

Win et al., 2020

Volume 6 Issue 3, pp. 25-42

Date of Publication: 13<sup>th</sup> November 2020

DOI- <https://doi.org/10.20319/mijst.2020.63.2542>

This paper can be cited as: Win, N. Z. H., Numprasanthai, A. & Laowattanabandit, P. (2020). The Effectiveness of Physical Separation Process for the Alluvial Tin (Heinda) Ore, Myanmar. *MATTER: International Journal of Science and Technology*, 6(3), 25-42.

This work is licensed under the Creative Commons Attribution-NonCommercial 4.0 International License. To view a copy of this license, visit <http://creativecommons.org/licenses/by-nc/4.0/> or send a letter to Creative Commons, PO Box 1866, Mountain View, CA 94042, USA.

## **THE EFFECTIVENESS OF PHYSICAL SEPARATION PROCESS FOR THE ALLUVIAL TIN (HEINDA) ORE, MYANMAR**

**Nay Zaw Htay Win**

Department of Mining and Petroleum Engineering, Faculty of Engineering, Chulalongkorn  
University, Bangkok, 10330, Thailand  
[knayzaw99@gmail.com](mailto:knayzaw99@gmail.com)

**Apisit Numprasanthai**

Department of Mining and Petroleum Engineering, Faculty of Engineering, Chulalongkorn  
University, Bangkok, 10330, Thailand  
[apisit.nu@chula.ac.th](mailto:apisit.nu@chula.ac.th)

**Pipat Laowattanabandit**

Department of Mining and Petroleum Engineering, Faculty of Engineering, Chulalongkorn  
University, Bangkok, 10330, Thailand  
[pipat.l@chula.ac.th](mailto:pipat.l@chula.ac.th)

---

### **Abstract**

*Mineral beneficiation is a process by which valuable constituents of an ore are concentrated through a physical separation process. In the present investigation, tin ore samples were collected from the Heinda tin mine, Thanintharyi region, Myanmar. Heinda mine is tin placer deposits which are located about 50 Km east of Dawai, Tanintharyi, Myanmar. The mine can be reached by road from Poo Nam Ron checkpoint, Kanchanaburi Province, Thailand. In this study, particle size analysis (PSD) was carried out over the range of - 6.7 mm and +0.075 mm in 9 different mesh sizes. The operating variables used to determine the recovery effectiveness of the jigging and shaking*

table include; particle size, stroke, table slope, and dilution ratio, then the percent recovery of tin concentrate was evaluated by applying X-ray fluorescence (XRF). The results showed that the tin mineral concentrate of the jig separator is 70.7% and the shaking table is 49.8%. The cassiterite recovery processes were conducted by using physical separation processes and the discounted cash flow model (DCF) for an economic analysis of the project. In this study, the internal rate of return (IRR) is 11.45 percent which is higher than the discount rate of 8 percent, and NPV is 790,886,832.61 US \$. The payback period of the project is equal to 8 to 9 years of project life for 30 years. Consequently, the Heinda tin ore project is proven feasible.

### **Keywords**

Tin, Gravity Separation, Physical Separation, Jig, Shaking Table, Discount Cash Flow (DCF)

---

## **1. Introduction**

A lot of previous researches and literature reviews had been reported the beneficiation of gravity separation processes for the alluvial tin. In Myanmar, tin placers are found in eluvial, colluvial, fluvial, and lacustrine sediments. They are generally comparable to those of the kaks and mintjan placers of Indonesia. The tin placer deposit at Heinda ( $98^{\circ} 26' E$ ,  $14^{\circ} 7' N$ ) is located approximately 45 km to the east of Dawei (Hpolontaung Hill) in the drainage area of the wet contact zone of the Central Range granite with the Mergui Series. Because several cassiterite-wolframite-bearing granites and greisen are known from this area, it is regarded as the source region for the cassiterite-bearing sediments of the Heinda deposit, particularly since the orientation of the detrital material indicates that it was transported from the W (F. Bender, 1983). Tin mining at Hpolontaung alluvial tin deposit was started in May 1928. Heinda Mine covering the Hpolontaung area is a unique alluvial tin deposit that occurs between reduced level (126) feet and (898) feet occurring to the explorations carried out by the former Anglo-Burma Tin Co. Ltd, between 1957 and 1960. A detailed surveying and ore reserve revaluation of the Hpolontaung area was done within April 1970 by the German Mission called "GrunstoffBeratang E.V. The gravity techniques applied to the recovery of cassiterite ( $SnO_2$ ), otherwise known as tinstone, and the basic commercial method of primary concentration is the sluice box used on alluvial deposits in Malaysia and Thailand, known as palongs (Falcon, 1982). The gravity separation is the oldest concentration technique employed in mineral processing to separate particles into heavy and light fractions (Burt, 1984). A typical gravity separation circuit in a beneficiation plant recovers about 50–60% of the tin

value (Lepetic, 1986; Egbe, E., Mudiare, E., Abubakre, O., & Ogunbajo, M., 2013). The gravity separation method has the attraction of generally low capital and operating costs which together with the lack of chemicals and excessive heating requirements means it is generally environmentally friendly. Over the last 25 years, new gravity separation equipment has enhanced these factors, such that wherever possible gravity separation is a preferred technique (Falconer, 2003). There are many types of gravity units such as jigs, heavy media cyclones, spirals, shaking tables, etc., which are generally used in the primary concentration stage, and the final concentrates can be produced following enhanced gravity separation or flotation. Gravity separation and flotation techniques are widely used in the beneficiation of tin ores (Falcon, 1982; Jeon et al., 2013).

Mineral beneficiation is a process by which valuable constituents of an ore are concentrated utilizing a physical separation process. The most common mineral beneficiation processes are known as sample preparation, comminution, size classification, and concentration. Cassiterite which is also known as the tin stone is mainly found in two types of deposits. The first type of deposit is called primary, it can be seen as a primary accessory constituent of certain late-stage granitic intrusions and which is found in veins and fissures both in the granite and surrounding country rock. The second type of deposit is of a secondary origin and occurs as alluvial or placer deposits (Youssef, M., Abd El-Rahman, M., Helal, N., El-Rabiei, M., & Elsaidy, S., 2009).

The geology of the tin deposit in the study area is a secondary deposit. Heinda mine, the biggest tin placer mine of the region, lies in the drainage area of the west contact zone of the central range granites and Mergui Group forming as the thick sequence of cassiterite bearing sediments, particularly in the Heinda Chaung, Shwe Chaung, and Hpolon Taung areas.

Flotation techniques have improved the recovery of valuable minerals such as copper and lead-bearing minerals. However, people who work in mineral industries have re-evaluated gravity systems due to increasing costs of flotation reagents and increasing environmental pollution in recent years (Angadi, S.I., Eswaraiah, Jeon, Mishra, & Miller, 2015; Angadi, S.I., Eswaraiah, Jeon, Mishra, & Miller, 2016). In the present investigation, a cassiterite sample collected from the Heinda tin mine, Myanmar, has been subjected to beneficiation studies using different gravity separators including a jig and shaking table. According to the experimental results, a gravity concentration technique has been proposed for the beneficiation of the Heinda tin ore.

## 2. Experimental Methods

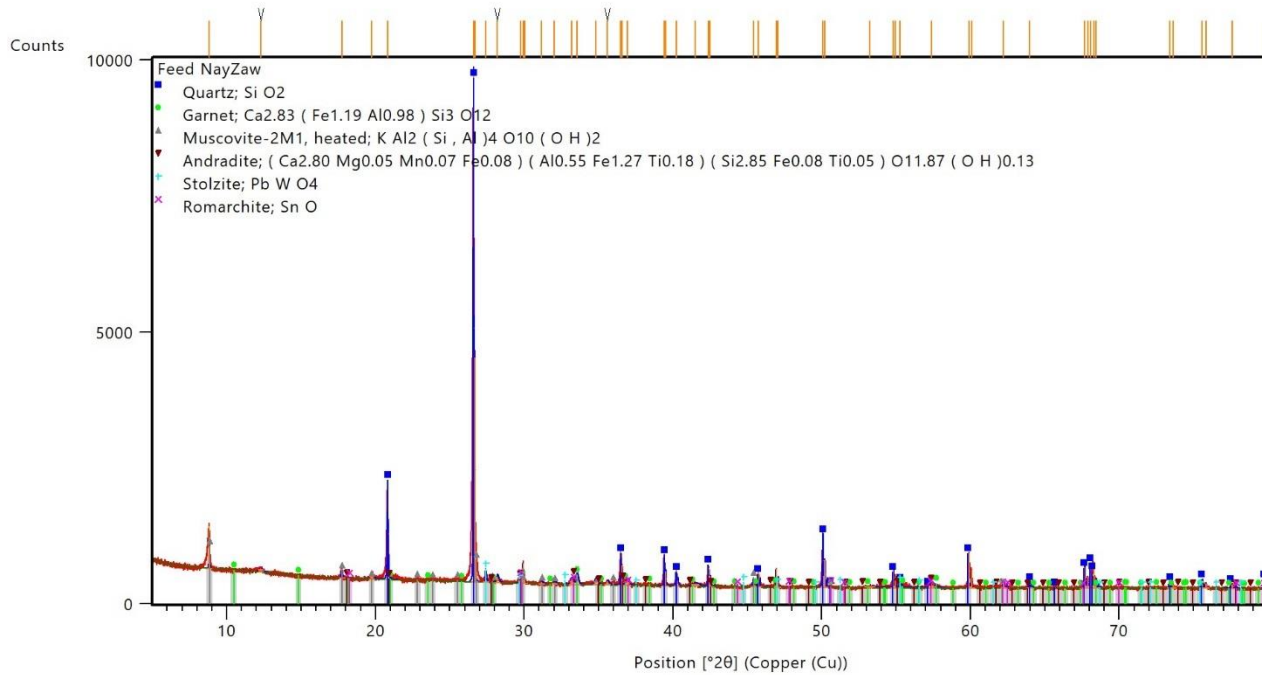
The experiments were designed to determine the optimum condition of tin recovery(grade) from the alluvial tin ore resources. A jaw crusher was used for size reduction and the sieving method was used for particle size analysis. Then, Jig separator and shaking table were also utilized. After that, the samples were analyzed by using X-ray Fluorescence Separator (XRF) and X-ray Diffraction (XRD).

### 2.1 Sample Preparation

A tin ore sample was collected from the Heinda Tin Mine, Myanmar has been used in the present investigations. Tin can see as cassiterite in the gravel clasts of Heinda Chaung, Shwe Chaung, and Hpolon Taung deposit along with the granite host rock. The major gangue mineral present in the ore is quartz and minor gangue mineral are garnet, muscovite, stolzite, and wolframite (see fig.1). Mineral constituent analysis following X-ray fluorescence presented that the feed contains about (0.568) % cassiterite (Sn). The percentage of the content minerals are shown in table 1.

**Table 1:** Chemical Analysis of the Heinda Crushed Sample

Elements	Mg	Al	Si	P	K	Ca	Ti	Mn	Fe	Rb	Ag	Sn	W
Assays	1.4	14.1	51.4	0.4	4.8	6.5	0.8	1.2	17.4	0.1	0.2	0.5	0.2
(%)	2	7	5	6	0	2	9	9	9	4	3	7	0



**Figure 1: XRD Analysis of Heinda Crushed Sample**

## 2.2 Particle Size Analysis of Feed Sample

Particle size distribution analysis (PSD) is a fundamental part of laboratory testing procedures in mineral processing. In the separation stage, the size analysis of the products is used to determine the optimum size of the feed. In the present investigation, sieve analysis is used to determine the optimum size of the feed to the ore sample (Wills & Napier-Munn, 2006; Parbrear, M., 2015).

## 2.3 Gravity Separation by Jigging

The jig operation consists of two actions. One is the effect of hindered settling meaning that a heavier particle will settle faster than a light particle. The other one is the separation process in an upward flow of water which will separate the particles by their density.

## 2.4 Shaking Table Separation

A cross-stream of water transports material over the table to riffles running perpendicular to the direction of feed. Particles build up behind each riffle and stratification occur with heavier particles sinking to the bottom. The light particles are carried over each riffle to the tailings zone. The shaking action of the tables carries the heavy particles along the back of each riffle to the concentrate discharge.

### 2.5 Economic Evaluation

Economic evaluation is an economic assessment of the mineral property generally for an investment decision which is a feasibility study. There are three different approaches to valuation of economic analysis of mine which is known as the income or cash flow approach, market approach, and the cost approach. The economic evaluation of this study is mainly based on the discount cash flow (DCF) method. DCF method is the discount factor and the assumption of long-term prices which means today value in future cash flow. The main parameters of discount cash flow calculation are net present value (NPV), internal rate of return (IRR), and payback period.

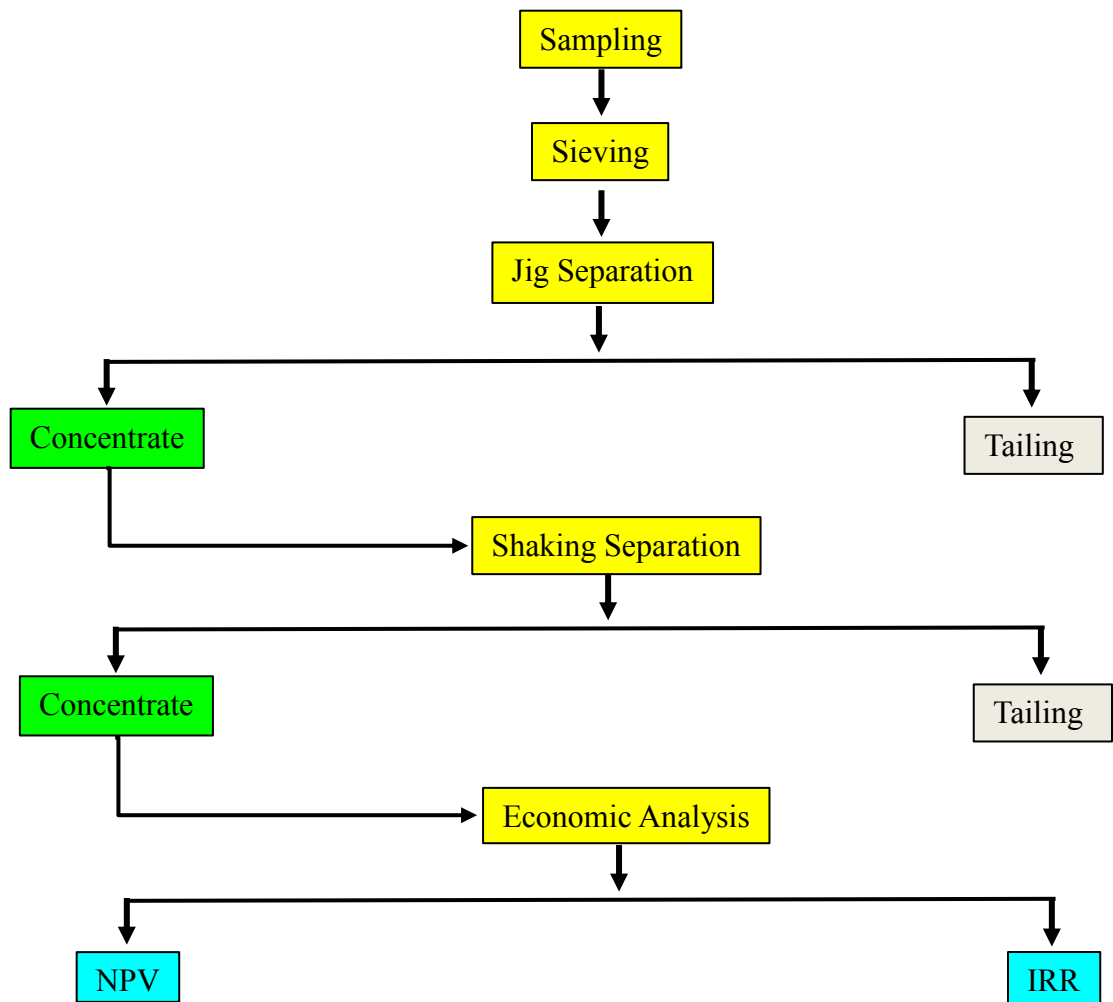


Figure 2: Experimental Method of the Project

### 3. Results and Discussion

The results of the experiment undertaken in this research such as particle size analysis by using wet sieve analysis, the results of jig separation, shaking table separation, X-ray Fluorescence spectrometer (XRF) analysis, and X-ray diffraction spectrometer (XRD). The results indicated that scientific evidence and results of the effectiveness of the gravity separation method for alluvial tin ore.

#### 3.1 Sieve analysis of Feed Sample

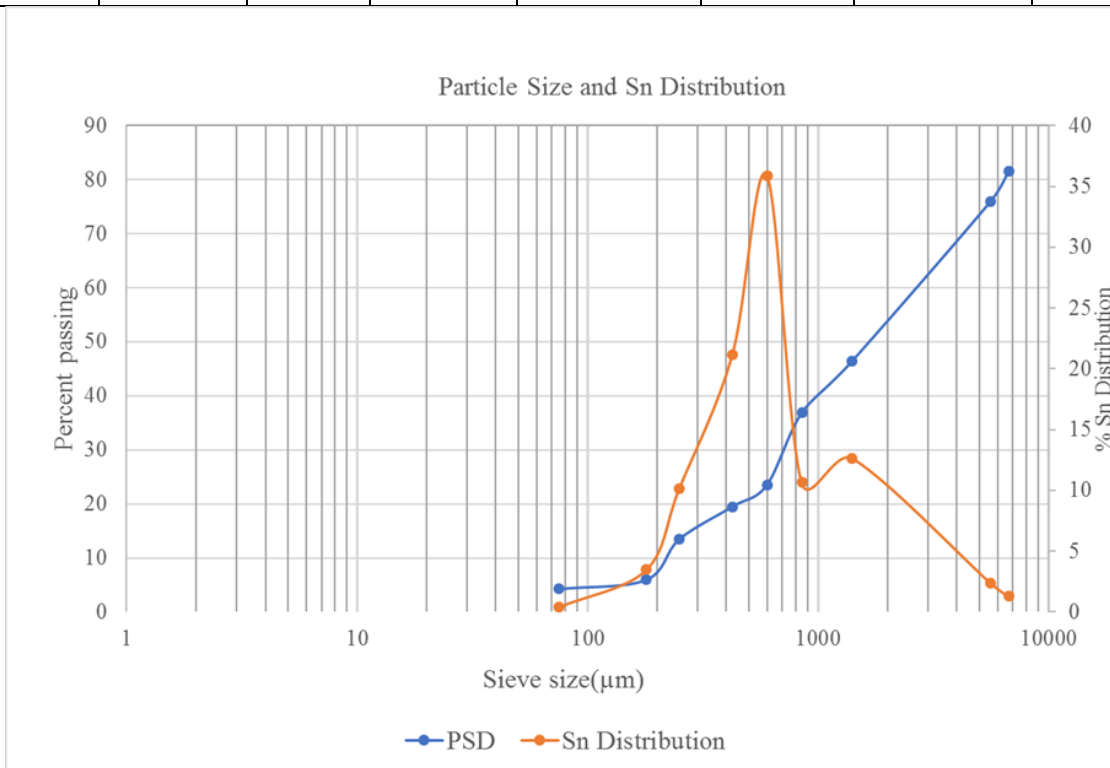
Particle size analysis was carried out over the range of - 6.7 mm and + 0.075 in 9 different mesh sizes, and Samples were sieved on the following set of meshes: 6.7 mm, 5.6 mm, 1.4 mm, 0.85 mm, 0.6 mm, 0.425 mm, 0.25 mm, 0.18 mm and 0.075 mm. A sample weight of 2g was the standard measurement for this experiment. The results obtained from sieve analysis are as shown in table 2 and the Sn distribution revealed by X-ray fluorescence are as shown in table 3. Then, Figures 3 was graphically illustrated for Sn distribution in every sieves size.

**Table 2:** *Sieve Analysis of the Sample*

Sieve size (mm)	Weight Sample Retained (gram)	Percent Retained (%)	Cumulative Retained (%)	Percent Passing (%)
+6.7	370	18.63	18.63	81.37
-6.7+5.6	110	5.54	24.17	75.83
-5.6+1.4	593	29.86	54.03	45.97
-1.4+0.85	190	9.57	63.60	36.40
-0.85+0.6	267	13.44	77.04	22.96
-0.6+0.425	80	4.03	81.07	18.93
-0.425+0.25	121	6.09	87.16	12.84
-0.25+0.18	150	7.55	94.71	5.29
-0.18+0.075	20	1.01	95.72	4.28
Pan (-75)	85	4.28	100.00	0.00

**Table 3: Sn% Distribution of the Sieve Sample**

Sieve size (µm)	Total (weight)	Weight (%)	Assay (% Sn)	Distribution (% Sn)	Size (microns)	Cumulative oversize (%)	Cumulative distribution (% Sn)
+6700	370	18.5	0.05	1.29	6700	18.5	1.3
-6700+5600	110	5.5	0.33	2.40	5600	24.0	3.7
-5600+1400	490	24.5	0.39	12.66	1400	48.5	16.3
-1400+850	190	9.5	0.85	10.64	850	58.0	27.0
-850+600	281	14.1	1.94	35.88	600	72.1	62.9
-600+425	173	8.7	1.85	21.12	425	80.7	84.0
-425+250	131	6.6	1.17	10.13	250	87.3	94.1
-250+180	150	7.5	0.35	3.48	180	94.8	97.6
-180+75	20	1.0	0.31	0.41	75	95.8	98.0
-75	85	4.3	0.34	1.89		100.0	99.9
	2000	100.0	7.59	99.90			



**Figure 3: Particle Size Distribution and Sn Distribution**



### 3.2 Gravity Separation by Jigging

The results obtained from the jigging operation are as shown in tables 4, 5, and 6 respectively. In this study, stroke and dilution were used to investigate the optimum condition of the jig. The percent recovery of tin concentrate was evaluated by applying X-ray fluorescence (XRF) to the analysis of each sample. The results of tin recovery can be seen in Table 7 and graphically presented in Figures 4.

**Table 4: XRF Analysis Results of Jigged Sample (3 mm stroke & 40 ml/s Dilution) - Concentrate Assay**

Elements	Mg	Al	Si	K	Ca	Ti	Cr	Mn	Fe	Sn	W
Assays (%)	0.40	8.98	40.96	1.70	17.42	0.55	0.17	1.61	23.56	4.29	0.14

**Table 5: XRF Analysis Results of Jigged Sample (5 mm stroke & 30 ml/s Dilution)-Concentrate Assay**

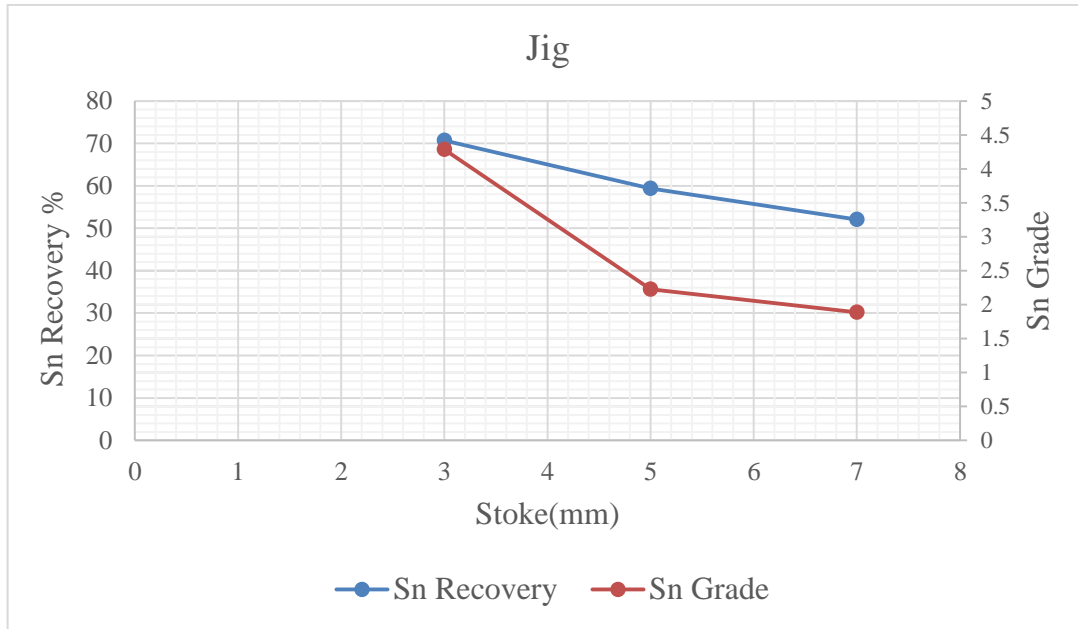
Elements	Mg	Al	Si	K	Ca	Ti	Cr	Mn	Fe	Sn	W
Assays (%)	0.45	9.05	43.60	1.92	17.35	0.56	0.20	1.66	22.60	2.23	0.13

**Table 6: XRF Analysis Results of Jigged Sample (7 mm stroke & 20 ml/s Dilution) - Concentrate Assay**

Elements	Mg	Al	Si	K	Ca	Ti	Cr	Mn	Fe	Sn	W
Assays (%)	0.69	10.23	51.07	2.93	12.15	0.64	0.12	1.43	18.38	1.89	0.15

**Table 7: The Percent Recovery of Jigging Operation**

Mesh (Size)	Stroke (mm)	Water Volume (ml/s)	Sn Assay in Feed (%)	Concentrate		Tailing		Recovery (%)
				Mass(g)	Sn %	Mass(g)	Sn %	
-12+35#	3	30	1.39	235	4.289	1752	0.155	70.71
	5	30	1.39	375	2.227	1585	0.112	59.40
	7	30	1.39	387	1.889	1570	0.114	52.07



**Figure 4:** The Percent Recovery of Jigging Operation

### 3.3 Shaking Table Separation

Shaking table separation used table slope at 20 degrees, 25 degrees, and 30 degrees to move most of the less-dense minerals (mainly silica) and improve the tin concentrate. The results obtained from the tables can be seen in the following Table 8, 9, and 10. Then, the percent recovery of the tin concentrate is shown in table 11. The condition of the three table slopes is graphically demonstrated in Figures 5.

**Table 8:** XRF Analysis Results of Shaking Table Sample (Table Slope 20 Degree & 180 ml/s Dilution) - Concentrate Assay

Elements	Mg	Al	Si	K	Ca	Ti	Cr	Mn	Fe	Sn	W	P
Assays (%)	1.80	10.36	52.09	3.58	9.99	0.68	0.13	1.17	18.20	0.79	0.16	0.40

**Table 9:** XRF Analysis Results of Shaking Table Sample (Table Slope 25 Degree & 220 ml/s Dilution) - Concentrate Assay

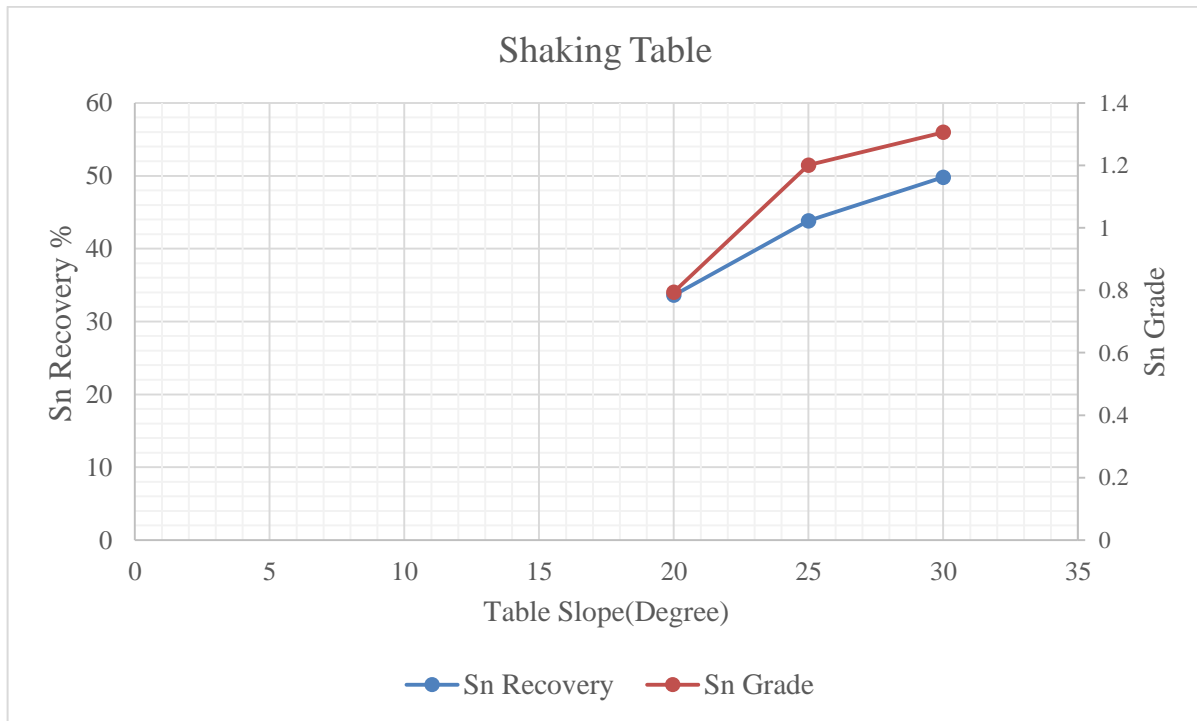
Elements	Mg	Al	Si	K	Ca	Ti	Cr	Mn	Fe	Sn	W	P
Assays (%)	0.79	9.33	52.84	3.27	11.11	0.63	0.21	1.21	18.30	1.20	0.15	0.38

**Table 10: XRF Analysis Results of Shaking Table Sample (Table Slope 30 Degree & 200 ml/s Dilution) - Concentrate Assay**

Elements	Mg	Al	Si	K	Ca	Ti	Cr	Mn	Fe	Sn	W
Assays (%)	0.87	9.70	51.11	3.32	11.78	0.61	0.13	1.37	18.96	1.31	0.15

**Table 11: The Percent Recovery of Shaking Table**

Mesh (Size)	Table Slope (Degree)	Water Volume (ml/s)	Sn Assay in Feed (%)	Concentrate		Tailing	Recovery (%)
				Mass(g)	Sn %	Mass(g)	
-35+80#	20	200	1.13	735	0.794	1221	33.60
	25	200	1.13	615	1.201	1283	43.82
	30	200	1.13	670	1.306	1309	49.79



**Figure 5: The Percent Recovery of Shaking Table Operation**

### **3.4 Mineral Beneficiation Processes of Heinda By Using Wet Physical separation**

The processing of Heinda tin ores is especially used in wet physical separation techniques. The run of mine raw material feeds into the grizzly hopper to separate the feeds. Then, a log washer used to remove surface impurities like clay and dust. After that feeds passing through the trommel and then circular jig. Circular Jig separated fine and coarse particles. The fine particle feed to the primary jig which also separated fine and coarse concentrates. The fine concentrate feeds to the primary shaking table, the coarse concentrate feed to the secondary jig and secondary shaking table. After shaking the table, the tailings feed to the spiral classifier for dewatering by using thickener and settling ponds. Finally, the wastes water from the process will be flow into the pond sludge and can be reused in the process again after the sedimentation (see figure 6).

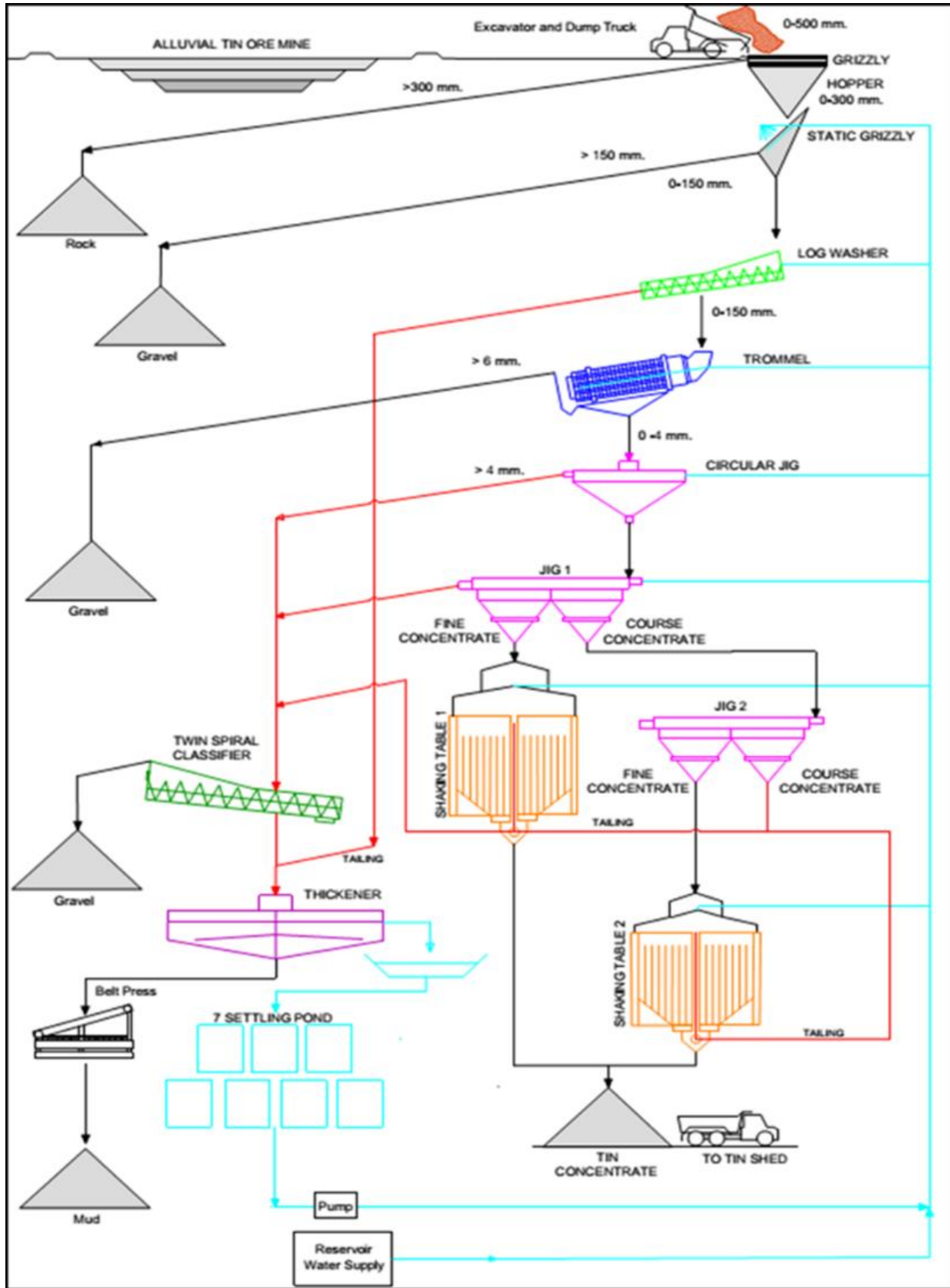


Figure 6: Mineral Beneficiation Processes Flowsheet

### 3.5 Discount Cash Flow Calculation of the Project

The discount cash flow calculation of the project is based on net income flow and outflow of money. There are many parameters in the calculation which are investment parameter, tonnage, and grade of the mineable reserve, the production schedule of the project, revenue of the project, the operation cost of the project, depreciation of the project, tax rate, royalty, and discount rate. The net present value of the project is 790,886,832 and the economic evaluation of the project can be seen in table 14.

**Table 12: Parameter for Financial Analysis**

<b>NO</b>	<b>Parameter</b>	<b>Value</b>	<b>Unit</b>
1	Tin Reserve	200,801	Ton
2	Tin grade (Sn)	0.75	Percent
3	Tin Price	15,590	US \$/Ton
4	Tin Production	5,000	Ton/year
5	Government Share's 35 % including 4% Royalty	22,578,543	US \$/Ton
6	Discount rate	8	Percent

**Table 13: Investment for Financial Analysis**

<b>No</b>	<b>Items</b>	<b>Capital Investment (1 – 30) years (US\$ M)</b>
1	Top-Soil Removal	Main Equipment Auxiliary Equipment 8.52
2	ROM ore excavation	Main Equipment Auxiliary Equipment 52.52
3	Processing Plant	Main Equipment Service Equipment 41.27
4	Tin Shed	Main Equipment Auxiliary Equipment 2.57
5	Plant Infrastructure	Service Equipment 2.89

6	Waste removal	Main Equipment Auxiliary Equipment	61.4
7	Drainage and Pit Support		5.88
8	Mine Infrastructure	Service Equipment	2.61
9	Service Equipment		14.57
10	Facilities & Support	Industrial Area Camp site Area Common site Area	3.52
11	Mine Planning & Grade Control		8.85
12	"General & Administrative Expenses"		13.04
13	MPC Management Department		12.35
	Total (CAPEX)		230
14	Working Capital		68.15
15	Land		0.55
16	Environmental Fund		4.18
17	Mine Closure		7.78
18	CSR		17.66
<b>Total (Investment)</b>			<b>328.32</b>

**Table 14: Discount Cash Flow Calculation of the Project**

<b>N o</b>	<b>Item</b>	<b>Year 0</b>	<b>Year 1</b>	<b>Year 2</b>	<b>Year 3</b>	<b>Year 4 - Year 30 (M)</b>
1	CAPEX	230,000,000				
2	Working Capital	68,150,000				
3	Land	550,000				
4	Environmental Fund	4,180,000				
5	Mine Closure	7,780,000				
6	CSR	17,660,000				

		0				
7	<b>Total (Investment)</b>	<b>328,320,000</b>				
8	Production (Ton)	0	5000	5000	5000	135,000
9	Price (US\$/Ton)		15,590	15,590	15,590	15,590
10	Gross Revenue		77,950,000	77,950,000	77,950,000	2,104,650,000
11	OPEX		5,773,210	5,773,210	5,773,210	155,876,659
12	Operating Incomes		72,176,790	72,176,790	72,176,790	1,948,773,341
13	DD&A		7,666,667	7,666,667	7,666,667	207,000,000
14	Gross Profit		64,510,124	64,510,124	64,510,124	1,741,773,341
15	Government's share 35% including royalty 4%		22,578,543	22,578,543	22,578,543	609,620,669
16	Taxable Income		41,931,580	41,931,580	41,931,580	1,132,152,672
17	Corporate Income Taxes (25%)		10,482,895	10,482,895	10,482,895	283,038,168
18	Net Income After Tax		31,448,685	31,448,685	31,448,685	849,114,504
19	Net Cash Flow	(328,320,000)	39,115,352	39,115,352	39,115,352	1,056,114,504
20	Discount Factor (8 %)		0.93	0.8573	0.7938	0.73502
21	Discounted Cash Flow		(267,774,5	(214,401,5	(167,471,1	790,886,832



1			84)	53)	17)	
NPV						790,886,832
IRR						11.45%
Payback Period(year)						8-9

The results show that the tin mineral concentrate of the jig separator is (70.71%) and the shaking table separator is (49.79). The results revealed that the performance of the jig separator performed better than the shaking table. Consequently, the jigging method should be used as the primary separation stage, and the shaking table method should be followed by the jigging process for the effectiveness of the physical separation process for the alluvial tin (Heinda) ore, Myanmar. Then, the NPV of the project is 790,886,832.61 US \$. The payback period of the project is equal to 8 to 9 years of project life for 30 years. Therefore, the Heinda tin ore project is proven feasible.

#### **4. Conclusion**

The gravity separation method is most effective in this study because gravity separation is an attractive unit operation as it generally has low capital and operating costs, uses few of any chemicals that might cause environmental concerns, and technically well-known. In this research, laboratory-scale jig and shaking tables were used as gravity separators. The physical separation method for the experiment of the project involved washing which is used to remove surface impurities like clay and dust and sieve analysis used to analyze particle size distribution. Then, the gravity separation method was used for the concentration stage by using a jig and shaking table. This study indicated the results of the effectiveness of the gravity separation method for tin ore extraction processes by using the jig and shaking table separation in mineral processing. The GMT corporation estimated the minable reserve of the Heinda mine is 200,801 metric tons of tin ore with the production of 6693 metric tons per year and then processing plant of tin product 5,000 metric tons per year. The results of the financial analysis shown that the internal rate of return (IRR) is 11.45 percent which is higher than the discount rate 8 percent and NPV is 790,886,832.61 US \$. Further work is required to be processed by using a magnetic separator to separate ferrous minerals, after shaking the table process and to extract the tin mineral from tailing, the study on the consumption of the new processing method.

## REFERENCES

- Angadi, S. I., Eswaraiah, C., Jeon, H., Mishra, B. K., & Miller, J. D. (2016). Selection of Gravity Separators for the Beneficiation of the Uljin Tin Ore. *Mineral Processing and Extractive Metallurgy Review*, 38(1), 54-61. <https://doi.org/10.1080/08827508.2016.1262856>
- Barry A. Wills, Tim Napier-Munn, 12 - Froth flotation, Editor(s): Barry A. Wills, Tim Napier-Munn, Wills' Mineral Processing Technology (Seventh Edition), Butterworth-Heinemann, 2005, Pages 267-352, ISBN 9780750644501. <https://doi.org/10.1016/B978-075064450-1/50014-X>
- Bender, F., & Bannert, D. (1983). Geology of Burma.
- Burt, R. O. (1984). Gravity concentration technology.
- Egbe, E., Mudiare, E., Abubakre, O., & Ogunbajo, M. (2013). Effectiveness of Gravity Separation Methods for the Beneficiation of Baban Tsauni (Nigeria) Lead-Gold Ore. *International Journal of Scientific and Research Publications*, 3(5), 1-7.
- Falcon, L. (1982). The gravity recovery of cassiterite. *Journal of the Southern African Institute of Mining and Metallurgy*, 82(4), 112-117.
- Falconer, A. (2003). Gravity Separation: Old Technique/New Methods. *Physical Separation in Science and Engineering*, 12(1). <https://doi.org/10.1080/1478647031000104293>
- Lepetic, V. M. (1986). Cassiterite flotation: A review. *Advances in Mineral Processing: a Half-Century of Progress in Application of Theory to Practice*, 343-350.
- Parbrear, M. (2015). *PROCESSING PLANT DESIGN OF TIN ORES AT SIKHARA MINING CO., LTD THAILAND* Chulalongkorn University].
- Angadi, S. I., Sreenivas, T., Jeon, Ho-Seok, Baek, Sang-Ho & Mishra, B. K. (2015) A review of cassiterite beneficiation fundamentals and plant practices, *Minerals Engineering*, Volume 70, 2015, Pages 178-200, ISSN 0892-6875. <https://doi.org/10.1016/j.mineng.2014.09.009>
- Youssef, M., Abd El-Rahman, M., Helal, N., El-Rabiei, M., & Elsaidy, S. (2009). Optimization of shaking table and dry magnetic separation on recovery of Egyptian placer cassiterite using experimental design technique. *Journal of Ore Dressing*, 11(22), 1.