A STUDY TO DETERMINE THE EFFICIENCY OF THE DELTA MINERAL JIG BASED ON FREE VISIBLE GOLD PARTICLES

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ABSTRACT

One of the most popular sectors nowadays is the small-scale gold mining. The main processing method in this sector is the sluice-box. Apart from the low recovery, the usage of Hg (Mercury) is another disadvantage that this method has. The gold mined in this sector usually has been deposited under different breakdown processes such as weathering and erosion. These depositions are referred to as secondary depositions and can either be alluvial, colluvial, elluvial or fluviatile. Different gravity separation methods can be applied to responsibly treat and process the ore from such deposits.
In this research the efficiency of the 10”x12” Delta Mineral jig concentrator was determined, in order to further encourage the implementation of this method in the small-scale gold mining sector. The parameters used for this determination were free visible gold particles. Three (3) tests were carried out at a mobile processing unit with tailing material from two (2) different sluice-box operation. The concentrates and tailing from the jig were further separately processed by an iCon Gold concentrator. The efficiency of the jig was in the order of 76%.

KEY WORDS: gravity concentration; delta mineral jig; concentration; tailing of small scale gold mines; recovery based on free visible gold particles

1. INTRODUCTION

Despite the low recovery methods that are being applied in the small-scale gold mining sector, it is one of the activities that has a major contribution to the financial incomings of Suriname. Some of these methods are drift, mechanical, hydraulic and a combination of mechanical and hydraulic mining, with the sluice-box being the most important processing unit. While implementing this processing method, Hg (mercury) is the best, cheapest but also the most dangerous binding-agent for the environment. In order to encourage responsible mining, this project was executed to further examine the possibility of the jig as an alternative concentrating equipment in the small-scale gold mining sector.
The jig concentrator is one of the many processing devices used to concentrate gold. Jigging is one of the oldest methods of gravity concentration where the separation is based on the difference in specific gravity of the minerals. Due to the natural breakdown processes, weathering and erosion, placer deposits get formed. In these deposits loose, uncombined with other minerals and in pure state gold particles can be found. This is referred to as free gold. Furthermore, gold can also be liberated by comminution, crushing and grinding of hard rock material by machines. This parameter, free gold, will be used to determine the efficiency of the jig concentrator.

The objectives of this research to analyze the particle size distribution the gold content of the feed, concentrate and tailing from the 10” × 12” Delta Mineral Jig. Also to determine the recovery based on free visible gold particles from the tailings of a small-scale gold mining operation.

2. METHODS AND TECHNIQUES

In order to complete this study, tailing material from two small-scale gold mining operations was used. In total there were three test carried out. The first with material from a mechanical - hydraulic and the second and third with material from a hammer-mill (H3) – sluicebox operation. The material was collected right at the ending of the sluice-boxes (figure 1).

Figure 1. Sample points of the material.

The sampled material was collected in buckets and transported to Paramaribo for further processing with the 10” × 12” Delta mineral jig and the iCon i150 concentrator at the portable mineral processing unit of the University of Applied Science and Technology in Suriname (UNASAT). For the upset of the operation circuit, the following tools were used: a slurry launder, an iCon iPump, a water hose, the 10” × 12” Delta mineral jig, jig ragging, a hutch water tank, a durotank and buckets of 12 and 20 liters. The jig was operated according the operation manual of the 10” X 12” Delta Mineral Concentrating Jig from Gray Manufacturing Company.
After the jig was prepared it was first operated with water for ± 4 mins. The operation circuit was as follow: the slurry launder led the materal into the iCon iPump (figure 2A) which mixed, slurrified and pumped the material to the feed inlet of the 10” × 12” Delta mineral jig (figure 2B) where it was processed. The tailing was collected in a durotank functioning as tailing pond (figure 2C).

Figure 2. The operation circuit used for the tests.

During the operation, the concentrates of the jig were also collected in buckets. Afterwards, the concentrates and tailing were further separately processed by an iCon i150 Concentrator.
For each test samples were taken thrice at the feed, the concentrates and the tailing of the jig. The samples were kept and analyzed separate in order to determine the Particle Size Distribution (PSD) of the material. The wet-weight and wet-volume of the feed samples were measured. From these three measurements, an average value was calculated. With this average value the solid content, density and flow rate of the slurry was determined.
The PSD determination was done at the laboratory of the Department of Geology and Mining at the Anton de Kom University in Suriname (AdeKUS) by using the wet-sieve method. This in order to prevent clotting of the fine particles due to the agitation while sieving. For the sieve analysis samples of ± 1kg were used. To achieve the required quantity, some of the samples needed some preparation. The methods used to prepare the samples were; splitting of the material by a splitter (soil splitter) and the coning and quartering technique. For the sieve analysis a Gilson sieve set was used

with sieve openings of 2000 µm, 1000 µm, 500 µm, 250 µm, 125 µm , and 63 µm. The material retained on the different sieves, were all dried, weighted and interpreted using Microsoft Excel Worksheet.

3. RESULTS AND DISCUSSIONS

The following formulae were used to calculate the parameters of the sampled material.

In table 1 the sampling parameters of the feed samples are presented.

Table 1. Sampling parameters of the feed samples.

FEED SAMPLES			
Parameters	**Test 1**	**Test 2**	**Test 3**
	Average	**Average**	**Average**
Wet Weight (g)	1300.1	1440.5	480.2
Dry Weight (g)	599.0	217.2	72.4
Volume Feed (l)	1.0	1.2	0.4
Sampling Time (s)	9.38	2.9	0.96
Density Slurry (kg/l)	1.3	1.2	1.2
Solid content (%)	46.1	15.1	15.1
Flow rate (l/s)	0.1	0.4	0.4

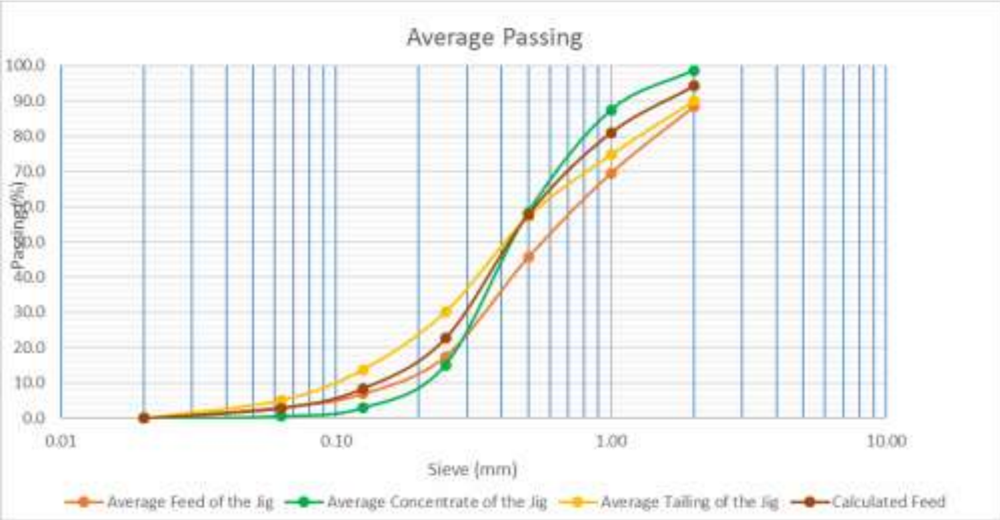
Table 2. shows the PSD analysis of the tests. Here the average values retained on the different sieves in percentage is presented .

Table 2. PSD analysis of test 2 and 3 (average % retained values).

Average Retained										
Product	Sieve	Test 1			Test 2			Test 3		
		Feed	Conc	Tailing	Feed	Conc	Tailing	Feed	Conc	Tailing
	(mm)	%	%	%	%	%	%	%	%	%
1	2	11.6	1.4	10.0	4.1	2.5	5.5	1.2	0.5	1.0
2	1	18.8	11.3	15.2	20.9	22.4	18.7	23.6	22.5	20.5
3	0.5	23.9	29.0	17.5	28.4	35.7	21.5	34.3	39.7	31.4
4	0.25	28.1	43.2	27.0	20.7	27.2	18.7	23.0	25.9	22.2
5	0.125	10.6	12.2	16.3	11.1	9.0	14.0	10.2	8.2	13.4
6	0.063	3.8	2.4	8.7	6.9	2.1	11.6	4.6	1.8	9.4
7	<0.063	3.1	0.6	5.2	8.0	1.1	10.0	3.0	1.5	2.2
Total		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Analysis and interpretation of the PSD data.

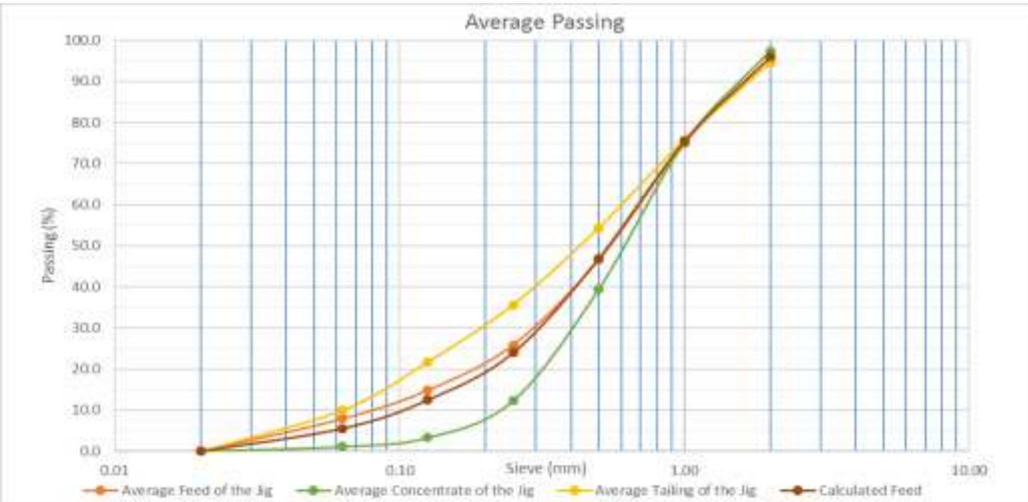
The calculated passing and retained percentage were used to analyze and interpret the PSD data. The average passing values were presented and analysed using graphs. Graph 1 is the comparison of the average passing values of test 1.



Graph 1. A graphical view of the average passing results of the PSD of test 1.

In graph 1. can be seen that the course of the feed and calculated feed are almost identical. At the sieve opening of 0.5 mm there is an intersect between the concentrate and tailing. Downward from this point, the tailing has finer particles than the concentrate. Forward from this point the concentrate has coarser particles than the tailing

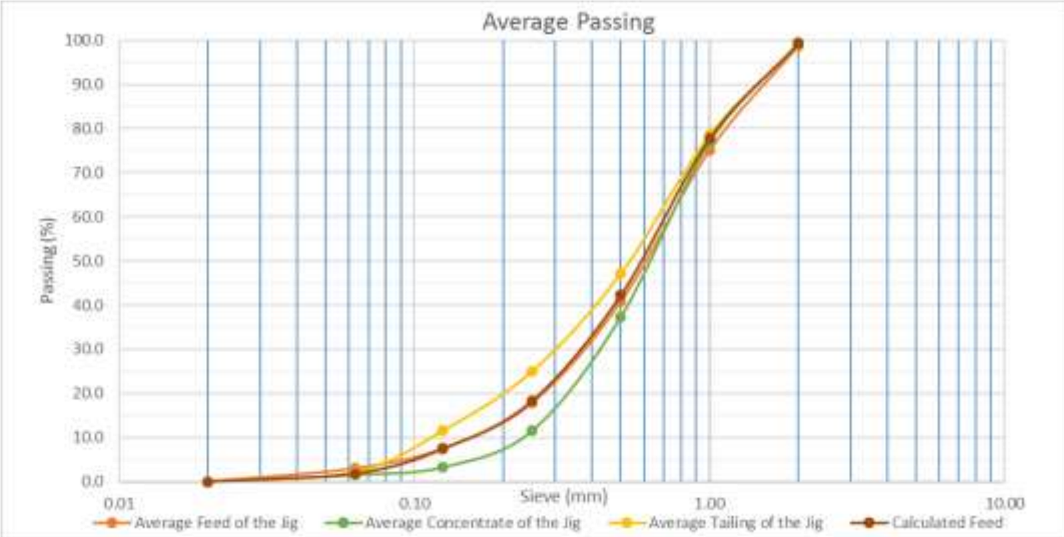
Graph 2. is the comparison of the average passing values of test 2.



Graph 2. A graphical view of the average passing results of the PSD of test 2.

In graph 2. can be seen that the course of the flows is almost identical. The feed and calculated feed almost have the same position. Furthermore, the tailing has a higher position than the concentrate, which indicates that the tailing consists of finer particles than the concentrate and the concentrate consist of coarser particle than the tailing.

Graph 3. is the comparison of the average passing values of test 3.



Graph 3. A graphical view of the average passing results of the PSD of test 3.

Graph 3. shows that most of the material used for test 3, resides on the sieve apertures of 1mm, 0.5mm and 0.25mm, with 0.5mm having the most. With almost 40.0%, the concentrate has the most material retained on the sieve of 0.5mm. In the fractions smaller than 0.125mm and 0.063mm it is the tailing which has the upper hand. Furthermore, it can be seen that most of the material of test 3, consists of particles of the 0.5mm fraction.

Gold results analysis.

The concentrates and tailings of the jig were further separately processed by an iCon Gold concentrator. The concentrates from this processing machine were sieved and batea-d per fraction. For the fractions were it was possible, the gold particles were separated by hand and then weighted. The free gold determination was only done for test 2 and 3. In table 4 the results of the free gold determination of the concentrate and tailing of test 2 are represented.

Table 3. Result of the free gold determination of the concentrate and tailing of test 2.

Product	Sieve	Retained		
		Concentrate Jig		Au
	(mm)	(g)	(%)	(g)
1	2	7.3	0.4	-
2	1	504.8	25.9	0.651
3	0.5	292.9	15.0	0.015
4	0.25	465.5	23.9	-
5	0.125	445.6	22.9	-
6	0.063	176.9	9.1	-
7	<0.063	53.5	2.7	-
Total		1946.5	100.0	0.666

Product	Sieve	Retained		
		Tailing Jig		Au
	(mm)	(g)	(%)	(g)
1	2	1.4	0.1	-
2	1	344.2	15.9	0.133
3	0.5	782.9	36.1	0.063
4	0.25	672.1	31.0	-
5	0.125	260.5	12.0	-
6	0.063	89.8	4.1	-
7	<0.063	18.3	0.8	-
Total		2169.2	100	0.196

From table 3 can be seen that for test 2 only in the 1mm and 0.5mm fractions, free gold particles were present and/or could be separated. A total weight of 0.666g gold was retained in the concentrate of these fractions and for the tailing a total weight of 0.196g gold was separated. The Recovery Efficiency (Reff) was calculated using formula 3.

$$\text{Reff} = \left(\frac{\text{Gconc}}{\text{Gconc} + \text{Gtail}}\right) \times 100\% = \left(\frac{0.666}{0.666+0.196}\right) \times 100\% = \left(\frac{0.666}{0.862}\right) \times 100\% = \mathbf{77.26}\%$$

In table 4 the results of the free gold determination of the concentrate and tailing of test 3 is represented.

Table 4. Result of the free gold determination of the concentrate and tailing of test 3.

Product	Sieve	Retained		
		Concentrate Jig		Au
	(mm)	(g)	(%)	(g)
1	2	0.9	0.1	-
2	1	231.5	23.1	0.156
3	0.5	287.8	28.7	0.074
4	0.25	221.2	22.0	0.063
5	0.125	157.2	15.7	-
6	0.063	59.6	5.9	-
7	<0.063	45.6	4.5	-
Total		1003.8	100.0	0.293

Product	Sieve	Retained		
		Tailing Jig		Au
	(mm)	(g)	(%)	(g)
1	2	2.1	0.2	-
2	1	232.9	22.5	0.024
3	0.5	230.4	22.3	0.013
4	0.25	162.8	15.7	0.055
5	0.125	185.8	18.0	-
6	0.063	96.0	9.3	-
7	<0.063	124.2	12.0	-
Total		1034.2	100.0	0.092

From table 4 can be seen that for test 3 in the 1mm, 0.5mm and the 0.25mm fractions, free gold particles were present and/or could be separated. A total weight of 0.293g gold was retained in the concentrate of these fractions and for the tailing a total weight of 0.092g gold was separated. The Recovery Efficiency (Reff) was calculated using formula 3.

$$\text{Reff} = \left(\frac{\text{Gconc}}{\text{Gconc} + \text{Gtail}}\right) \times 100\% = \left(\frac{0.293}{0.293+0.092}\right) \times 100\% = \left(\frac{0.293}{0.385}\right) \times 100\% = \mathbf{76.10}\%$$

Earlier studies from Renoeska Kisoen (*A Study Of The Implementation Of The Jig Concentrator In The Processing Unit Of The Small–Scale Mining In Suriname*) and Renoesha Naipal (*Study Of Some Operational Variables Which Can Influence The Performance Of A Mineral Jig*) also gave efficiencies in the order of 76% for. the Delta Mineral Jig. For these test fire assay was used to determine the gold content of the samples.

1. CONCLUSIONS

Based on the PSD analysis it can be concluded that the material used for test 1 consisted mostly of particles of the fraction 0.25mm. Furthermore, it is clear that the material used for test 2 and 3 consisted mostly of particles of the 0.50mm fraction.
The fractions 0.50mm and 0.25mm are dominant in the concentrates of the test. This indicates that for these tests the 10”x12” Delta Mineral jig concentrator recovered these fractions the best. Also as expected, the tailing of the jig consisted of more fine particles than the concentrate. This indicates that the jig performed well during the operation. Based on the determined Recovery Efficiency, the Delta Mineral jig can be seen as a

useful addition in the processing scheme of the small-scale gold mining sector in Suriname.

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