THE PERFORMANCE OF THE H2 AND H3 HAMMER MILL IN A SMALL SCALE GOLD MINING OPERATION A CASE STUDY AT THE KRIKI NEGI AREA DISTRICT BROKOPONDO SURINAME

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ABSTRACT

Comminution is the breaking of the ore to sizes small enough to free or liberate the valuable components from the gangue. Blasting can be described as the first stage of comminution carried out in the mine site in order to remove ores from their natural beds. Comminution in the mineral processing plant takes place in a sequence of crushing and grinding processes. Crushing reduces the particle size of the ore to such a level that the grinding mill can process it further until the mineral and gangue are substantially produced as separate particles. For this project, samples were taken from the end of the sluice box from two different operations, namely: the H2 and H3 Hammer mill- sluice box operations. The objective of this project was to study the effectiveness of the H2 and H3 Hammer mill. The gold content of the samples were studied by the fire assay method and the effectiveness of the hammer mill was determined by the measured parameters and the particle size distribution analysis. Based on the findings of this project it could be concluded that neither one of the hammer mills reached half of their production rate.

KEYWORDS: mineral processing, comminution, hammer mill, gold content, measured parameters, particle size distribution

1. INTRODUÇÃO

The main goal of mineral processing is to produce a maximum value from a certain raw material. There are two fundamental operations in mineral processing: namely the release, or liberation, of the valuable minerals from their waste gangue minerals, and seperation of these values from their gangue, this process being known as concentration (Wills& Napier-Munn, 2006). To reduce and liberate the gold particles, the hammer mill is one of the most used comminution devices in the small-scale gold mining in Suriname. The Hammer mill in combination with the sluice box is the most used operation circuit in the small scale gold mining to process gold from quartz veins in the weathering profile. In this operation the sluice box is the concentrator and different sizes of Hammer mills can be used, such as: the H2 and H3 with a deutsch motor of 4 cilinders and 2 hammers; H4 with a deutsch motor of 6 cilinders and 4 hammers. In this project the focus will be on a H2 and H3 hammer mill-sluice box operation. The material of the H3 was taken directly from the mine while material of the H2 was taken from the tailing pound of the H3. According to the sellers of these equipments the H2 stands for a production rate of 2 t/h and the H3 for 3 t/h. The main purpose of this study is to determine the effectiveness of the Hammer mill.

2. MATERIAL E MÉTODOS

For this project field and laboratory work was carried out. Fieldwork took place in district Brokopondo. Tailing samples were taken from two different operations: namely, an H2 and H3 Hammer mill-sluice box operation (Figure 1) at the Kriki Negi Area. Sampling of each operation was done in three different days. All the samples were further prepared at the laboratory of the Department of Geosciences at AdeKUS. The tailing material was dried and homogenized, known as the alongated pile method. A certain weight of 5 kg was taken for further processing by quartering and splitting. For quartering the classical cone and quarter technique as described by Raab et al (1990) was used. One sample of about 1 kg was used for the determination of the Particle Size Distribution (PSD) and this same sample was sent to Filab for the determination of the gold content.

Measured Parameters determination: Each sampling day, one extra sample was taken to determine the measured parameters. The samples for the measured parameters were also put to dry. After this, the weight and volume were calculated. With these results the following could be determined: mass flow; volume flow; mass % and solid density.

Fig. 1: Photograph showing a hammer mill-sluice box operation

Particle size distribution determination: For determination of the PSD wet sieving was carried out and Microsoft Excel was used to calculate the PSD. The following sieve sizes were used 2000 µm, 1000 µm, 500 µm, 250 µm, 125 µm and 63 µm. After the determination and analysing the particle size distribution, the fractions were prepared for fire assay method for determination of the gold content .

3. RESULTADOS E DISCUSSÃO

The measured parameters

The results of the solid mass flow, mass percent, volume flow and density of the dried solid of the H3 and H2 are shown in table 1. The average mass content of the H3 is 11.12% which means that the slurry consisted of 11.12% solid material and 88.88% water. The average mass content of the H2 is 8.45% which means that the slurry consisted of 8.45% solid material and 91.55% water. According to the equipment's seller the maximum dry solid production rate of the H3 is 3 t/h and that of the H2 is 2 t/h. The average production rate of the H3 is 0.78 t/h and that of the H2 is 0.26 t/h. As you can see the H3 and H2 both did not perform well, they did not even reached halve of their normal production rate.

Table 1: Results of the measured parameters of the H3 and H2 samples

Solid									
Samples H3	**Mass Flow (t/h)**	**% Mass**	**Volume Flow (m^3/h)**	**Solid Density (t/m^3)**	**Samples H2**	**Mass Flow (t/h)**	**% Mass**	**Volume Flow (m^3/h)**	**Solid Density (t/m^3)**
Sample A	0.77	12.18	0.53	1.73	**Sample A**	0.27	8.91	0.18	1.51
Sample B	1.02	11.63	0.93	1.57	**Sample B**	0.30	7.49	0.21	1.44
Sample C	0.56	9.54	0.45	1.46	**Sample C**	0.22	8.96	0.13	1.65
Average	0.78	11.12	0.64	1.59	**Average**	0.26	8.45	0.17	1.53

Results of the Particle Size Distribution

In Table 2 the average passing and retained of the H2 and H3 are presented. From this table there can be observed that 51.51% of the H3 is concentrated on a grain size bigger than 500µm and 30% of the H2 is concentrated on a grain size bigger than 500µm. As you can see the most reduction has taken place in fractions bigger than 500µm. Less than 8% of both samples are finer than a grain size of 63µm. It can be said that the material was rather coarse.

Table 2 The average retained and passing of the H2 and H3

Average				
Fraction (µm)	**Retained (%)**		**Passing (%)**	
	H3	**H2**	**H3**	**H2**
2000	3.34	X	96.66	X
1000	18.62	6.82	78.04	93.18
500	29.55	23.08	48.49	70.1
250	22.25	24.62	26.24	45.48
125	15.26	27.63	10.98	17.84
63	5.85	10.69	0.51	0.71
<63	5.12	7.15	0	0
Sum	100	100		

In figure 2 the average retained of the H2 and H3 samples is given. It is possible to see that most of the material of the H2 is concentrated on the 125 µm sieve opening and most of the material of the H3 is concentrated on the 500 µm sieve opening. The feed of the H2 consisted of tailing material of the H3. This material was already processed by the H3 crusher, which explains that the H2 material was finer than that of the H3.

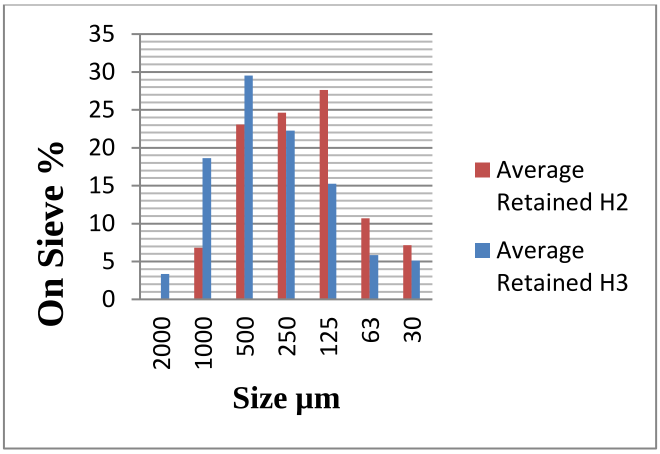

Fig. 2: The average retained of the H2 and H3

In figure 3 the average passing of the PSD of the H2 and H3 is given. There can be seen that the particles of the H3 are coarser than the H2. The H2 line is steeper than that of the H3. How steeper the line how finer the material.

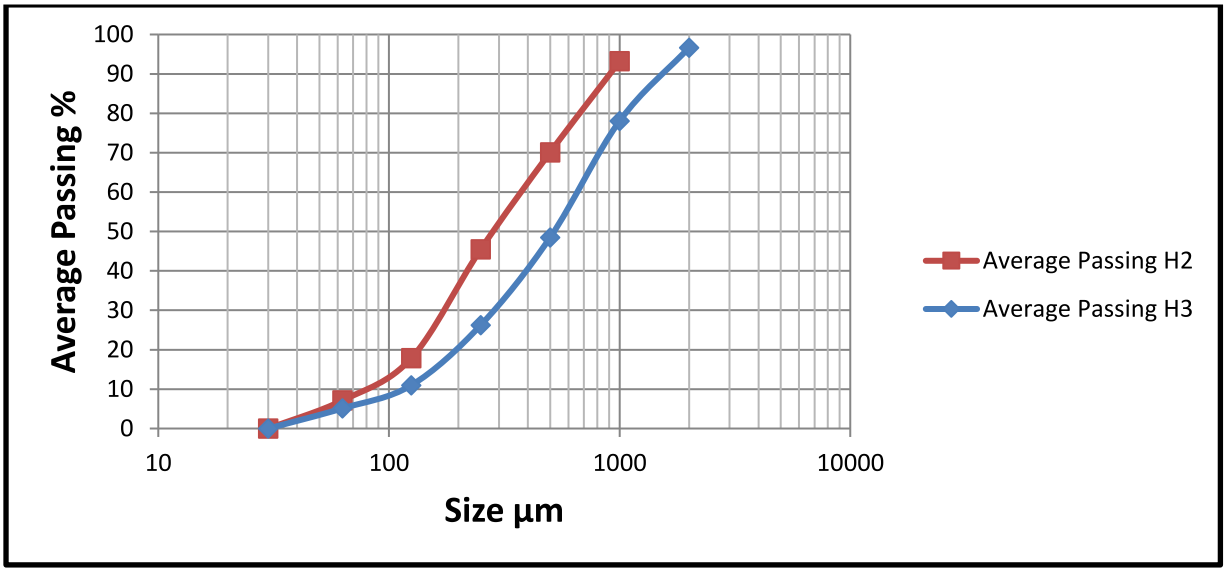

Fig. 3: The average passing of the PSD of the H2 and H3

Results of the Gold Content

In table 3 the average gold content of the H2 and H3 are presented. There can be said that the tailing material of the H3 had an average gold content of 3-4 ppm and the tailing material of the H2 had an average gold content of 1-2 ppm.

Table 3: The average gold content of the H2 and H3

Fraction (mm)	Average (PPM)	
	Gold Content H3	Gold Content H2
1000	3.62	1.39
500	3.79	2.23
250	4.25	1.97
125	6.98	1.19
63	3.21	1.14
<63	3.51	1.6

In figure 4 the average gold content of the H3 and the H2 are plotted. There can be seen that the gold content of the H3 samples are almost two times higher than the H2 samples. This can be explained by the feed material that was used for the H2, the feed was already processed (tailing) but the feed for the H3 came straight from of the mine. There is still enough gold available in the tailing material of the H2.

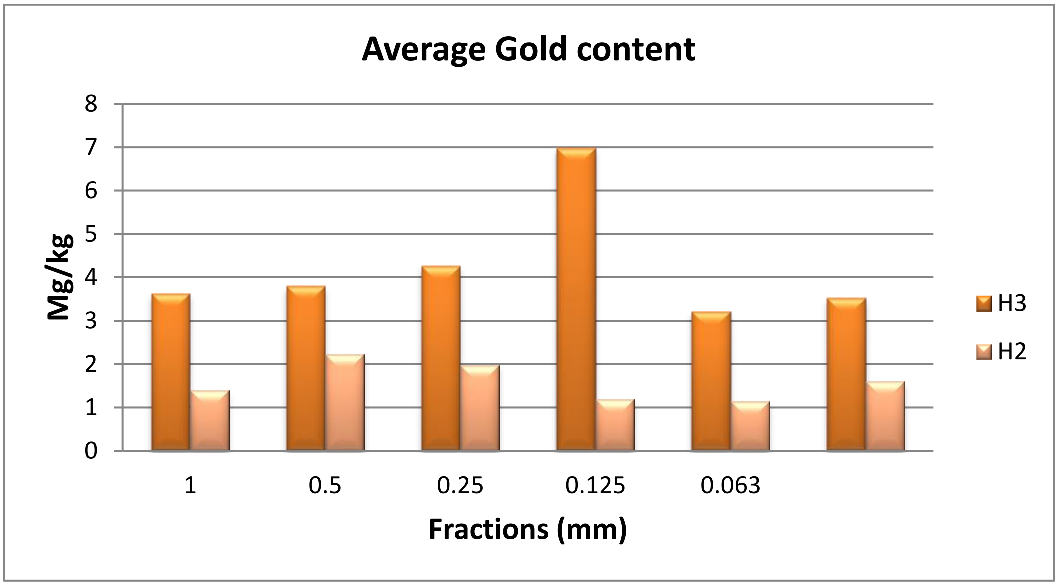

Fig. 4: The average gold content of the H2 and H3 samples

4. CONCLUSÕES

From this research it can be concluded that both of the Hammer mills didn't perform effectively, they didn't even reached halve of their production rate.

In both samples more than 60% of the material lies between a grain size of 1mm and 0.063mm.

In both samples the particles between a grain size of 1mm and 0.063 consisted of the highest gold content.

It can also be concluded that the tailing material of the H2 still consisted of enough gold particles even though its feed was from the tailing compound of the H3.

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