A STUDY ON THE PERFORMANCE OF THE RP4 SHAKING TABLE AND THE MICRON MILL WAVE TABLE M7

KASANRADJI, R.S.[1], FINKIE, R.L.[2], JATEMAN, R.[3], WIJNGAARDE, G.W.[4], SOESMAN, M.P.[5]

[1] Anton de Kom University of Suriname, Faculty Technology, Department of Geosciences
e-mail: ryandall_kasan@hotmail.com
[2] Anton de Kom University of Suriname, Faculty Technology, Department of Geosciences
e-mail: r.finkie@uvs.edu
[3] Anton de Kom University of Suriname, Faculty Technology, Department of Geosciences
e-mail: raoulcd93@hotmail.com
[4] Anton de Kom University of Suriname, Faculty Technology, Department of Geosciences
e-mail: genevieve.wijngaarde1992@hotmail.com
[5] Anton de Kom University of Suriname, Faculty Technology, Department of Geosciences
e-mail: mma-tumelo@live.com

ABSTRACT

UNASAT School of Geology & Mining Technology offers a course of current methods and techniques that are available for producing gold without the use of mercury. UNASAT has two shaking tables, namely RP4 Shaking Table and Micron Mill Wave Table M7. Both shaking tables use gravity concentration to separate valuable minerals from the gangue minerals. This project was carried out to compare the designs, operating variables and overall performance of both tables. To study the influence of the operating variables of the shaking tables the feed and concentrate of the two shaking tables were sampled and analyzed. Particle Size Distribution (PSD) analysis was done on all the samples using the wet sieving method. Based on the results from the PSD analysis there can be concluded that the concentrates on the Micron Mill Wave Table are overall finer than the concentrates on the RP4 Shaking Table.

KEYWORDS: Gravity Concentration, Shaking Table, RP4 Shaking Table, Micron Mill Wave Table M7, Performance.

1. INTRODUCTION

Gravity concentration is a mineral processing method which separate minerals of different specific gravity by their relative movement in response to force of gravity and one or more other forces. This process physically separates the particles of valuable minerals from the gangue minerals without the use of strong chemicals like cyanide and mercury and excessive heating, which makes it environmental friendly. UNASAT School of Geology & Mining Technology offers a certificate program in Mercury Free Gold Production. The course provides a broad overview of current methods and techniques that are available for producing gold without the use of mercury. UNASAT has a few gravity concentration devices in their possession, including a centrifugal concentrator: iCON Concentrator, which is used for primary concentration of ore, and two shaking tables, namely RP4 Shaking Table and Micron Mill Wave Table M7, which are used for final concentration. In light of the first author's bachelor thesis a study on these two shaking tables was carried out, comparing their designs, operating variables and overall performance. The objectives of this study are: determining the Particles Size Distribution of the feed and concentrate of each table, studying the effects of the operating variables on the PSD of the concentrates of each table, and determining the density of the concentrates of each table.

2. METHODS AND TECHNIQUES

The sample material used for this study came from a practical training camp in a concession of a small scale gold mining company, located in district Brokopondo near the Afobakka stuwmeer. Samples were taken at two different locations inside the training camp. Two samples were taken at the first location but at different depths, sample A and sample B. A third sample, C was taken at the second location. These samples were transported to Paramaribo where they were dried, homogenized and weighted. The samples were each concentrated separately on the iCON i150 centrifugal concentrator as part of another student's project. After the process the three concentrate samples were collected to be further prepared for the tests on the two shaking tables. For further preparation the concentrates were dried in the oven(Heraeus) and then homogenized, split using the quartering method and weighted. In total, there are now six samples that can be seen in column 3 of table 1, three feed samples for each shaking table. Each sample was split again, one part was used as feed for the test on the shaking table and the other was used to determine the PSD of the feed.

Table 1: Overview of all samples in this project.

iCON i150 Concentrates	Shaking Tables	Shaking Tables Feed	Shaking Tables Concentrates	Shaking Tables Tailings
A50	RP4	A50R-F	A50R-C	A50R-T
	M7	A50M-F	A50M-C	A50M-T
B50	RP4	B50R-F	B50R-C	B50R-T
	M7	B50M-F	B50M-C	B50M-T
C50	RP4	C50R-F	C50R-C	C50R-T
	M7	C50M-F	C50M-C	C50M-T

Before testing on the shaking tables could take place, both shaking tables needed to be installed first and cleaned thoroughly, to prevent contamination from previous operations.

The efficiency of separation on a shaking table is affected by a number of operating variables. According to (Bilkerdijk, 2016) operating variables, like the deck angle of a shaking table are dependent on the composition of the material used on the shaking table. So the operational variables needed to be adjusted for each test. On both the RP4 and the M7, only the deck angle and wash water flow rate are adjustable, while the other operating variables are not.

During each test on the RP4 the instructions as given in the (RP4 Shaking Table Instruction Manual) were used to set the correct deck angle and wash water flow rate for each sample. And on the M7 the correct deck angle and wash water flow rate for each sample was set using the method provided by (Freelander, 2015).

Before a sample could be processed on the shaking table it needed to be pre-mixed with water creating a 25% solid percentage feed slurry. The feed slurry was then steadily and continuously fed onto the shaking table, while the correct deck angle and wash water flow rate was set. During the test the processing time was measured for the calculation of the average feed rate. After the test the wash water flow rate was determined and the deck angle was measured using an inclinometer. These procedures were repeated for each test on each shaking table.

After each test the concentrates were collected and prepared for PSD determination. To determine the particle size distribution of the concentrate samples the wet sieving procedure was used with the following sieve sizes: 2000 µm; 1000 µm; 500µm; 250µm; 125µm and 63µm. The results of the sieve analysis are presented by semi-logarithmic plots known as particle size distribution curves, using Microsoft Excel. The sieve sizes are plotted in log scale, and the percentage passing in arithmetic scale. This procedure was also used to determine the PSD of the feed materials.

3. RESULTS AND DISCUSSIONS

Test conditions

The feed rate, deck angle and wash water flow rate of each sample during each test is shown in Table 2 and Table 3. The average feed rate was calculated using the sample weight and processing time. Comparing table 2 and 3 with each other there can be noted that the RP4 used more wash water than the M7.

Table 2: Feed rate, deck angle and wash water flow rate for each test on the RP4.

RP4 Shaking Table					
Feed sample	**Weight (gram)**	**Production Time (sec)**	**Avg. Feed Rate (g/min)**	**Deck Angle (^{o})**	**Water Flow Rate (l/min)**
A50	367.70	922	23.93	1	36
B50	319.30	795	24.10	1.1	52
C50	490.18	690	42.62	0.9	52

Table 3: Feed rate, deck angle and wash water flow rate for each test on the M7.

Micron Mill Wave Table M7						
Feed Sample	Weight (gram)	Production Time (sec)	Avg. Feed Rate (g/min)	Deck Angle (°)	Water Flow Rate Conc (l/min)	Water Flow Rate Feed (l/min)
A50	367.60	922	23.92	0.9	5.2	20
B50	309.74	795	23.38	1	5.6	20
C50	512.88	690	44.60	1	5.6	20

Results of the Particles Size Distribution of the feed samples

The passing data from the PSD determination of the feed samples have been plotted in Figure 1. The passing of sample A50R (RP4) and sample A50M (M7) show a similar curve. The same can be observed for sample B50R and B50M and also for C50R and C50M.

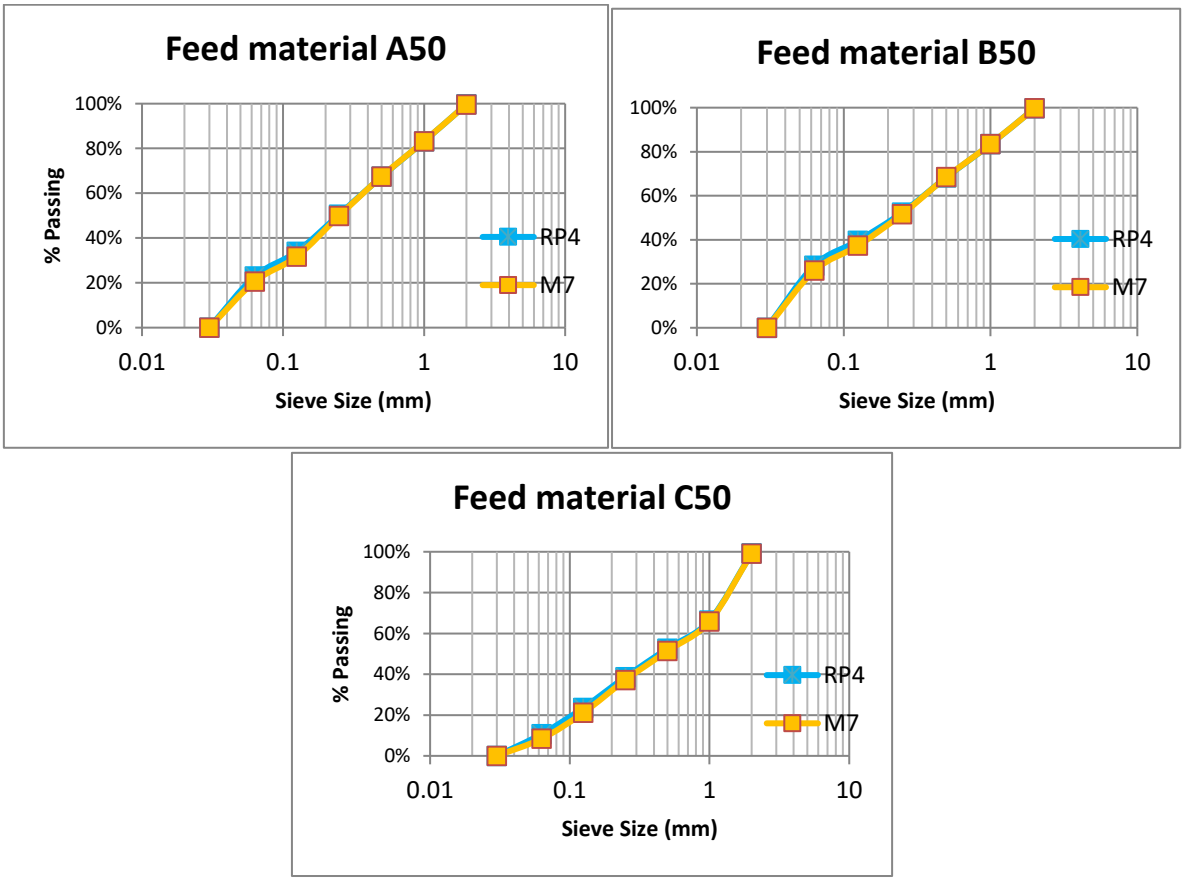

Figure 1: Comparisons between the PSD curves of the feed of RP4 and M7.

The feed samples A50, B50 and C50 are presented in Figure 2 by a scatter plot. It can be observed that A50 and B50 have almost identical PSD curves, while C50 is overall coarser. Because material A and B have the same Particles Size Distribution, it is possible that material A and B are the same material, which could be expected as both were taken at the same location but at different depths.

Figure 2: Comparison between the PSD curves of feed sample A50, B50 and C50.

Results of the Particles Size Distribution Analysis of the concentrate samples

The result of the Particle Size Distribution of the concentrate samples of the two shaking tables will be presented in the following charts.

Figure 3 below, compares the passing data of the PSD determination of the concentrate of the RP4 shaking table and the Micron Mill Wave Table M7. The passing of the concentrates from the M7 are overall finer in comparison to the concentrates from the RP4, which is overall coarser.

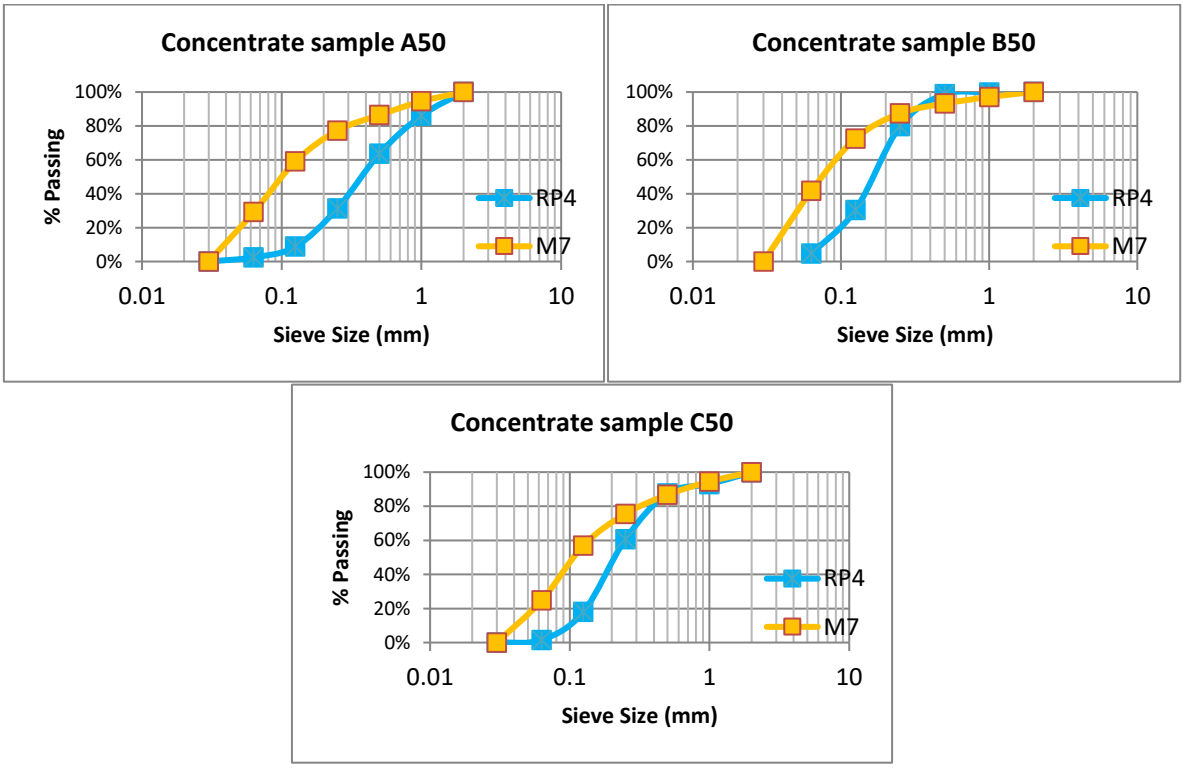

Figure 3: Comparison between the PSD curves of the concentrate of RP4 and M7.

The concentrate samples A50R, B50R and C50R of the RP4 Shaking Table are illustrated in Figure 4 by a scatter plot. It can be observed that B50R is overall finer than C50R and A50R, while A50R is the coarsest. It was expected that A50R and B50R would have similar PSD curves as each other due to the fact that their respective feed samples did have similar PSD curves as seen in figure 1, however they do not have similar PSD curves. This could be explained by the difference in wash water flow rate between the two tests. Table 2 shows that the wash water flow rate is 36 liter per minute with a deck angle of 1° for sample A50R and 52 liter per minute with a deck angle of 1.1° for sample B50R. The steeper deck angle and higher wash water flow rate for sample B50R caused more coarse particles to move into the tailings resulting in an overall finer concentrate.

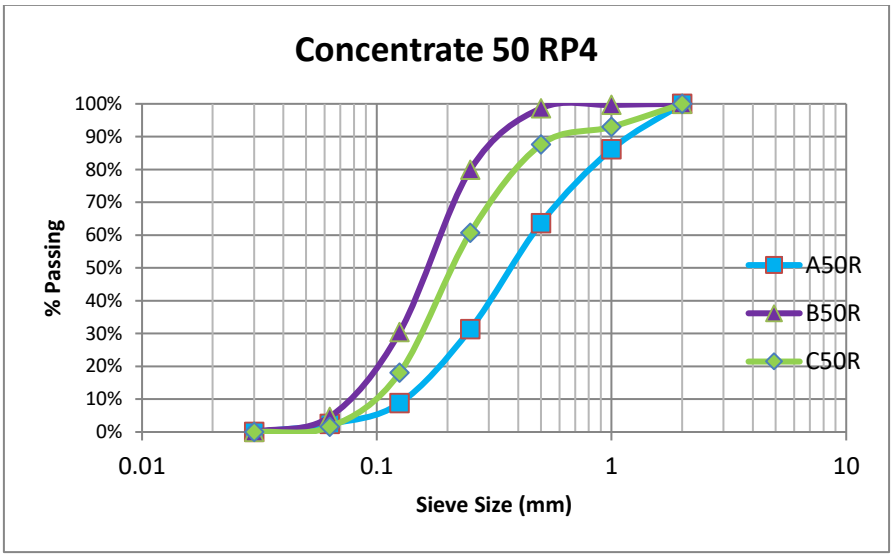

Figure 4: Comparison between the PSD curves of the concentrate samples of the RP4.

The concentrate samples A50M, B50M and C50M of the Micron Mill Wave Table M7 are presented in figure 5 by a scatter plot. It can be observed that B50M is overall finer than A50M and C50M. It was expected that A50M and B50M would have similar PSD curves as each other due to the fact that their respective feed samples did have similar PSD curves as seen in figure 1, however they do not have similar PSD curves. This could be explained by the difference in wash water flow rate between the two tests. Table 3 shows that the wash water flow rate is 5.2 liter per minute with a deck angle of 0.9° for sample A50M and 5.6 liter per minute with a deck angle of 1° for sample B50M. The steeper deck angle and higher wash water flow rate for sample B50M caused more coarse particles to move into the tailings resulting in an overall finer concentrate.

Another surprising observation is that concentrate samples A50M and C50M have similar PSD curves even though their feed samples are different materials with different PSD curves (see figure 2). This result could be caused by the difference in feed rate between the two tests. During the tests sample A50M had a feed rate of 23.92 grams per minute and C50M had a feed rate of 44.60 grams per minute. The steeper deck angle and higher feed rate of sample C50M caused more coarse particles to go to the tailings, resulting in a concentrate samples as fine as concentrate sample A50M. This means that different types of

feed materials can have concentrates with the same PSD if the right combination of operating variables is used during operation of the shaking table.

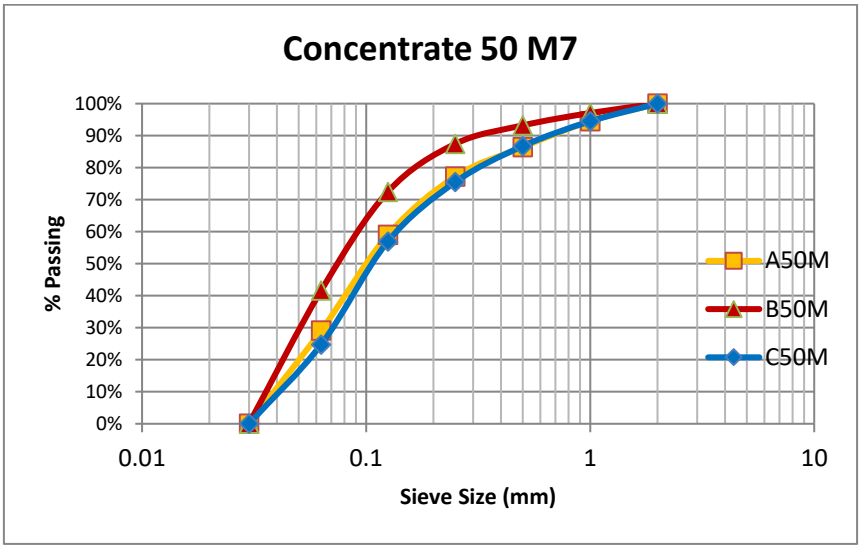

Figure 5: Comparison between the PSD curves of the concentrate samples of the M7.

Density and Mass of the concentrate samples

The mass and volume of the concentrate samples were measured. The density and mass of the concentrate samples of the two shaking tables are presented in figure 6 below by histograms.

There can be observed that the concentrates of the Micron Mill Wave Table M7 all have a higher density, compared to the concentrates of the RP4 Shaking Table. It could indicate that the concentrates of the M7 have a higher grade of heavy minerals, like gold compared to the RP4. However the concentrates of the RP4 have more mass, which could indicate that the recovery is higher than that of the M7.

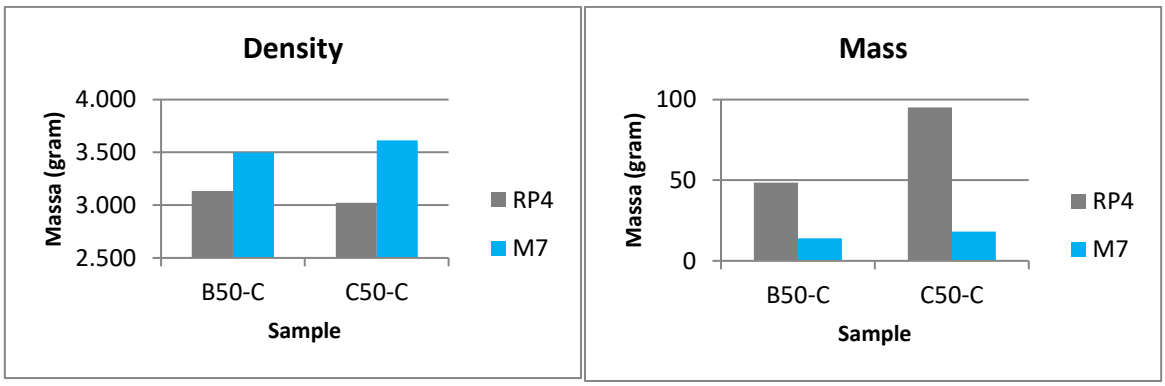

Figure 6: Histograms of the density and mass of the concentrate samples of the RP4 and M7.

4. CONCLUSIONS

Feed material A and B have a similar Particle Size Distribution (PSD).

On both the Micron Mill Wave Table M7 and the RP4 Shaking Table a steeper deck angle and a higher wash water flow rate causes more coarse particles to move into the tailings, resulting in a finer concentrate. This is similar to what (Tripathy, Ramamurthy, Sahu, Panda, Singh, & Tathavadkar, 2010) found.

From the PSD curves can be concluded that the concentrates of the Micron Mill Wave Table M7 are overall finer than the concentrates of the RP4 Shaking Table for all materials (A, B and C).

The RP4 requires more wash water than the M7 to achieve the same fine concentrate, because even though the wash water flow rate was lower on the M7 in comparison to the RP4 during all tests, the concentrates of the M7 were overall finer than the concentrates of the RP4.

The concentrates depend on the type of feed material that goes onto the shaking tables. Different types of feed materials will result in different concentrates. However for the Micron Mill Wave Table M7 different types of feed material can still result in the same concentrate if the right combination of operating variables is used during the processing on the M7. This could also be the case for the RP4 Shaking Table, but further study must first be done.

The concentrates of the Micron Mill Wave Table M7 all have a higher density, compared to the concentrates of the RP4 Shaking Table. This can conclude that the concentrates of the M7 have a higher grade of heavy minerals, like gold compared to the RP4. However the concentrates of the RP4 have more mass, which could indicate that the recovery on the RP4 is higher than that of the M7.

5. ACKNOWLEDGEMENTS

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