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FLOTATION RECOVERY OF BARITE FROM ORE USING PALM BUNCH BASED COLLECTOR

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ABSTRACT

Froth flotation of Azara barite ore was carried out using a mixture of available raw materials, the burnt empty palm (*Eleasis guineesis*) bunch solution, and analytical grade palmitic acid as collector, sodium silicate as depressant. Optimum recovery was obtained at collector concentration of 0.01 moles litre^{-1}. Energy Dispersive X-ray spectrophotometric analysis of the feed ore and concentrate showed an increase from 75.4 % to 91.1 % $BaSO_4$, respectively. The variation of flotation parameters show that between pH range of 4 and 10 and equilibration time of 10 minutes, barite recovery increased. Analysis of the processed palm bunch showed that its major chemical component is K_2O (52.1%) which generates KOH on hydrolysis. The investigation reveals that palmitic acid and palm bunch product is a good collector for barite.

Key words: Barite, *Eleasis guineesis*, Flotation, Palm bunch, Palmitic acid, Recovery

INTRODUCTION

Barite is a non-metallic ore that occurs in lead zinc vein fissure in limestone deposits[1]. A vein – fissure or cavity is a space in a rock crystal which has not been filled with crystalline materials before growth ceased[2]. Nigerian barite reserve has been estimated at 41,000 tons within the Benue trough alone (N.G.S., 1959). However, recent discoveries in Gombe, Plateau, Cross River and Nasarawa States have put the reserve ore at 500,000 tonnes. The present study is on Azara barite found in Nasarawa State within the upper Benue trough. The Azara barite ore, brownish white in color has a specific gravity of 4.04, which is slightly below the minimum value of 4.20 needed for petroleum drilling[3,4].

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With the increasing demand for barite in the petroleum industry in Nigeria[5], it become obvious of the need to develop economic routes for the beneficiation and recovery of this all important ore. Onyemaobi and Nwoke[6] carried out similar research on the beneficiation of Azare (Bauchi State) ore using sodium oleate as the collector. Onyedika and Njoku[7] floated galena-sphalerite ore using xanthate collector from locally sourced caustic potash, while Lynch[8] found that small addition of barium chloride can activate the floatation of barium chloride. Martinez et al.[9] successfully floated barite from calcareous ore using sulphosuccinamate as collector in combination with relatively high concentration of sodium silicate. Barite floatation like any other is carried out in an alkaline medium as most collectors including the xanthates are stable under these conditions and corrosion of cell component is minimized.

Palmitic acid is one of the most common saturated fatty acids found in animals and plants. As its name indicates, it is a major component of the oil from palm trees (palm oil and palm kernel oil). Palmitic acid is the first fatty acid produced during lipogenesis (fatty acid synthesis) and from which, longer fatty acids can be produced. The structural formula is $C_{16}H_{32}O_2$.

In this work, the objective is to float Azara barite from Nasarawa State Nigeria, using oxyhydryl collector prepared from locally available burnt empty palm bunch (BEPB) solution and palmitic acid. This is to reduce the cost of using imported chemicals such as caustic soda and oleic acid. Prior to this work, no research has been reported on the preparation of oxyhydryl collectors using palm bunches.

EXPERIMENTAL

Materials and methods

The barite ore was collected from Azara in Nasarawa State in North Central Nigeria, and brought to National Metallurgical Development Center, Jos, where the experiments were carried out. The empty palm bunch was collected from Adapalm (Nig) Ltd., Ohaji in Imo State. The palmitic acid, sodium silicate, potasium hydroxide and sulphuric acid, are all analytical grade reagents (May and Baker) and were used as provided. Other materials used are octagon digital screening machine, set of sieves, roll crusher, ball milling machine, pH meter (WTN Ph 422), Denver laboratory flotation cell, DDS 307 conductivity meter, JA digital balance MS 050, laboratory oven (Gallenkamp) and Energy Dispersive X-ray fluorescence spectrophotometer (ED – XRFS) model mini pal 2005.

The empty palm bunch stalks were dried and burnt in the open. 200 g of the ash were sampled by method of quartering, dissolved in 2 liters of distilled water and repeatedly filtered in white "China cloth" until a clear solution was obtained. The solution was reduced to 50% its volume by evaporation and cooling. Its concentration was determined titrimetrically using standard 0.1 moles/litre of sulphuric acid. The titrimetric method used here was based on the fact that the solution was naturally alkaline.

The density of the palmitic acid was determined at $62^{o}C$ to be $0.853\ gcm^{-3}$ using 50 mL picnometer. The various volumes of BEPB solution needed to react completely with palmitic acid to form the collector were calculated based on the relation.

$$M_1V_1 = M_2V_2 \qquad \ldots(1)$$

Where M_1 = Molar concentration of the stock (BEPB solution), V_1 = Volume of stock solution (BEPB) required to prepare the potassium palmitate soap and M_2 = concentration of BEPB solution required to react with palmitic to produce the desired concentration.

The size analysis of the 100 g pulverized representative Azara barite ore was done using a nest of eleven sieves on a mechanical screen vibrator for 15 minutes[10]. The weight of ore (in grams) retained on each screen was determined and recorded. Flotation was carried out by varying the pulp pH at constant collector concentration (0.010 moles/litre) and varying the collector concentrations at constant pH. The analytical potassium hydroxide and sulphuric acid was used to achieve the pH adjustments. All the tests were carried out at a pulp density of $1.14\ g/cm^3$ at room temperature of $30^{o}C$ in Denver flotation cell of capacity of 1.5 liters using impeller agitation speed of 1500 rpm. The optimum flotation time in each case was 10 minutes. Flotation was also carried out at varying agitation time. The resulting concentrates collected, filtered and kept in a laboratory electric oven at $105^{o}C$ to dry. The chemical analyses of samples were carried out using ED-XRFS to elucidate the amount of $BaSO_4$ contained in them. The percent barite recovered was then calculated using the relationship;

$$\%\ \text{Recovery} = (Cc \div Ff) \times 100 \qquad \ldots(2)$$

Where C = weight of concentrate in grams, c = assay of concentrate, F = weight of feed ore in grams and f = assay of feed ore.

RESULTS AND DISCUSSION

The result of the analysis of burnt empty palm bunch (BEPB) was done using energy dispersive x-ray fluorescence spectrophotometer. The results are shown in Table 1.

Table 1: Chemical analysis of empty palm burnt ash

Compound contained	SiO_2	Fe_2O_3	MgO	CaO	K_2O	Na_2O	P_2O_5	SO_3	Cl
% Weight	8.52	0.96	2.61	21.50	52.10	1.97	2.20	2.60	5.19

Compound contained	TiO_2	MnO	BrO	SrO	ZrO_2	RuO_2	NiO	CuO	ZnO
% Weight	0.11	0.19	0.86	0.10	0.02	0.59	0.10	0.15	0.15

Table 2 presents the chemical analysis of the barite ore as received. Fig. 1 is the plot of cumulative percentage passing and retained against particle size in micron for the sieve test. The result of froth flotation of barite using the potassium palmitate at varying concentrations, pH and agitation times were noted. Fig. 2 represents the plots of percentage recoveries at varying collector concentrations (A), pH (B) and agitation times (C).

Table 2: Chemical analysis of Azare barite

Compound contained	**(wt. %)**
$BaSO_4$	75.40
SiO_2	7.98
Fe_2O_3	6.48
SrO	1.39
TiO_2	1.10
MgO	0.20
CaO	0.14
CuO	0.09
ZrO_2	0.08
SO_4	0.07
Na_2O	0.05
Ga_2O_3	0.02

Sieve analyses results in Fig. 1 show the average particle distribution of about 58.7% from –500 µm + 400 µm. This means that blinding of the surface screen was minimized.

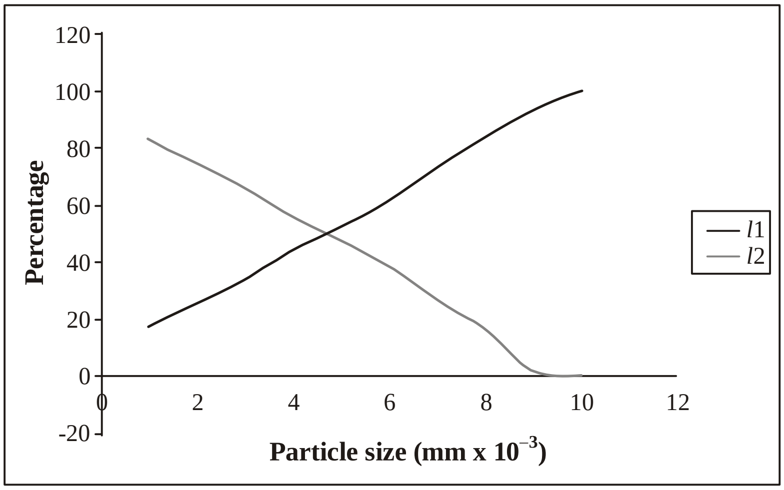

Fig. 1: Plot of percent passing and retained against particle sizes

Chemical analysis of the burnt empty palm bunch (BEPB) as in Table 1 shows a high percentage 52% of K_2O which is the main source of potassium hydroxide needed to form the palmitate collector with palmitic acid. The possible equation of reaction for the formation of palmitate collector is:

$$C_{16}H_{32}O_2 + KOH \longrightarrow C_{16}H_{31}OO^{-}K^{+} + H_2O \qquad \ldots(3)$$

Chemical analyses of the ore as shown in Table 2 show that $BaSO_4$ is 75.4%, SiO_2 accounted for 7.98%. The percentage $BaSO_4$ was improved by froth flotation as shown in Fig. 2.

Optimum barite recovery was recorded at 0.010 moles/liter of the collector. The plot of barite recovery against pH shows that as the pH increases from 4 to 10, recovery also increased to 86% after which recovery decreased. This shows that pH 10 is the pH of maximum recovery, at this point the net adsorbed ion charges become zero. Beyond this pH, recovery decreases due to the preponderance of OH^- as the net proton charge (H^+) is neutralized. More so, the surface of the barite particle for the adsorption of the collector could be said to be saturated with collector monolayer[11]. The plot percentage recovery against times of agitation shown in Fig. 2 (C), also indicates that recovery increases with time up to 10 minutes beyond which recovery decreases due to reverse process of desorption of the palmitate molecules from the surface of the barite particles.

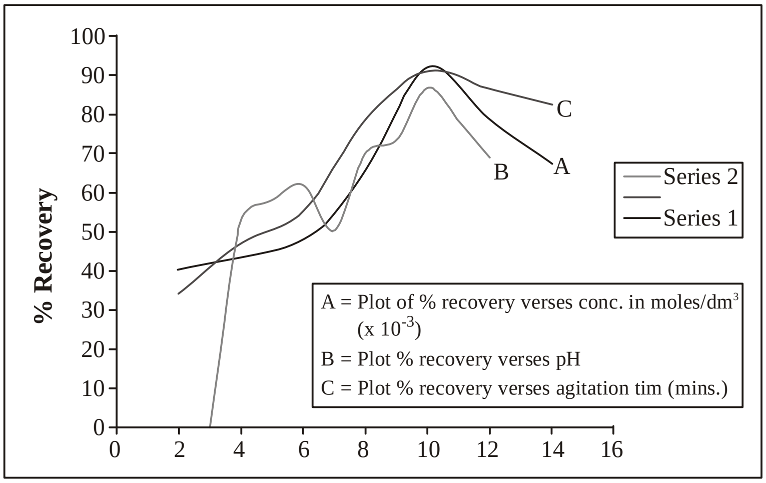

Fig. 2: Plot of percentage (%) recovery against concentration (A) (mol dm^{-3}), pH (B) and agitation time (C) (min)

CONCLUSION

This study has shown that Nigerian barite could be floated effectively using locally available raw materials such as the burnt empty palm bunch to prepare a palmitate collector. Palmitic acid is also a major component of palm oil. The results obtained agreed with previous research works on barite flotation using different commercial collectors which are not readily available in most countries. But the use of locally available palm bunch as raw materials to prepare the collector reagent in this work has made a difference as the grade of barite obtained shows an upgrade from 75.4 % to 91.9 % in the concentrate. The final barite recovery which represents about 18 % increase in assay meets the requirement for petroleum and other allied industries. We also advocate that other beneficiation methods e.g. jigging and magnetic separation should be carried prior to flotation to add excelling value to the mineral.

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