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EFFECTIVE SEPARATION OF GALENA CONCENTRATE FROM THE MIXTURE OF GALENA AND QUARTZ BY TABLING

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ABSTRACT

Separation of a clean galena (lead sulphide) concentrate from the mixture of galena and quartz by tabling operation has been investigated. The Nigerian Lead ore composed mainly lead sulphide and quartz. Tabling method was employed on the ore as a method of gravity concentration. The mineral constituents of the ore were successfully separated based on the relative specific gravities of the constituent minerals. The results of the work are useful to mineral processing industries for the separation of Nigerian lead ore and will also serve as database for similar industrial processing plant and similar ore deposits.

Keywords: Galena, Quartz, Separation, Concentration, Tabling.

INTRODUCTION

Nigeria is endowed with large varieties of mineral resour , which include lead ore deposit. Processing and utilization of these resources would serve a dual-purpose source of local raw material and foreign exchange earnings. Therefore there is need to explore every opportunity to effectively exploit these resources and consequently promote industrial development. Tabling operation is a gravity concentration method of mineral processing of ore to yield marketable products and waste without damage to the physical and chemical properties of the ore, (Kenyen, 1992). The practice of ore dressing constitutes the backbone of the total effort involved in the recovery of metal from ores because most ore as mined contain more than one species of mineral, (Wills, 1989). Gravity concentration utilizes the differential movement of minerals due to mass hydraulic currents. It is essentially good for effective separation of minerals when marked density difference exists between the mineral values and gangue (Gaudin, 1971).

The first step to be involved in the dressing of mineral products is concentrating procedure, which entail hand sorting and washing. It was discovered quite early in the development of the art that valuable particles generally occur in relatively intimate aggregation with worthless material and that improvement in the operations could be obtained by first crushing the ore and then separating the dissimilar grains. The introduction of Wilfley table significantly advances the field of flowing film concentration. The introduction of riffles in Wilfley table increased the capacity and allowed treatment of coarse feed and fines as well as heavy and light minerals by effective and rugged head motion. This marks the anxillary principle utilized in shaking table, (Gaudin, 1971).

The motion of a particle in a fluid is dependent not only on its specific gravity but also on its size. Large particles will be affected more than smaller ones. The efficiency of gravity processes therefore increases with particle size to enhance movement in accordance with Newton's Law. Particles, which are so small that their movement is dominated mainly by surface friction, respond relatively poorly to commercial high capacity gravity method. In practice, close size control of feeds to gravity processes is required in order to reduce the size effect and make the relative motion of the particles specific gravity dependent, (Adepoju and Olaleye, 2001).

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Tabling theory involves the horizontal oscillation of the shaking table and concentration of the high-density particles due to martial differences created by reciprocating motion of the inclined deck of the table. Adjustment of operational variables (speed, dilution, tilt angle and stroke) of the concentrating table is made relative to the nature of the feed (coarse or fine).

Thin strips metal on the deck, parallel to the motion act as riffles. The feed slurry (about 25% solids) spreads on the deck of the table due to the reciprocating motion and the transverse flow of the water. As the slurry flows on the deck, the higher particles are washed over the riffles whereas the heavier particles travel along the riffles activated by the reciprocating motion and discharged over the end of the inclined deck. The light particles of the tailings are entrained by the weak flow of wash water over the lower edge of the deck. A middling product flows off between the concentrate and the tailings. Oluwole (1999) worked on the separation of galena concentrate from the mixture of galena and quartz by jigging operation and found out that the separation were only effective within the size ranges of 2000μm to 600μm since a high weight percentage of galena is still predominant in the – 600μm of the mixture, hence the investigation of this work on the mixture to examine whether tabling operation can effectively enhance further separation.

MATERIALS AND METHOD

The galena sample used in the investigation was obtained from Ishiagwu lead Ore deposit in Nigeria while the quartz was obtained from quartz

Table 1: Pulverizer product of sieve analysis of galena

Sieve Size(μm)	Normal Aperture (μm)	Wt Retained (g)	Wt.% Retained	Cum. % wt. retained	Cum.% passing
2000	2000	195	14.33	14.33	85.67
-2000 + 1700	1700	38	2.79	17.12	82.88
-1700 + 1180	1185	72	5.29	22.41	77.59
-1180 + 850	850	42	3.08	25.50	74.50
- 850 + 600	600	36	2.64	28.15	71.85
- 600 + 212	212	133	9.77	37.92	62.08
- 212 + 75	75	205	15.06	52.98	47.02
- 95 + 53	53	295	21.67	74.66	25.34
- 53	-53	345	25.34	100.00	0

Table 2: Pulverizer product of sieve analysis of quartz

Sieve size(μm)	Normal Aperture (μm)	Wt. Retained (g)	Wt.% Retained	Cum Wt. %retained	Cum. % passing
2000	2000	291	22.77	22.77	77.23
-2000 + 1700	1700	17	1.33	24.10	75.90
-1700 +1180	1180	42	3.29	27.39	72.61
-1180 + 850	850	35	2.78	30.17	69.83
- 850 + 600	600	54	4.23	34.40	65.60
- 600 + 212	212	322	25.20	59.60	40.40
-212 + 75	75	161	12.60	72.20	27.80
- 75 + 53	53	84	6.57	78.77	21.23
- 53	- 53	272	21.28	100.00	0

Table 3: Results of Tabling Operation.

Sieve size (μm)	Feed (g)	Conc. Retained (g)	Conc. % retained	Tailing retained (g)	Tailing % retained	Middling retained (g)
2000	100	45.07	90.14	32.70	65.40	21.23
1700	34	14.20	83.53	13.40	78.82	5.8
1180	84	38.20	90.95	36.40	86.66	7.2
850	70	30.40	86.86	28.20	80.58	10.4
600	72	14.68	40.78	16.42	45.62	40.0
212	100	24.80	49.62	30.20	60.40	42.0
75	100	20.20	40.40	30.80	61.60	47.0
53	100	18.57	37.14	42.50	85.00	38.2
-53	100	7.98	15.96	20.80	41.60	71.0

leposit in Ondo State. The feed preparation involved three major minerals processing operations; crushing, pulverizing and sieve analysis.

Representative samples of lump of galena and quartz were crushed with laboratory jaw crusher for size reduction and pulverized with laboratory pulverizer separately and weighed. 1400grams of galena and 1300 grams of quartz were sieved separately. The sieving procedure involved the arrangement of the sieve on a stack or next with the coarsest sieve (2000μm) on top and the finest (53μm) at the bottom. A tight fitting pan or receiver was placed on top of the coarsest sieve to prevent escape of samples during separation. The galena and quartz samples were placed successively in the uppermost, coarsest sieve and the nest was then placed on sieve shaker, which liberated the material in gyratory vertical motion. An automatic timer incorporated with the shaker controls the duration of sieving. During the shaking, the undersized material fell through successive sieve until it was retained on a sieve having apertures slightly smaller than the diameter of particles. In this way, the samples were separated into fractions. After the required time set, 20 minutes, the nest was taken apart and the amount of material retained on each sieve was weighed, recorded and stored in a sample tray. Inverting the sieve and tapping the frame gently removed most of the near mesh particles, which blocked the openings. Failing this, the entrapped of the gauze were brushed gently with a soft brass wire brush. The product of galena and quartz of the same size range were mixed together in ratio 1:1 by weight and the samples were fed into the feed box of the concentrating table for separation.

The concentrating table used is Wilfley table, which is a simple mechanical means of separating two or more materials of different specific gravities. It comprises a table or deck made of wood with a covering of linoleum on to which is nailed a series of wooden slats or riffles. At one end of the deck is the vibrator or head motion, which impacts a reciprocating movement to the table in a horizontal plane. The eccentric who produces the motion is designed so that it causes the material on the deck to move progressively forward. The same movement impacts a jigging action, which stratifies the material being treated according to its specific gravity.

The material was fed into the table feed box in the form of a pulp. The consistency of the pulp was four parts of water to one part of solid. The feed pulp was acted upon by three forces on the table: the current of water which carries the pulp over the riffles towards the bottom or tailings discharge and of the table, the gravity which causes the heavier particles to sink to the bottom of the riffles and the reciprocating movement which causes the heavier particles to move towards the concentrates discharge end. The feed were the separated into concentrate, middling and tailings.

These products were dried, weighed and recorded. In the analysis, galena and quartz are referred to as concentrate and tailing respectively.

RESULTS AND DISCUSSION

Tables 1 and 2 show the results of pulverize products of sieve analysis of galena and quartz respectively while table 3 is the result of the tabling operation of the mixture of galena and quartz samples. Figures 1, 2 and 3 are the graphs of mean sieve size against respective parameters. Figure 4 is the representation of the riffle table showing how it distributes particles by density. From figures 1 and 2, it would be observed that the size distribution of the weight retained and other parameters followed the same trend, that is, there is a good correlation between the two tables. Also, this is an indication that size analysis of the product can be used to determine the optimum size of the feed to the process for maximum efficiency and to determine the size range at which much fire occur in the plant so that it can be minimized. The result of the sieve analysis in table 1 shows that much of the galena is present in the –53 μm fraction and this constitutes 25.34% of the total bulk of the material. This also applies to table 2. From table 3 where the result of tabling operation is shown, the rate of recovery of galena concentrate from the mixture of galena and quartz was more efficient in the sieve size range of 2000 μm than in the sieve range – 5 μm . That is, efficiency of concentrate recovery by tabling operation

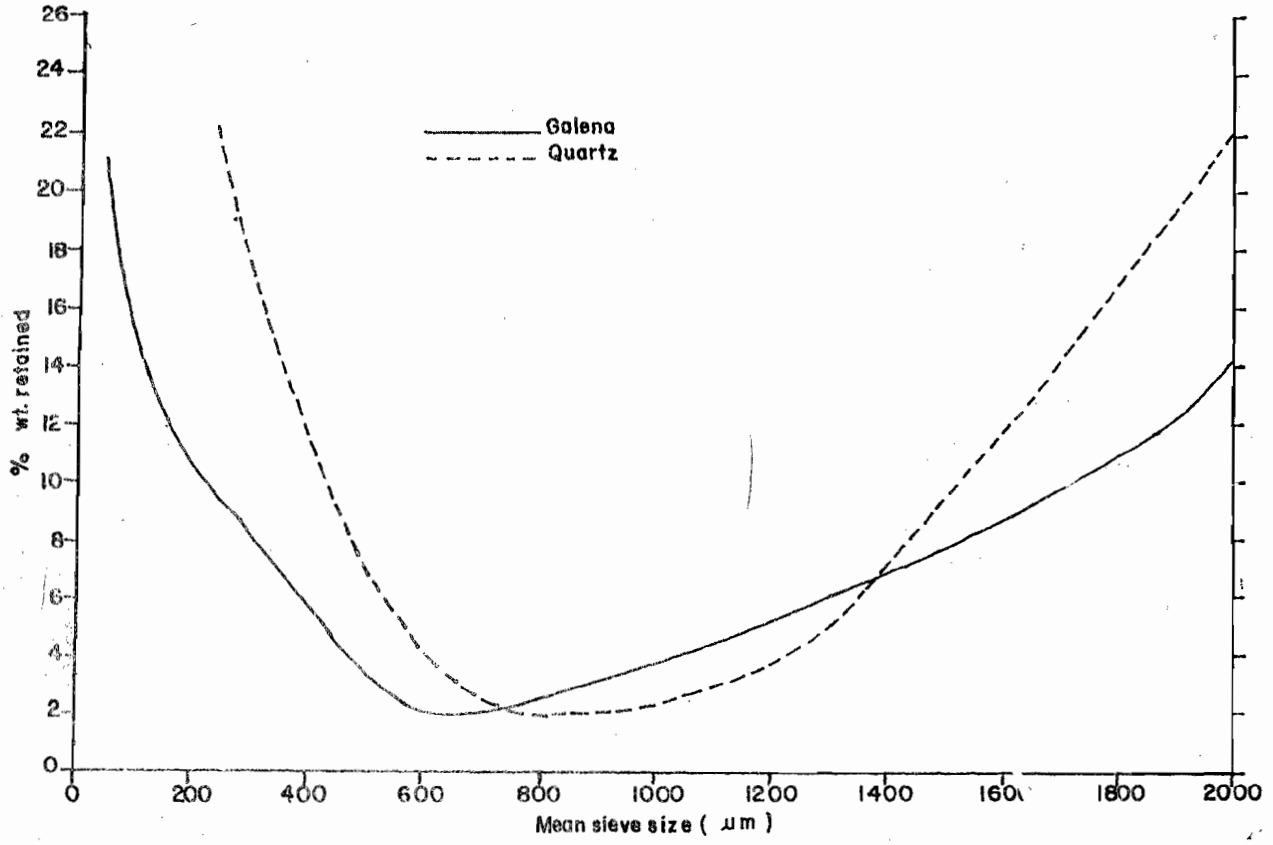

Fig. 1: Direct charting of size analysis of galena and quartz.

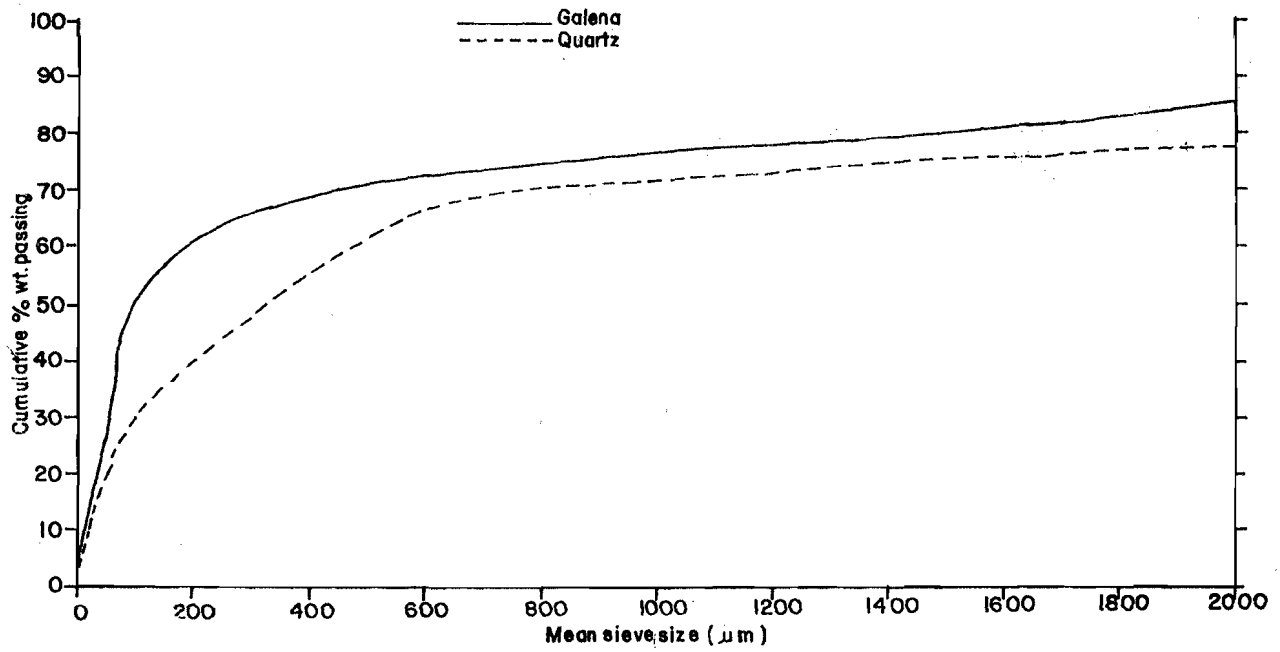

Fig.2: Cumulative charting of size analysis of galena and quartz.

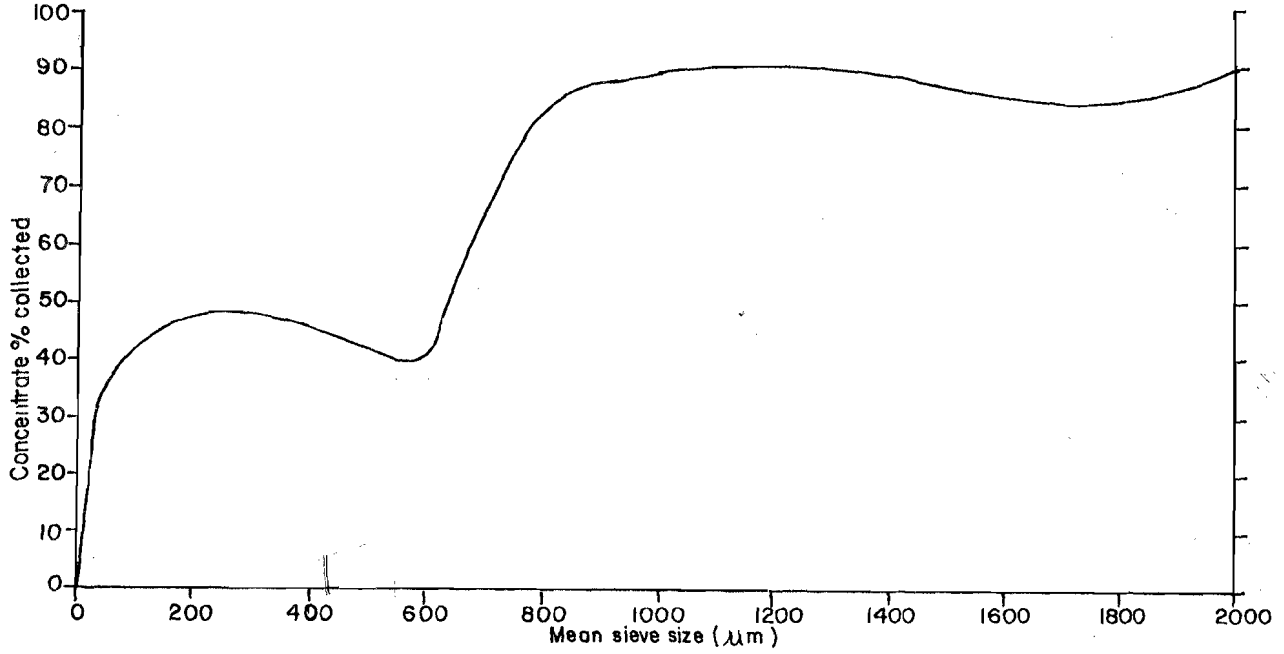

Fig.3: Plot of concentrate recovered from the mixture of galena and quartz in the tabling operation.

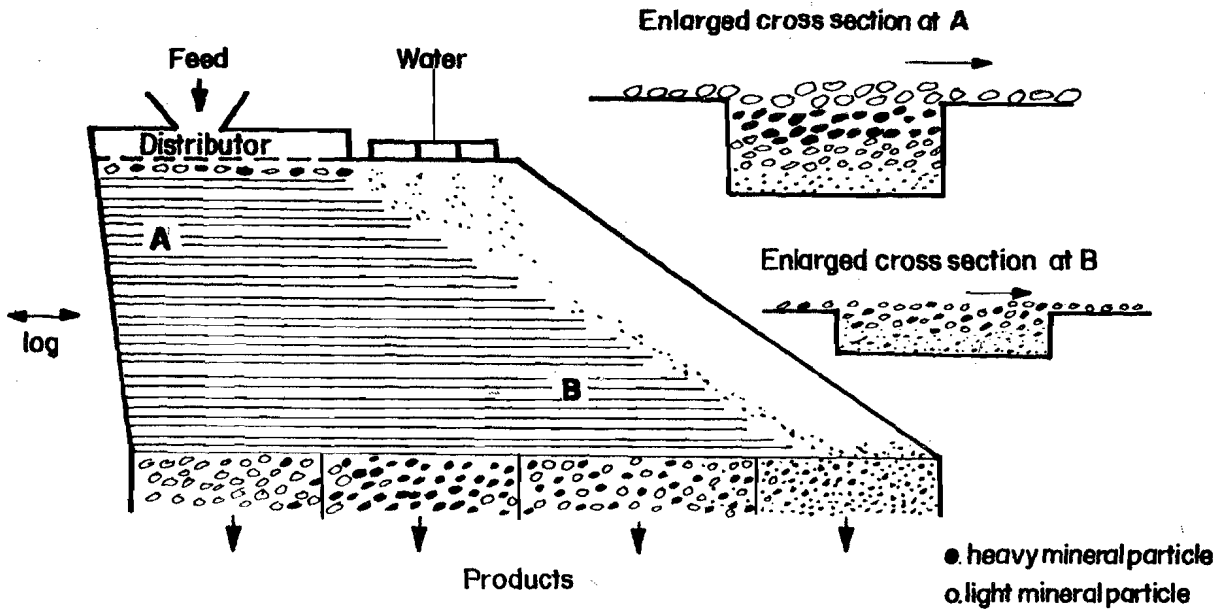

Fig.4 Representation of a rifle table showing how it distributes particles by size and density.

decreases with particles size. This indicates that the efficiency of the Wilfley table on coarse and fine particles differs. However, it can be deduced that most of the fine concentrate particles happened to wash away to the middling compartment during the process of separation. This indicates that during separation, there may be difficulty in processing very fine particle size material. This is evident from the concentrate recovery of the size ranges + 53 μm and –53 μm which are 37.14% and 15.90% respectively.

CONCLUSION

The result of this analysis has clearly indicated that the separation of galena from the mixture of galena and quartz by tabling operation is practicable. The total recovery of galena from the mixture of galena and quartz has clearly shown the effectiveness of the gravity concentration method within coarse size range using tabling operations. Since the tabling operation could not effectively separate very fine particle concentrate, communition of material for tabling operation should be at the least sieve size range of 53μm for maximum efficiency during concentration. This method of separation will be adequate for the type of galena Ore deposit in Nigeria because of its association with quartz mineral. The results of the investigation would be useful as a database to any Galena Ore processing company.

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