllo, 1987
2. Technological instruction of obtaining Fe-Ni in "Ferronikeli" smelting complex – Glogoc 1983.
3. Elkem a/s Engineering, The possible adoption of the open bath process for the production of a higher grade Fe-Ni at Ferronikeli – Prishtina 1985.
7.
4. Daily, monthly and yearly reports of obtaining Fe-Ni, official documentation of smelting complex of NewCo Ferronikeli Complex – Drenas, 2007, 2008 and 2009.
5. Daily, monthly and yearly reports of chemical analysis of smelting complex of New Co Ferronikeli Complex, Drenas, 2007, 2008 and 2009.
6. Sh. Imeri, N. Tahiraj, H. Mehmeti, Processing of converter slag in the process of obtaining Fe-ni in New co Ferroniceli complex L.L.c. of Drenas, Aktet, 2010.