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Determination of Liberation Size of Agwada Chalcopyrite Ore, Nasarawa State, Nigeria

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Abstract

This research work centered on the determination of Liberation Size of Agwada chalcopyrite Ore in Nasarawa State, Nigeria. This study reviewed the Comminution process for the release or liberation of the valuable minerals particles from the associated gangue. The ore was comminuted and sieved to liberation size. The mesh of grind was found to be 189µm and liberation size established to be 125µm, sieve size having the highest percentage of copper of 8.17% which was assessed by using x-ray fluorescence spectrometer (XRF).

1.0 Introduction

Most minerals are finely disseminated and intimately associated with gangue, as such, they must be intimately unlocked or liberated before separation can be undertaken. The liberation of the valuable minerals from the gangue is accomplished by comminution to release the valuable mineral from the associated gangue mineral at the coarsest possible particle size. If such an aim is achieved, this could not only save energy, but also reduce the amount of fines produced, hence subsequent separation stages becoming easier and cheaper to handle (Wills and Atkinson,1993).

Comminution in mineral processing plant or "mill" takes place as a sequence of crushing and grinding processes. Crushing precedes grinding, which can be carried out until the mineral and gangue are substantially produced as separate particles (Flavel, 1978). Crushing is the first mechanical stage in the process of comminution in which the main objective is the liberation of the valuable minerals from the gangue (Lewis et al, 1976). Crushing is accomplished by compression of the ore against rigidly constrained motion path as against abrasion and impact of the ore by the free motion of unconnected media such as rods, balls or pebbles in the case of grinding (Wills, 2006).

Grinding is the last stage in the process of comminution. In this stage, the particles are reduced in size by a combination of impact and abrasion, either dry or in suspension in water. It is performed in rotating cylindrical steel vessel which contains a charge of loose crushing bodies, the grinding medium which is free to move inside the mill, thus comminuting the ore particles (Wills, 2006).

Particle size analysis is of great important in establishing the degree of liberation of the values from the gangue at various particle sizes. Therefore, size analysis must be accurate and reliable, as important changes in plant operation may be made on its outcome. Size analysis is accomplished by passing a known weight of sample materials through fine sieves usually by agitation and material retained are weighed. The effectiveness of a sieving test depends on the amount of materials put on the sieve (the "charge") and the type of movement imparted on to the sieve. A comprehensive account of sampling techniques for sieving is given in BS 1017 (Levin, 1989).

2.0 Methodology

The following techniques were adopted in order to determine the liberation size of Agwada chalcopyrite ore:

2.1 Sample Collection

The samples were obtained from the main bulk in Agwada, Nasarawa State from seven different locations spaced at 15m interval and depth of 3.5m.

2.2 Sample Preparation

The samples collected in lumps size were broken manually with sledge hammer to provide a required size acceptable to laboratory jaw crusher. The samples were crushed and pulverized, then coned and quartered to yield a representative sample

2.3 Sieve Analysis

100g of the prepared sample was subjected to sieve analysis. The selected and arranged of the sieves were with respect to root of two ($\sqrt{2}$). Five sieves were arranged in a stack with the coarsest one on the top and the finest at the bottom. A tight-fitting pan was placed below the bottom sieve to receive the final undersize and a lid was placed on top of the coarsest sieve to prevent escape of the sample. The arranged sieves were placed in a sieve shaker which vibrates the materials vertically. The duration of the screening was set at 30minutes.

After a successful operation, each size fraction retained on each sieve was collected, weighed and recorded.

2.4 Chemical Analysis

XRF spectrometry was used to determine the elemental composition of inorganic based materials. It is typically used for bulk chemical analysis on solids and powders. The pellet loaded in the sample chamber of the spectrometer and voltage (30kV maximum) and a current (1mA maximum) applied to produce the x-rays to excite the sample for a present time (10 minutes in this case). The system controlled by a PC, running the dedicated mini analytical software (Anon, 2015).

3.0 Results and Discussions

Results of various laboratory experiments and analysis carried out are presented and discussed below.

3.1 Sieve size

It was observed from the sieve test results presented in table 1 that 13.63g of the total weight was retained on the 250μm sieve size, 10.09g on 180μm, 17.63g on 125μm, 15.84g on 90μm and 17.32g on 63μm. From the table, the mesh of grind was calculated by correlating the cumulative weight passing value of 76.28% of 180μm to establish equivalent value at 80% leading to189μm.

Table 1: Result of Sieve Analysis

Sieve size Range (µm)	Weight retained (g)	% weight retained	Nominal aperture	Cumulative % Weight retained	Cumulative % Weight passing
+250	13.63	13.63	250	13.63	86.37
-250+180	10.09	10.09	180	23.72	76.28
-180+125	17.63	17.63	125	41.35	58.65
-125+90	15.84	15.84	90	57.19	42.81
-90+63	17.32	17.32	63	74.51	25.49
-63	25.49	25.49	-	100	0.00
Total	100.0	100.0			

If 180 µm $\longrightarrow$ 76.28
X µm $\longrightarrow$ 80%

$$X = \frac{180 \times 80}{76.28} = 188.8\mu m \text{ at } 80\%$$

3.2 Chemical analysis

The chemical analysis of the sample was conducted on all the five sieve sizes (Table 2). The result in its elemental form indicated that 250μm contain 4.16%Cu,180μm contains 1.02% Cu, 125μm contains 8.17%Cu, 90μm contains 6.48% Cu while 63μm contain 3.03% Cu. The result has confirmed 125μm having the highest deportment of copper in its elemental form.

4.0 Conclusion

Therefore, from the foregoing, the research work established the mesh of grind to be 189μm for Agwada chalcopyrite ore and liberation size to be 125μm sieve size having the highest recovery of mineral of interest copper (Table 2) of 8.17%. It is hoped that with the above figure, further research work can be done to estimates reserve and develop beneficiation routes.

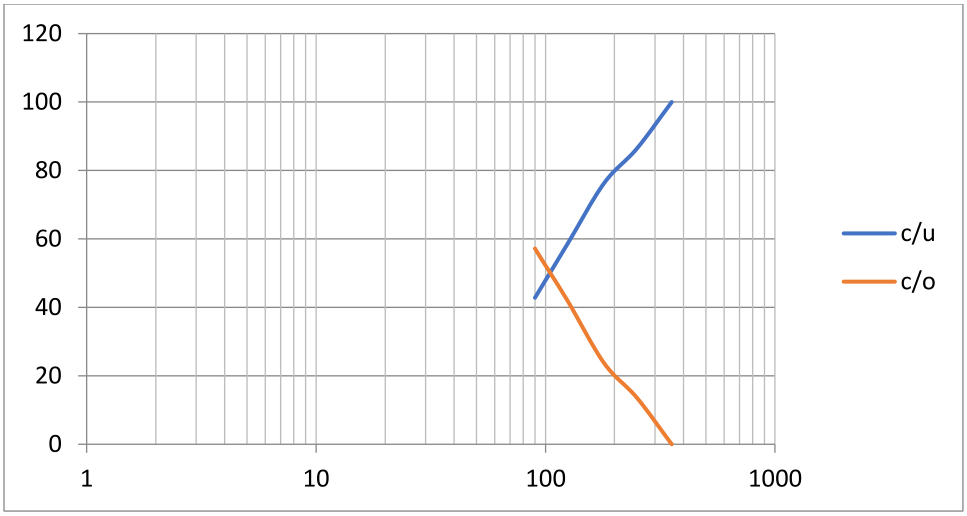

Figure 3: PSD Curve For Agwada Chalcophyrite Ore

Table 2: Result of the Chemical Analysis of Head Sample in Element form

Aperture size (μm)	K	Al	Si	Ca	Fe	Mn	Zn	S	Cu
250	4.48	2.91	9.02	9.17	29.69	1.95	6.56	5.56	4.16
180	2.27	0.59	3.36	1.26	21.29	0.19	1.13	0.22	1.02
125	4.49	4.96	10.83	14.51	26.89	0.21	0.97	2.56	8.17
90	6.03	3.97	7.90	6.22	19.04	0.51	0.23	1.26	6.48
63	4.50	2.17	15.54	8.29	23.46	0.15	1.13	1.95	3.03

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