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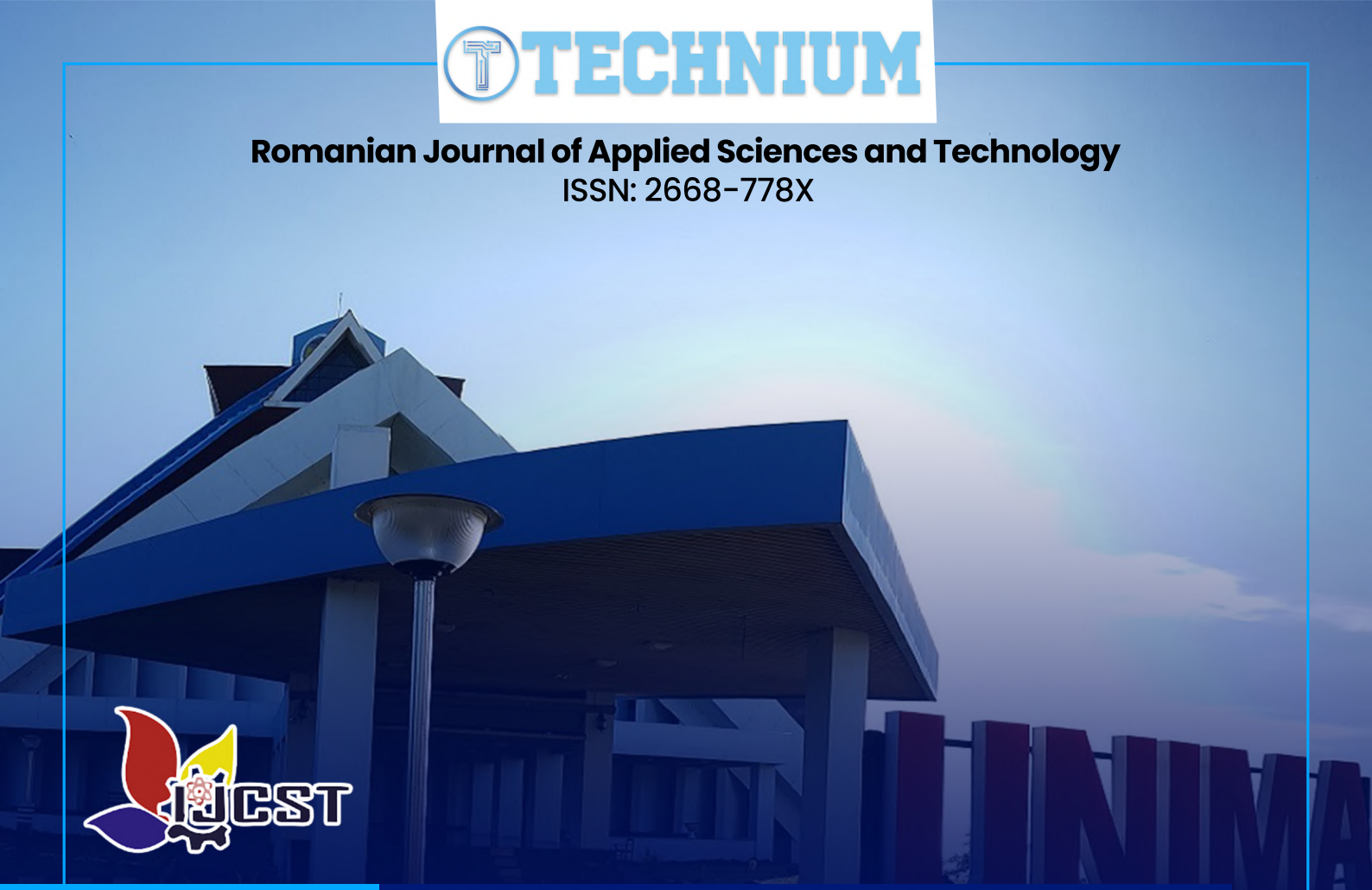

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Analysis of Nickel Ore Content Results of the Blending Methode at PT. Aneka Tambang Tbk Site Pakal, East Halmahera Regency

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Abstract. There is a variation in nickel content produced by PT. Aneka Tambang Tbk Site Pakal with the needs of the processing industry so that the blending method needs to be applied. Blending is the process of mixing two or more materials that have different qualities to get the right mixture. In the blending process, it must meet the specific ore according to the needs of the processing plant. The results of the XRF analysis on the stockpile Sosolat, Bicoli, Maba, Mafia, Sangaji, Roomstock Harmony, Resampling Sangaji were respectively 2.26%, 1.61%, 1.48%, 1.35%, 1.32%, 1.53%, and 1.60%. The results of theoretical simulations and actual blending in the field obtained factory quality of 1.75%, Buana Jaya barge with simulated Ni content of 1.87% and realized Ni content of 1.76%, Bukit Emas barge with simulated Ni content of 1.83% and realized Ni content of 1.90, TGH barge with simulated Ni content of 1.85% and realized Ni content of 1.76%, Ilir Jaya barge with simulated Ni content of 1.87% and real Ni content sai is 1.85%, the DBS 3029 barge with a simulated Ni content of 1.88% and a realized Ni content of 1.78%.

Keywords: blending, nickel content, processing plant, stockpile

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1 Introduction

PT. Aneka Tambang Tbk (PT. Antam Tbk) UBPN Malut is a state-owned company engaged in nickel ore mining located on the Pakal Island site, Maba District, East Halmahera Regency, North Maluku Province [1]. Nickel ore mining is carried out by surface mining, namely mining by removing overburden in non-mined areas using the selective mining method [2][3]. The implementation of mining using the selective mining method includes the stages of land clearing, stripping overburden, ore getting, ore loading, ore hauling and grade quality control [4][5][6].

Quality control of content is carried out in order to know that grades of nickel ore are in accordance with the cut off grade (COG) [7][8]. There is a determination of levels of PT. Antam Tbk monitors grade quality so that the grade of nickel ore mined is in accordance with the company's cut off grade of 1.5%. While the nickel ore content with marketing needs is 1.75%. There are differences in the levels of companies and consumer needs, this is intended to meet nickel ore market standards in accordance with predetermined consumer needs [9]. Based on the determination of these levels, PT. Antam Tbk supervises the nickel ore produced so that it remains in accordance with the company's COG and maintains the level of nickel ore that consumers need by carrying out blending. Blending is the process of mixing two or more materials that have different qualities to get the right mixture [10][11]. In the blending process, specific ores must be met according to the needs of the processing plant.

2 Methodology

This research was conducted at PT. Antam Tbk UBPN Malut which is located on the Pakal Island site, Maba District, East Halmahera Regency, North Maluku Province. The implementation time is March to April 2023. This research is a type of quantitative research, where in this method the results can be rated and calculated [12][13]. Laterite nickel ore content data in the stockpile were tested using X-Ray Fluorescence (XRF), then calculating the average content before blending using the equation 1

$$\bar{k} = \frac{k\,1 + k\,2 + k\,3 + \cdots k\,n}{n} \% \ldots\ldots\ldots\ldots \text{Equation (1)}$$

k is the average content (%), k n is the value of the content (%) and n is the amount of content data. The Ni content of the blending simulation results uses equation 2.

$$K = \frac{(V1 \times K1) + (V2 \times K2) + \cdots (Vn \times Kn)}{V\ total} \% \ldots \text{Equation (2)}$$

K = Content of blending results (%)
V1 = Volume (m^3)
V total = Total volume (m^3)
K1 = Total content (%)

An illustration of the implementation of nickel ore blending from 2 stockpiles with different grades, as shown in Figure 1 below:

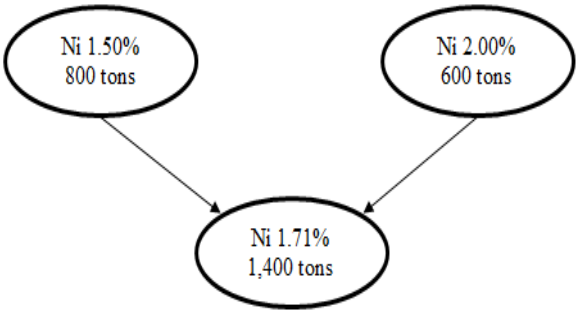

Fig. 1. Illustration of blending method

Sampling is the initial stage of an analysis, therefore this sample is selected by sampling method and the sample is considered representative [14][15]. Sampling is the work of taking a small portion of the material, in such a way that the sample represents the properties of the entire material [16]. In conducting a sample, it is better to take several times with a small amount than to take a sample only once with a large number. The sampling process at the Bicoli stockpile is shown in Figure 2.

Fig. 2. The sampling process at the Bicoli stockpile

3 Result and Discussion

The following are the results and discussion of the research conducted.

3.1 Nickel Content in Stockpile

Based on research in the field there are seven different stockpiles to accommodate five barges with different capacities. The Sosolat stockpile required 24,240 tons with an average Ni content of 2.24%, a Bicoli stockpile of 7,160 tons with an average Ni content of 1.61%, a Maba stockpile of 16,340 tons with an average Ni content of 1.49%, a stockpile Mafia 560 tons with an average Ni content of 1.35%, Sangaji stockpile of 720 tons with an average Ni content of 1.32%, Roomstock Harmony stockpile of 260 tons with an average Ni content of 1.53%, Sangaji Resampling stockpile of 340 tonnes with an average Ni content of 1.60%. The quality of nickel ore in each stockpile is shown in table 1.

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Table 1.
Nickel Ore Quality in Stockpile

No	Stockpile	Tonnage	Content (%)				
			Ni	Fe	SiO_2	MgO	MC
1	Sosolat	24,240	2.24	22.43	28.1	15.06	34.15
2	Bicoli	7,160	1.61	21.73	28.58	16.65	33.47
3	Maba	16,340	1.49	20.37	30.15	18.48	32.48
4	Mafia	560	1.35	29.71	21.98	13.14	34.37
5	Sangaji	720	1.32	19.15	36.26	17.42	34.23
6	Roomstock Harmony	260	1.53	23.78	28.51	15.90	33.77
7	Resampling Sangaji	340	1.60	16.08	36.98	20.00	34.23

In addition to Ni grades, XRF results also showed Fe levels ranging from 16.08% -29.71%. The silicon oxide (SiO_2) content ranges from 21.98%-36.98% while the MgO content ranges from 13.14%-20.00%. The moisture content (MC) ranges from 32.48% - 34.23%. In general, the Ni content is inversely proportional to the Fe content for the 7 stockpile data.

3.2 Ni Content Simulation Result and Realization of Blending

In actual conditions in the field there are differences in Ni content in the stockpile and Ni content in factory demand for barging activities. Then the blending method was carried out by knowing the Ni content in the stockpile. The things that must be considered at the time of barging activities on table 2 are the content of Ni, moisture content (MC) and S/M (silicon oxide compared to magnesium oxide) [17]. Ni content in PT. ANTAM Tbk is ≥1.75%, it is necessary to blend between stockpiles that have different quality content so that they can reach the factory demand.

Table 2.
Factory Quality Target

Content (%)		
Ni	**MC**	**S/M**
≥ 1.75	≤ 35.00	1.80 – 2.15

The blending process is carried out by following the provisions, namely preparing a stockpile map in advance along with data from the analysis results from the laboratory; grouping of piles based on buyer specifications to facilitate the blending process; calculate the blending simulation using the formula of equation 2, the ratio of tonnage and grade is adjusted to the target demand and stockpile; the blending process occurs at the time of sampling; and the change in content between the simulation and the actual blending is +/- 0.10 % of the desired concentration target.

The MC content is ≤ 35.00% where when blending the MC content must not exceed the tolerance limit because it can result in liquefaction. When the ship is sailing, the vibration from the ship's engine and the movement of the ship when the ship is hit by waves are the main factors for the occurrence of liquefaction. The effect of this vibration causes the nickel ore in the hold to form a flat liquid. Under these conditions, the melted nickel ore will flow to one side of the ship following the direction of the ship's movement and when it flows to one side it has a tendency not to return to the center due to the density of the nickel ore. So what then happens is the ship will lose its stability and then it will make the ship capsize.

The S/M parameter is 1.8-2.15%. If the S/M content is in accordance with the manufacturer's quality objectives, it means determining the melting point of the slag so that during the processing process, no clinker is formed. If it does not meet the manufacturer's quality objectives, solids will form which can cause trouble to the tool.

Table 3.
Blending Simulation Results

No	Barge	Tonnage	Grade (%)		
			Ni	MC	S/M
1	Buana Jaya	12,800	1.87	32.80	1.76
2	Bukit Emas	8,820	1.83	34.05	1.73
3	TGH 3306	11,300	1.85	35.77	1.72
4	Ilir Jaya VI	8,160	1.87	20.12	1.01
5	DBS 3029	8,540	1.90	30.98	1.88

Based on table 3 of the blending simulation, the five barges that entered were for the Buana Jaya barge with a Ni demand content of 1.75%, a planned 12,800 tons of ore with a Ni content of 1.76%. The Bukit Emas barge with a demand grade of Ni of 1.75% is planned for 8,820 tonnes of ore with a grade of Ni of 1.90%. The TGH 3306 barge with a demand grade of Ni of 1.75% is planned for 11,300 tons of ore with a grade of Ni of 1.76%. The Ilir Jaya VI barge with a demand content of Ni of 1.75% is planned for 8,160 tons of ore with a Ni content of 1.85% and the DBS barge with a demand content of Ni of 1.75% is planned for 8,540 tons of ore with a Ni content of 1.90%.

Table 4.
Blending Realization Results

No	Barge	Tonnage	Grade (%)		
			Ni	MC	S/M
1	Buana Jaya	12,800	1.76	35.65	1.75
2	Bukit Emas	8,820	1.90	32.01	1.57
3	TGH 3306	11,300	1.76	35.06	1.64
4	Ilir Jaya VI	8,160	1.85	35.63	1.66
5	DBS 3029	8,540	1.78	32.07	1.05

Based on table 4, the results of blending realization showed that the five barges entered were the Buana Jaya barge with a capacity of 12,800 tons of ore with a Ni content of 1.76%, the Bukit Emas barge with a capacity of 8,820 tons of ore with a Ni content of 1.90%, the TGH 3306 barge with a capacity of 11,300 tons of ore with a Ni content of 1.76%, the Ilir Jaya barge with a capacity of 8,160 tons of ore with a Ni content of 1, 85% and the DBS 3029 barge has a capacity of 8,820 tonnes of ore with a Ni content of 1.78%.

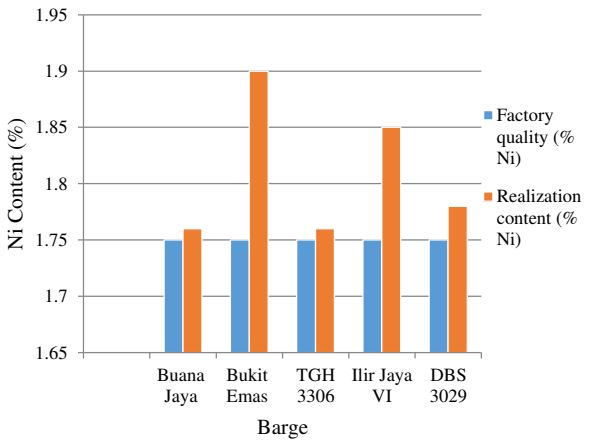

Fig. 3. Comparison of realization content and factory quality

Figure 3 shows that the actual blended Ni content has exceeded the factory standard Ni content. All barges carrying ore from PT. Aneka Tambang Tbk is confirmed to be accepted by the processing industry because the Ni content meets the set standards.

The process of loading nickel ore on a barge at the Pulau Pakal site of PT. Aneka Tambang Tbk UBPN Malut is shown in Figure 4.

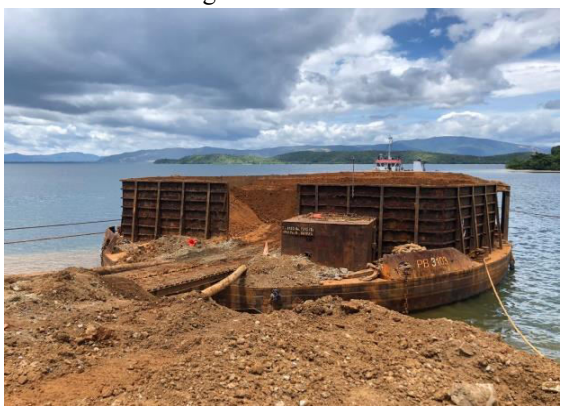

Fig. 4. Process of loading nickel ore on a barge

3.3 Factors Affecting Changes in Ni Content

Factors affecting the change in Ni content between the blending simulation and the blending realization were sampling, human error, and taking the wrong sample pile. The method used when conducting sampling is 2:1 (% w/w) according to company standards. Where samples are taken with a weight of 50-55 kg in every 2 dump truck rotations. Human error is a factor where mining workers are negligent in carrying out activities in accordance with the Standard Operational Procedure (SOP) that has been set by each work unit. It was wrong to take a pile sample, where when blending required 4-7 different piles, the dump truck unit should be given a different colored flag to distinguish each pile.

4 Conclusion

Based on the description above, it can be concluded as follows:

1. The value of stockpile nickel ore content to meet five types of barges that have different capacities. Sosolat stockpile requires 24,240 tons with an average grade of 2.24%, Bicoli stockpile requires 7,160 tons with an average grade of 1.61%, Maba stockpile requires 16,340 tons with an average grade of 1.49%, Mafia stockpile requires 560 tons with an average grade of 1.35%, Sangaji stockpile requires 720 tons with an average grade of 1.32%, Roomstock harmony stockpile requires 260 tons with an average grade of 1.53%, Sangaji resampling stockpile requires 340 tons with the average content is 1.60%.
2. The theoretical simulation results and the realization of blending in the field obtained factory quality, namely 1.75, the Buana Jaya barge with a simulated Ni content of 1.87% and a realized Ni content of 1.76%, which met the factory quality objectives, the Bukit Emas barge with a simulated grade of Ni 1.83% and realized Ni content of 1.90% met factory quality objectives, TGH barge with simulated Ni content of 1.85% and realized Ni content of 1.76% met factory quality objectives, Ilir Jaya barge with simulation Ni content of 1.87% and realized Ni content of 1.85% met factory quality objectives, DBS 3029 barge with simulated Ni content of 1.88% and realized Ni content of 1.78% met factory quality objectives.
3. The factors that can affect the change in concentration between the simulation and the actual blending are sampling, human error and taking the wrong sample pile.

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