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Study of the Effect of Electric Current Strength and Magnet Height Distance with Belt Three Disc Magnetic Separator on Middling Reprocessing Results from Processing Minerals at PT Timah Tbk

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Abstract: *This study aims to reprocess middlings from the mineral processing process carried out at PT Timah Tbk which still contains cassiterite minerals using a three disc magnetic separator tool with variations in electric current strength and distance between the height of the magnet and the belt. Sn content will be analyzed using XRF. Variations in the strength of the electric current used are ranging from 0.3 A to 1.3 A which will be divided into 3 variations and variations in the height distance of the magnet with the belt used, namely 0.7, 1 and 1.3 cm. This research was carried out 9 times of testing which will be sought for the optimum level and recovery produced. The results showed the distribution of tin distribution in each size fraction. In addition, the Sn content and Sn recovery produced also varied for each test variation. The highest Sn content (%), 27.1%, was obtained in the test with the highest electric current strength variation and the smallest magnet height distance. Meanwhile, the highest recovery of 85.12% was obtained in the test with the smallest electric current strength and the largest magnetic height distance. Based on the results of the study, the higher the electric current strength used, the higher the Sn content obtained, but the lower the Sn recovery obtained. Meanwhile, the higher the height distance of the magnet with the belt used, the lower the Sn content obtained but the higher the Sn recovery obtained. As well as for the optimum levels and recovery obtained in research using strong electric current and the height distance of the magnet with a medium belt with Sn content of 12.2% and Sn recovery of 54.67%.*

Keywords: *Three Disc Magnetic Separator, Middling, Cassiterite.*

1. INTRODUCTION

Indonesia has a very diverse mineral resource content. The content of mineral resources is very useful for industry and has upstream and downstream linkages that are important for the economy in Indonesia. One of the mineral resources that are abundant in Indonesia is the mineral tin, causing Indonesia to become one of the second largest producers in the world after China (Bunga, 2021).

Tin (Sn) can be found in the form of primary and secondary deposits. In Indonesia, tin mineral deposits are found in alluvial deposits. Minerals that contain the element tin (Sn) are cassiterite ($SnO2$) minerals (Bunga, 2021). Bangka Belitung Islands is an area that has the largest tin content in Indonesia and the second in the world, which at this time most of the management of its utilization is held by PT Timah Tbk (Agusfo et al, 2019). Tin ore contains follower minerals such as ilmenite, zircon, and monazite. Processing activities are carried out in order to obtain tin ore that is ready to be melted where the separation is carried out based on physical properties (M Rizki, 2021).

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The tin ore processing process at PT Timah Tbk produces products in the form of concentrates, middlings and tailings. Middling from this processing process contains many associated minerals, namely ilmenite, zircon and monazite. One of the participating minerals from tin ore processing is ilmenite ($FeTiO3$) which still contains low grade tin. The ilmenite mineral has magnetic properties while the cassiterite mineral ($SnO2$) has non- magnetic properties, so it can be separated based on its magnetic properties using a three disc magnetic separator. In the cassiterite retrieval process using a three disc magnetic separator that has been carried out at PT Timah Tbk, the resulting magnetic product still contains Sn content of more than 1.5%. So it is necessary to conduct research to find the optimal parameters for the tin retrieval process using a three disc magnetic separator. The research uses variations in electric current strength and the height distance of the magnet with the belt of the three disc magnetic separator.

2. RESEARCH METHODS

In this study, the process of retrieving tin in the middling results from the processing process at PT Timah Tbk using a three disc magnetic separator tool with variations in electric current strength and the distance between the height of the magnet and the belt. The variation of current strength used is 0.3; 0.5; 0.7; 0.7 A (variation 1), 0.5; 0.7; 0.9; 1.1 A (variation 2), and 0.7; 0.9; 1.1; 1.3 A (variation 3). Variations in the distance between the height of the magnet and the belt used are 0.7; 1 and 1.3 cm. This study uses a feed weight of 40.1 kg for each test, a feeding speed of 40kg/25 minutes, and a feed grain size of 50+100 mess. The procedure in this research is as follows.

1. Preparation

a. Sampling

The middling to be used is stored in a jumbo bag, then sampling is carried out using a thief sampler by inserting it into the jumbo bag and rotating it so that the material enters the thief sampler hole where the material is used as a sample. Sampling is done at several points. Then the sample division was carried out using a riffle sampler, so that the samples were divided with details of 1820 grams for sieve shakers, 20 grams for XRF analysis and the rest were stored as parent samples.

b. Sieve Shaker

Sieving was done to determine the percent distribution of Sn in each size fraction. The sieve sizes used are 20, 50, 70, 100, 140 and 200 mesh. At this stage using a sample of 1820 grams with an amplitude of 0.9 mm for 10 minutes. The results of each size fraction were divided using a riffle sampler so that 20 grams would be obtained for content analysis using XRF.

c. Pulverized

This stage is carried out to refine the sample to be analyzed using XRF. Before grinding, the plastic bowl that will be used as a container will be cleaned first so that the previous sample is not mixed with the new sample. A 20 gram sample that had previously been divided using a riffle sampler was then put into a plastic bowl that had been cleaned and then crushed using a pulverizer for 1 minute. The fine sample can already be analyzed using XRF.

d. Vibro Round Screen

After sieving and knowing the percent distribution of Sn, the screening process is carried out using a vibro round screen on a production scale. The sieve sizes used in this vibro round screen are 20, 50 and 100 mesh. Then the -50+100 size is used as feed in the concentration process using a three disc magnetic separator.

e. Sampler Reducer

At this stage, the feed is divided into 9 tests with each test amounting to 40.1 kg. The feed that has gone through screening will be divided and homogenized again using a 1/16 sample reducer. The results of the process obtained samples which will be taken 20 grams to be analyzed using XRF and 250 grams for the parent sample.

2. Concentration Process

In this concentration process aims to increase the level of a mineral, which increases the level using a three disc magnetic separator. Samples that have passed the screening process using vibro round screen and has been divided using 1/16 sample reducer then put into a three disc magnetic separator tool that has been set parameters, so that magnetic minerals and non-magnetic minerals will be obtained which will be weighed using a sitting scale and will be sampled using sample splitters for XRF testing.

3. XRF Testing

This XRF test aims to determine the feed content contained in the middling. This test uses a sample that has previously been separated as much as 20 grams at the sample preparation stage. The stages carried out in this XRF test are as follows:

- Grinding the sample using a pulverizer to get a finer sample.
- After the sample is smooth, it is then put into a plastic cup and compacted for the content analysis process using XRF.
- Furthermore, the XRF analysis process was carried out using a Portable XRF tool.

3. RESEARCH RESULTS

1. Tin Distribution

Before testing, a sampling process was carried out on the initial feed to carry out sieve analysis using a sieve shaker tool with the aim of knowing the percent distribution of tin in each size fraction which would then be analyzed using XRF. The distribution results for each size fraction can be seen in Table 1 below.

Table 1. Distribution of Tin (Sn) Distribution Based on Size Fraction

Sieve Size		Weight Retained		% Cumulative		% Sn Tertahan	gr Sn Tertahan	% Dist
Mesh	Mikron	gr	%	Retained	Passing			
20	841	1,2	0,07	0,07	99,93	12,32	0,15	0,15
50	297	44,4	2,44	2,51	97,49	21,68	9,63	9,7
70	210	523,2	28,75	31,25	68,75	3,803	19,90	20,04
100	149	839,5	46,13	77,38	22,62	3,423	28,74	28,95
140	105	267	14,67	92,05	7,95	5,537	14,78	14,89
200	74	91	5,00	97,05	2,95	12,42	11,30	11,39
Pan		53,7	2,95	100,00	0,00	27,52	14,78	14,89
Total		1820	100,00			5.45	99,27	100,00

When viewed from the resulting Sn content, for sizes <74 microns, 74 microns, 105 microns, 297 microns and 841 microns, the Sn content has increased using only the sieving process without using a concentration device, so that these sizes can be separated and can reduce the energy costs required. For sizes 149 microns and 210 microns still have low levels, namely for the size of 149 microns has a Sn content of 3.42% and for the size of 210 microns has a Sn content of 3.80%, so for both sizes requires a further concentration process to increase Sn levels.

2. Evaluation of Middling Processing Results

The parameter variations used in this study are as shown in Table 2 below.

Table 2. Variations of Tests Used

Testing	Variation of Electric Current Strength				Distance Variation Magnet Height
	Coil 1	Coil 2	Coil 3	Coil 4	
1	0.3 A	0.5 A	0.7 A	0.9 A	0.7 cm
2	0.3 A	0.5 A	0.7 A	0.9 A	1 cm
3	0.3 A	0.5 A	0.7 A	0.9 A	1.3 cm
4	0.5 A	0.7 A	0.9 A	1.1 A	0.7 cm
5	0.5 A	0.7 A	0.9 A	1.1 A	1 cm
6	0.5 A	0.7 A	0.9 A	1.1 A	1.3 cm
7	0.7 A	0.9 A	1.1 A	1.3 A	0.7 cm
8	0.7 A	0.9 A	1.1 A	1.3 A	1 cm
9	0.7 A	0.9 A	1.1 A	1.3 A	1.3 cm

From this middling processing process, the Sn content value of non-magnetic products will be obtained and recovery and concentration ratio calculations will be carried out in each experiment as can be seen in Table 3 below.

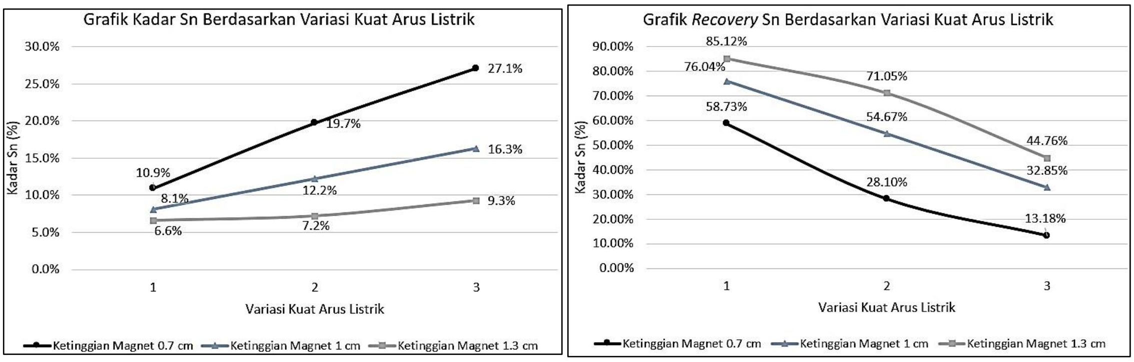
Table 3. Variations of Tests Used

Testing	*Feed* Weight (kg)	% Sn content in Feed	Concentrate Weight (kg)	% Sn in Concentrate	% *Recovery*	Concentrati on Ratio
1	40.1 kg	4.87%	10.5 kg	10.9%	58.73%	3.82
2	40.1 kg	4.89%	19.1 kg	8.1%	76.04%	2.10
3	40.1 kg	5.13%	25.3 kg	6.6%	85.12%	1.58
4	40.1 kg	5.07%	2.8 kg	19.7%	28.10%	14.32
5	40.1 kg	4.79%	8.6 kg	12.2%	54.67%	4.66
6	40.1 kg	4.71%	19 kg	7.2%	71.05%	2.11
7	40.1 kg	4.86%	1 kg	27.1%	13.18%	40.10
8	40.1 kg	4.82%	3.8 kg	16.3%	32.85%	10.55
9	40.1 kg	4.90%	9.5 kg	9.3%	44.76%	4.22

4. DISCUSSION

1. Effect of Electric Current Strength on Sn Content and Recovery

This study uses three variations of electric current strength in a three disc magnetic separator to analyze the effect on the level and recovery of Sn produced. With the same distance between the height of the magnet and the belt, experiments were carried out using 3 different variations of electric current strength. The results of the experiment obtained changes in Sn content and recovery in each variation used as can be seen in Figure 1 below.



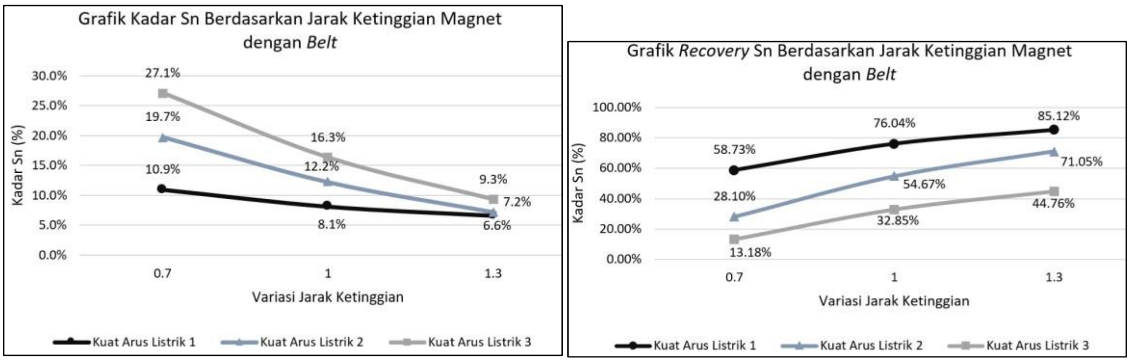
(a) (b)

Figure 1. (a) Graph of Sn Content at Variation of Electric Current Strength, (b) Graph of Sn Recovery at Variation of Electric Current Strength

Judging from Figure 1 above, the higher the variation of electric current strength used, the higher the Sn content obtained, but the Sn recovery value will decrease. This is in accordance with research conducted by Soni Septian Sitepu and Sajima that the higher the strength of the electric current used, the more magnetic minerals are attracted, so that the acquisition of non-magnetic minerals obtained will be more and more, and the Sn content in non-magnetic minerals will increase.

2. Effect of Magnet Height Distance with Belt on Sn Recovery

In this study using 3 variations of the height distance of the magnet with the belt, namely the height distance of 0.7 cm, 1 cm and 1.3 cm. Tests were carried out with the same strong electric current treatment using different magnet height distances with different belts where variations in electric current strength were used From the research conducted, changes in Sn content and recovery were obtained that were different in each variation as can be seen in Figure 2 below.



(a) (b)

Figure 2. (a) Graph of Sn Content at Variation of Magnet Height Distance, (b) Graph of Sn Recovery at Variation of Magnet Height Distance

Judging from Figure 2 above, the higher the variation in the distance between the height of the magnet and the belt used, the lower the Sn content obtained, but the higher the Sn recovery value. This is in accordance with research conducted by Soni Septian Sitepu and Sajima that the higher the electric current strength, the higher the Sn recovery value, the more magnetic minerals used, the more magnetic minerals will be attracted, so that the acquisition of non-magnetic minerals obtained will be more and more, and the Sn content in non-magnetic minerals will increase. This is in accordance with research conducted by Agus Santoso et al, which in the study concluded that the close magnetic distance will cause the magnetic strength to be large, so that minerals that are magnetic will be more easily attracted by magnets.

3. Optimum Level and Recovery Based on Variations Used

From all the tests that have been carried out, it is obtained that the optimum Sn content and recovery occurs in test variation 5 using variations in electric current strength of 0.5 A; 0.7 A; 0.9 A; 1.1 A and variations in the distance between the height of the magnet and the belt of 1 cm where the Sn content obtained is 12.2% Sn and the Sn recovery obtained is 54.67%. In addition, the most optimum test is also seen from the acquisition of magnetic products as can be seen in Table B.5 in the Appendix where the magnetic product testing variation 5 has a small Sn content, for magnetic product 1 has a Sn content of 0.52% Sn, magnetic product 2 has a Sn content of 0.76% Sn, magnetic product 3 has a Sn content of 3.88% Sn, and magnetic product 4 has a Sn content of 0.2% Sn.

5. CONCLUSION

Based on the results of the research and discussion on the research that has been done, the following conclusions can be drawn:

a. The higher the electric current strength used, the higher the Sn content obtained, but the lower the Sn recovery. The highest Sn content of 27.1% was carried out in test variation 7 which used the highest variation of electric current strength, namely 0.7 A; 0.9 A; 1.1 A; 1.3 A.
b. The higher the distance between the height of the magnet and the belt used, the lower the Sn content, but the higher the Sn recovery. The highest Sn content of 27.1% was carried out in test 7 which used variations in the height of the magnet with the lowest belt height of 0.7 cm.
c. Optimum levels and recoveries produced in the middling retreatment process occurs in test variation 5 which uses a strong variation in electric current of 0.5 A; 0.7 A; 0.9 A; 1.1 A and a variation of the distance between the height of the magnet and the belt of 1 cm. The resulting Sn content was 12.2% Sn and recovery was 54.67%.

REFERENCE

Agustina, I Putu. (2022). Optimasi Pengaruh Parameter Terhadap Sifat Mekanis pada Sambungan Similar Baja Tahan Karat AISI 304. Jurnal METTEK, 8(1), 59-64.

Agustriyana, L., & Surya Irawan. (2011). Pengaruh Kuat Arus dan Waktu Pengelasan pada Proses Las Titik (Spot Welding) Terhadap Kekuattan Tarik dan Mikrostruktur Hasil Las Dari Baja Fasa Ganda (Ferrite-Martensite). Jurnal Rekayasa Mesin, 2(3), 175-181.

ASM International. (1992). ASM Metals Handbook, Vol 02 Non Ferrous. United States America: ASM International.

Bell Helicopter Textron, I. (2019). BELL 412EPI Product Spesifications. Texas: Bell Helicopter Textron Inc.

Bianto, Adli. (2022). Pengaruh Variasi Arus pada Las Spot Welding Material Beda Jenis SUS 301 dan DIN L4003. Teknik Mesin. Universitas Muhammadiyah Ponorogo.

Daniswara, M Audris. (2022). Analisis Proses Resistance Spot Welding Terhadap Sifat Mekanis (Destructive Test) Aluminium 2024-T42 pada Part Cover Side L Pesawat NC-212i PT. Dirgantara Indonesia. Teknik Mesin, Universitas Muhammadiyah Malang.

Deng, L., Li, Y. B., Haselhuhn, A. S., & Carlson, B. E. (2020). Simulating Thermoelectric Effect and Its Impact on Asymmetric Weld Nugget Growth in Aluminum Resistance Spot Welding. Journal of Manufacturing Science and Engineering, Transactions of the ASME, 142(9).

Fuad, Bian Yusriansyah., dkk. (2020). Pengaruh Kombinasi Ketebalan Plat Aluminium 2024 T42 Terhadap Sifat Mekanis pada Proses Resistance Spot Welding Part Door Assy Helikopter NBELL 412EP. Seminar Nasional Teknologi dan Rekayasan (SENTRA), 2527-6050.

Fuadi, Afirus Nurul. 2019. Analisa Fatigue Index Untuk Menentukan Batas Calender Time Usia Pakai Pesawat Hawk Skadron Udara 1. Teknik Mesin, Universitas Muhammadiyah Pontianak.

Haikal. (2014). Pengaruh Tegangan Listrik dan Waktu Pengelasan Terhadap Sifat Fisik dan Mekanik Sambungan Las Titik (Resistance Spot Welding) Logam Tak Sejenis 3 Lapis 316L, SS400, J1. Teknik Mesin, Universitas Sebelas Marert Surakarta, Surakarta.

Harsono Wiryosumarto, T. O. (2000). Teknologi Pengelasan Logam. Jakarta: PT. Pradnya Paramita.

Hendaryati, H., dkk. (2022). Pengaruh Variasi Ketebalan Plat Aluminium 2024 T42 Terhadap Kekuatan Tarik dan Macrography Pada Proses Resistance Spot Welding. Jurnal Terapan Teknik Mesin, 3(2). 96 – 107.

Ibrahim, Setiani., dkk. (2020). Pengaruh Variasi Arus Terhadap Sifat Mekanis dan Daerah Weld Nugget pada Pengelasan Titik Collar Muffler. Jurnal Vokasi Teknologi Industri, 2(1). 2656 – 6664.

Lucky, Julius. (2017). Analisa Proses Friction Stir Welding Pada Plat Aluminium Jenis A1100.

Nugroho, Fajar. (2015). Pengaruh Rapat Arus Anodizing Terhadap Nilai Kekerasan Pada Plat Aluminium Paduan AA Seri 2024-T3. Jurnal Angkasa, 7(2).

Pavlou, D. G. (2002). A phenomenological fatigue damage accumulation rule based on hardness increasing, for the 2024-T42 aluminum. Engineering Structures, 24(11), 1363–1368.

Purwanti, Endang Pudji. (2017). Analisa Pengaruh Parameter Pengelasan Spot Welding Terhadap Shear Strength Menggunakan Metode Taguchi. Seminar Matermatika dan Pendidikan Matematika.

SAE International, E. (2017). Aerospace Material Specification - AMS QQ-A-250/5B. SAE International.

Septian, Andino. (2021). Redesain JIG dan Fixture UntukInstalansiRadome dan Maletero pada Pesawat N212-400 PT Dirgantara Indonesia. Fakultas Vokasi. Institut Teknologi Sepuluh Nopember.

Smith, W. F. (1993). Foundations of Materials Science and Enginering. New York: McGraw-Hill Inc.

Teknik Mesin. Universitas Muhammadiyah Malang.

Wiryosumarto, Harsono. (2000). Teknologi Pengelasan Logam. Jakarta: PT. Pradnya Paramita.