

Optimization of the solar drying platforms of the Ernesto Che Guevara company mine

Optimización de las plazoletas de secado solar de la mina de la empresa Ernesto Che Guevara

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Ernesto Che Guevara Nickel- Producing Plant, Moa, Cuba

Abstract: The improvement of the solar drying platforms at the Ernesto Che Guevara mine in Moa is proposed to reduce the average moisture content of the ore feed. The process allows for improved dryer operation by reducing adhesion and material recirculation in the plant. The improved mixing of lateritic ores is evident in the sampling results and in the decreased moisture content of the ore entering the Ore Receiving Plant. The procedure used in the run demonstrated improved quality stability of the nickel ores fed into the technological process. The average moisture content of the ore feed was reduced by 3.83 %, allowing for improved dryer operation by reducing adhesion and material recirculation.

Key words: solar radiation, heart treatment, humidity control

Resumen: Se propone el perfeccionamiento de las plazoletas de secado solar de la mina de la industria Ernesto Che Guevara de Moa para la reducción de la humedad promedio de las menas alimentadas. El proceso permite una mejor operación en los secaderos, al disminuir los fenómenos de adherencia y recirculación del material en la planta. La mejora de la mezcla de las menas lateríticas, se evidencia en los resultados del muestreo y en la disminución de la humedad en el mineral de entrada a la Planta de Recepción de Mineral. Con el procedimiento empleado en la corrida se evidenció una mejor estabilidad de la calidad de las menas niquelíferas que alimentan el proceso tecnológico. La reducción de la humedad promedio de las menas alimentadas fue de 3,83 %, permitiendo una mejor operación en los secaderos, al disminuir los fenómenos de adherencia y recirculación del material.

Palabras clave: radiación solar, tratamiento térmico, control de humedad

Introduction

The solar energy use has been consolidated as a future power source, in favor of the sustainable development (Araújo, Varella & Guerra Vale, 2021; Moyado *et al.*, 2023; Roncancio Bedoya *et al.*, 2024). The solar energy use has been validated, based on its pertinence and sustainability, as it is a clean energy source, which enables to reduce the environmental impacts, as compared to the traditional energy sources (Osornio *et al.*, 2022; Molina & Torres, 2022; Rao *et al.*, 2025; González-Urrieta *et al.*, 2025; Xu & Liu, 2025; Arreaga, Camas & Subarán, 2025).

The solar-drying method is a traditional method, which has been used in order to remove the ore moisture. This drying process is one of the most used by the material extractive industry nowadays (Fonseca Aguilar *et al.*, 2024). The solar-drying method implementation at the mining industry, allows to get a significant energy saving, as well as a reduction of toxic gases emissions to the atmosphere (Estenoz & Pérez, 2000).

In the nickel industry the lateritic ores are subjected to a solar-drying process in order to reduce the ore moisture content (Estenoz, 2001; Retirado-Mediaceja *et al.*, 2011; RetiradoMediaceja & Legrá-Lobaina, 2011; Retirado-Mediaceja *et al.*, 2012; Belette, 2020; Retirado Mediaceja *et al.*, 2024; Retirado Mediaceja *et al.*, 2025). This system is implemented by stockpiling the lateritic ore in bulk, making outdoor ore stockpiles. (Retirado-Mediaceja *et al.*, 2016). The solar technology in Moa, is carried out by distributing the lateritic ores on artificial platforms, as an alternative, in order to rationalize the Caron Process, that has been applied for the nickel plus cobalt production process (Fonseca Aguilar *et al.*, 2024).

The solar-drying system application at Ernesto Guevara nickel-producing Company, from Moa, has been considered, based upon the insertion into the Integrated Ore-Preparation System, which includes the integral mining of the mineral resources and the development of an excellence mining (Estenoz & Pérez, 2000). A mining system has been set up in this nickel plus cobalt producing company, in order to increase the lateritic ore quality. This system takes into consideration a natural ore-drying technology, providing several advantages; but it also shows limitations that reduce its feasibility (Retirado-Mediaceja *et al.*, 2018). The search of a suitable solar ore-drying technology, at the ore preparation plant, will enable a greater industrial development (Retirado-Mediaceja *et al.*, 2007).

Fonseca Aguilar (2024) asserts that the application of this company's lateritic ore deposits solar ore-drying system, enables to reduce the ore moisture, oil consumption, as well as increasing the industry productivity.

The direct ore feeding is carried out, from the mining faces, at Ernesto Guevara nickel-producing company, which implies a greater incorporation of rocks into the process. Besides, the ore is fed to the process with greater moisture content. So that this paper is aimed at optimising the solar ore-drying platforms, in order to reduce the average ore feed moisture, that is fed into the Ore Preparation Plant.

Materials and methods

The ore stockpiles-removal operation was carried out between 30 to 55 removal passes(everyday). An alternative way was found in order to reduce the ore removal time, which could be effective with just 16 removal passes, in order to reduce the drying time and the ore moisture.

An experimental run test was carried out, from filling the platforms 4, 5, 7 and 8 of the solar-drying project. The ore stockpiles were made with nickel ores from Yagrumaje Sur, Camarioca Este and Punta Gorda's ore deposits, by making 3 ore stockpiles and 6 sectors at each platform. The ore stockpiles remounting and removal were carried out, using a back-hoe loader, by removing the ore stockpiles for 16 days, from the 7:00 am to 7:00 pm schedule. Upon completing the remounting process, the sampling to characterise the lateritic ores and the saprolite ore, deposited in the sectors and the stockpiles of the aforementioned platforms, was carried out.

Design, experimentation, analyses and tests

The platforms supply was carried out with nickel ores from Punta Gorda, Yagrumaje Sur and Camarioca Este ore deposits. The platforms were made up with three ore stockpiles of two sectors each one, stockpiling them in 3 different rows (Figure1).

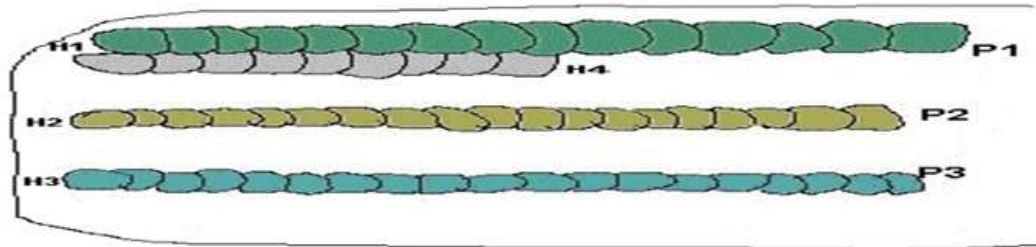


Figure 1. Discharging diagram of the ore-haulage trucks, which download on ore stockpiles rows, in order to make up the solar-drying ore stockpiles in the platforms. (P1 ore stockpile 1, P2 ore stockpile 2, P3 ore stockpile 3, H1 row 1, H2 row 2, H3 row 3, H4 row 4).

The rows for the ore-haulage trucks trips: (a) they were made up, just leaving a small ore stockpile (b); then two rows which were placed on the small one, were deposited, resulting in the ore stockpile C (Figure 2). Then the ore removal process was started.

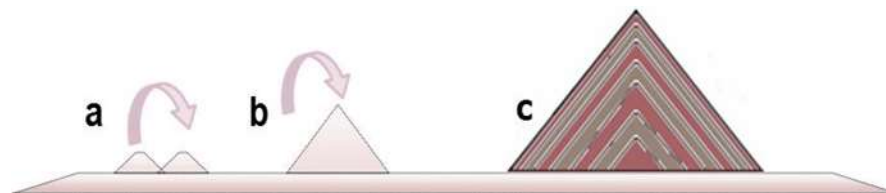


Figure 2. Row-remounting process and ore stockpiles making for solar drying. a) Remounting of the first row on the second one, b). Less height ore stockpile made up by two rows. c) Ore stockpile completed with all its rows remounted.

The removal process was performed in parallel with the supplying process. The drying process by removal was carried out taking an ore layer, from down to top at the north slope and leaving it to fall down towards the slope of the south part, which provides a great benefit of the solar energy, the wind energy, as well as the natural heat, enabled by the total ore stockpiles completion at once.

The organization and displacement during the removal operation, the regulation of the exposure area for ore stockpiles drying, and the inclination of the slopes for rainfall drainage, during the drying process, were carried out at the ore stockpile with 16 removal passes, depending on the height of the ore stockpile, and at the same time the number of layers, that there were in the ore stockpile or the platform. At the completion of the removal operations, the ore stockpiles were made and they were ready for the characterization sampling (Figure 3).

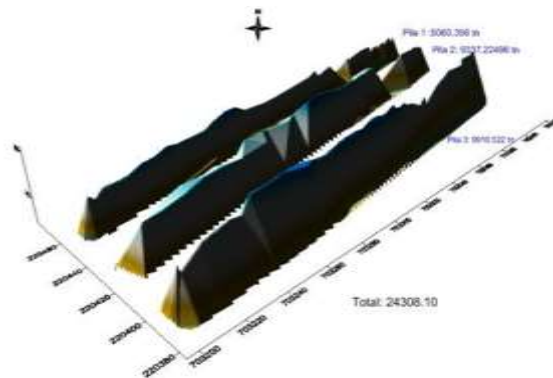


Figure 3. Ore Stockpiles platforms, made up after the removal operation.

For the characterization process, the samples from the ore stockpiles walls were taken, per each three meters and the ore stockpiles were fractioned by using a back hoe in order to do the sampling of their inner part, by using the groove method, that consisted of obtaining the lateritic ore with the help of a paddle (Figure 4).



Figure 4. Groove-method sampling of the lateritic ore in the stockpiles of the platforms.

The materials used for the sample takings were a paddle and nylon bags with 10 kg capacity of lateritic ores.

Physical processing of the samples and preparation for the chemical determinations

The samples taken were transferred to the ore-preparation room of the ore reception and supply plant, where the following procedures were performed:

- Drying: in a universal stove at 120°C for a time period of 2 hours.
- Crushing process: by a jaw crusher, with an outer diameter of the particles between 3 to 6 mm. A sample quarter was used in order to reduce the sample size.
- Pulverization: in disk mills with a particle size of less than 100 mesh.

- The samples were placed into snitches and they were transferred to the company's chemical laboratory.
- In the laboratory, the samples were placed into the stove again, in order to reduce the traveling moisture and to assure the proper ore sample blending, before conforming the analysis procedure.
- The sample processing was carried out individually. The moisture analyses were carried out on a thermal-gravimetric scale.
- The determination of the chemical elements in the samples was carried out by using the Analytical X-Ray Fluorescence Method, that is used at Ernesto Che Guevara Company's Chemical laboratory.
- The samples chemical analyses were completed and the results were modelled in charts and tables and they were interpreted.

Results of the lateritic ore moisture control and chemical composition

The evaluation was carried out at the platforms 5, 7, and 8 of Ernesto Che Guevara nickel-producing Company's solar-drying ore deposits. The ore stockpiles and the sectors were made up with minerals from Punta Gorda, Camarioca Este, and Yagrumaje Sur ore deposits. During the characterization procedure, a total of 370 samples were taken, as follows: a) 119 samples came from the platform 5; b) 120 samples from the platform 7; and 131 samples from the platform 8.

The platform 5 was made up with nickel ores of Punta Ore deposit, with a volume of 25 438 t, that was structured by three ore stockpiles and two sectors in each one of them. Then they were subjected to the solar-drying process, with an inlet 36.43 % moisture. The removal was conducted during 16 days, from 7:00 am to 7 :00 pm time, in September, 2021.

The removal process was completed form the south slope to towards the north slope, on layers of 15 to 50 cm, and after 16 removal passes, so that a final moisture of 32.7 % was registered, which decreases by 3.73 %.

After the completion of the ore stockpiles removal, the characterization sampling was carried out. The results are shown in the following Table 1.

Table 1. Results of lateritic ores final characterization on the platform 5

Number of samples	Plataform 5	Ni	Co	Fe	SiO ₂	Mg	Al ₂ O ₃	H ₂ O
39	Stockpile 1	1.370	0.107	41.89	6.90	4.28	7.25	33.0
40	Stockpile 2	1.160	0.113	43.34	5.67	3.24	8.40	34.2
40	Stockpile 3	1.310	0.102	41.99	8.18	4.92	6.82	30.8
Average value		1.280	0.107	42.41	6.92	4.15	7.49	32.7

Thus, the platform 7 was made up with nickel ores from Camarioca Este ore deposit, with a volume of 48652 t, making it up with three ore stockpiles, as well as two sectors at each one. Then it was subjected to the solar-drying process with 37.51 % initial moisture, the removal was carried out for 16 days at the 7:00 am to 7:00 pm time in September, 2021. The removal process was carried out from the south slope towards the north slope, on layers of 15 to 50 cm, after performing 16 removal passes, a final moisture of 33.6 %, with a reduction of 3.91 %, was registered.

After completing the ore stockpiles removal, the characterization sampling was carried out. The results are shown in the table 2 as follows:

Table 2. Results of lateritic ores final characterization at the platform 7

Number of samples	Plataform 7	Ni	Co	Fe	SiO ₂	Mg	Al ₂ O ₃	H ₂ O
40	Stockpile 1	1.188	0.130	41.68	7.14	3.43	7.47	33.8
40	Stockpile 2	1.158	0.108	42.02	7.50	3.42	6.97	34.2
40	Stockpile 3	1.283	0.114	41.98	7.31	3.91	7.04	32.7
Average value		1.210	0.117	41.89	7.32	3.59	7.16	33.6

The platform 8 was made up with the nickel ores from Yagrumaje Sur ore deposit, with a volume of 50 211 t, by three ore stockpiles and two sectors at each one. It was subjected to the solar drying process with 37.66 % inlet moisture. The removal was carried out for 16 days at 7:00 am to 7:00 pm time in November, 2021. The removal process was carried out from the South slope towards the North, on layers of 15 to 50 cm, and after 16 removal passes, it is completed with 33.8 %, moisture, which is reduce to 3.86 %. After completion of the ore stockpile, the characterization sampling was carried out and the results are shown in the following table 3.

Table 3. Results of the final nickel ore final characterization at the platform 8

Number of samples	Platform 8	Ni	Co	Fe	SiO ₂	Mg	Al ₂ O ₃	H ₂ O
51	Stockpile 1	1.234	0.113	44.73	5.17	2.09	8.09	32.7
47	Stockpile 2	1.171	0.114	39.22	8.18	4.49	7.43	33.9
33	Stockpile 3	1.104	0.111	40.95	7.30	3.56	8.20	34.8
Average value		1.170	0.113	41.63	6.88	3.38	7.91	33.8

Run tests of the ore fed to the metallurgical process

Concerning the experimental run tests, the ore feed started at the platforms 5, 7 and 8. Since then, the metallurgical process was fed with useful ores from the solar drying platforms for 24 days. The figures 5, 6 and 7 show the quality behavior of ores fed to the process during the days of the run tests at the sampling points of the technological process.

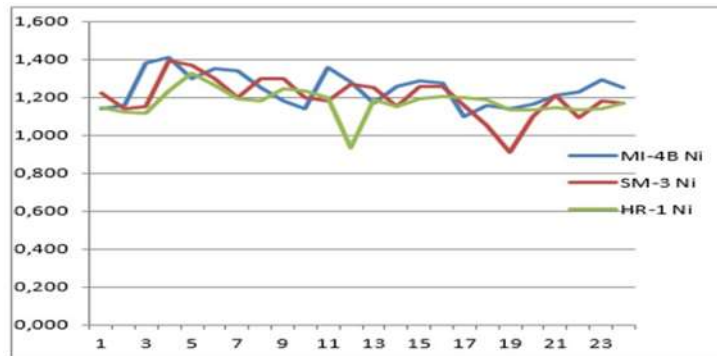


Figure 5. Nickel ore behavior in the samples that were taken at the platforms, in SM-3 and HR-1.

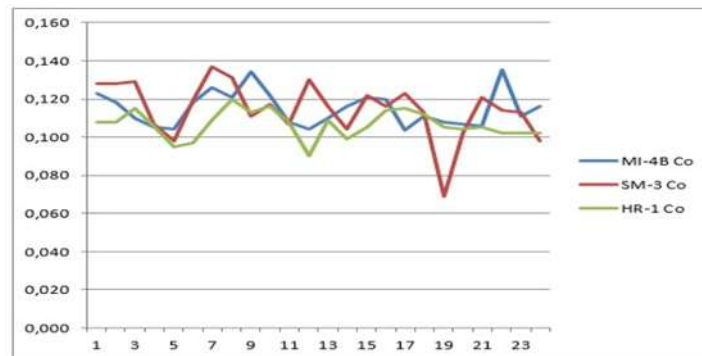


Figure 6. Cobalt ore behavior in the samples taken from the platforms, in the SM-3 and HR-1.

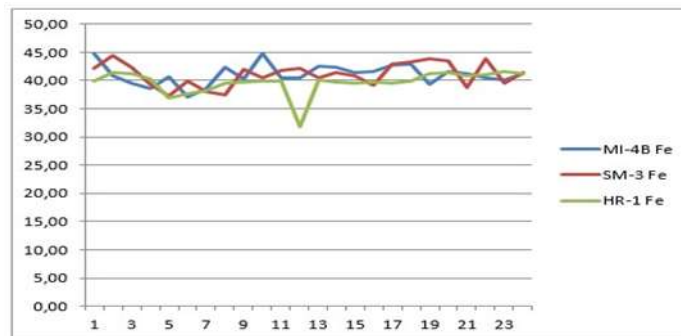


Figure 7. Iron behavior in the samples taken from the platforms, at the SM-3 and HR-1.

The samples behavior at the platforms 5, 7 and 8 are shown in the tables 4, 5 and 6 respectively.

Table 4. Sampling behaviour at the platform 5. (MI-4C: Useful ore at the platforms SM-3: Ore fed to the dryer; MI-4B: Useful ore fed to the factory)

Sample	Ni %	Co %	Fe%	SiO ₂ %	MgO %	Al ₂ O ₃ %
MI-4C	1.28	0.107	42.41	6.92	3.81	7.49
SM-3	1.261	0.116	40.93	7.56	4.02	7.76
Mi-4B	1.281	0.112	40.660	8.71	4.50	7.62

Table 5. Sampling behavior at the platform 7

Sample	Ni %	Co %	Fe %	SiO ₂ %	MgO %	Al ₂ O ₃ %
MI-4C	1.210	0.117	41.89	7.32	3.59	7.16
SM-3	1.240	0.118	40.44	8.33	4.57	7.95
MI-4B	1.254	0.118	41.40	7.78	3.91	7.55

Table 6. Sampling behavior at the platform 8

Sample	Ni %	Co %	Fe %	SiO ₂ %	Mg %	Al ₂ O ₃ %
MI-4C	1.17	0.113	41.63	6.88	3.38	7.94
SM-3	1.14	0.109	41.06	7.49	3.53	8.16
MI-4B	1.15	0.113	40.83	7.92	3.74	8.05

As it is explained in the results, the three samples taken from the same platform, shows similarities, so that it is evidenced that the sampling works, as well as the tests, meet the quality requirements.

Oil consumption at the ore preparation plant during the run test time period.

During the second ten-day time period, estimated as the one of least affectation, a saving of 1.018 kg of oil /t of ore, equal 183 t, notwithstanding there was affectation at the dryer operation section for two days; consequently, oil consumption was increased.

Conclusions

The application of the aforementioned new procedure for the run tests, evidenced a better-quality stability of the nickel ores fed to the technological process, with minimum differences regarding the useful and harmful components in the samples MI-4B, MI-4C y SM-3.

The average moisture reduction of the ores fed to the process was 3,83 %, allowing a better operation in the dryer's section, upon reducing the ore feed adherence and recirculation phenomena at the aforementioned plant.

A reduction of 1.018 kg oil consumption/t of ore fed to the process, equal 183 tones, representing a saving of 1,65 million CUP, was reported during the run test period.

The solar-drying platforms implementation, enables to get the average moisture reduction, of the ores fed to the process, allowing a better operation of the dryers. Upon reducing the adherence and recirculation phenomena of the ore fed to the aforementioned plant, the oil consumption is reduced, which means saving for the industry.

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