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Flotation of Copper ORE from SOSSEGO Mine Utilizing Palm Oil as Collector Auxiliary

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Abstract: One of currently used methods to improve the fine recovery during ore flotation is the use of diesel oil as hydrophobicity enhancer. However, this compound can be environmentally harmful. Several vegetal oils found in the Amazon area present the potential to be used in the mineral industry, yet are seldom focus of studies. Such supplies are renewable and present a low environmental impact. In that scenery, the present work aims to evaluate the palm oil as a collector auxiliary during the flotation of Copper ore from Sossego mine (Canaã dos Carajás, Pará). With that aim, physical, chemical and mineralogical characterizations of the copper ore were made, as well the refining and physical-chemical characterization of Palm oil. The batch flotation tests used 8 g/t of Xanthates as collector and 30 g/t of MIBC as frothing agent. The collector auxiliary (palm oil) concentrations used were: 60, 80, 100 and 120 g/t. In all concentrations the added nonpolar oil was emulsified. The results were compared as the ones found with diesel oil, which is currently used during the Copper ore processing from Sossego. For the tests using palm oil, the copper content in the concentrated was up to 17.9%, while with diesel oil, the maximal copper content was 15.5%. The average metallurgical recovery found during the tests was 95.74% with palm oil and 97.02% with diesel oil. These results show that palm oil presents a high performance as collector auxiliary during the copper ore flotation, being a relevant option to replace diesel oil total or partially.

Key words: flotation, palm oil, diesel oil, environmental

1. Introduction

Recovery of fine mineral particles (< 38 μm) is the main problem that affects sulphide Copper concentration plants. Processing plants are, generally, projected for medium size and high flotation kinetic particles recovery. Furthermore, ore commodity rising demand and high content deposits exhaustion brings the need to process fine scattered and low content ores. Thus, a finer milling is necessary to release the mineral of interest [1].

Many techniques have been researched to minimize fine particles flotation issue, including extensor flotation, that consists on utilizing nonpolar oils (emulsified or not) along standard collectors covering hydrophobic mineral surfaces rising the nonpolar character and improving particle-bubble attachment. However, the major importance of extensor flotation lies on fine and ultrafine particles recovery by homoaggregation process, in which occurs the particle size increase through interactions among thousands of colloidal dimension oil drops (1-5 μm) produced during emulsification process [2].

Presently this flotation technique is already applied in industrial scale, generally, utilizing diesel oil as collector auxiliary [3, 4]. Meanwhile, besides not come from a renewable energy source, diesel oil has in its composition: sulphur, aromatic hydrocarbons (BTEX) and polyaromatic hydrocarbons (PAH's), high pollutant elements that are harmful to human being health [5].

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Mineral activity, due to its essence, is the less acceptable activity within the new conceptual framework for sustainable development. Thus, it is necessary a reassessment of inputs and processes used by the mining industry. Accordingly, there is a considerable amount of vegetable oils whose properties indicate the possibility of use as reagents in ore flotation [6].

The present paper objective is show the main results of fine Copper ore recovery by extensor flotation technique utilizing palm oil (*Elaeis guineensis Jaquim*), justified due to its low environmental impact, renewable character, besides the source abundance on Amazon area.

2. Methodology

2.1 Ore

During this work it was used copper sulphide ore from Sossego mine (VALE), from Canaã dos Carajás, Pará. To prepare the ore its granulometry was reduced to reach a P_{80} of 150 µm, similar to the feed for the rougher stage in the processing plant. Figs. 1 and 2 show the granulometric distribution of the samples and the content of copper according to the particle size, respectively.

The main minerals found on the sample determined by the X-ray diffraction are shown on the diffractogram from Fig. 3.

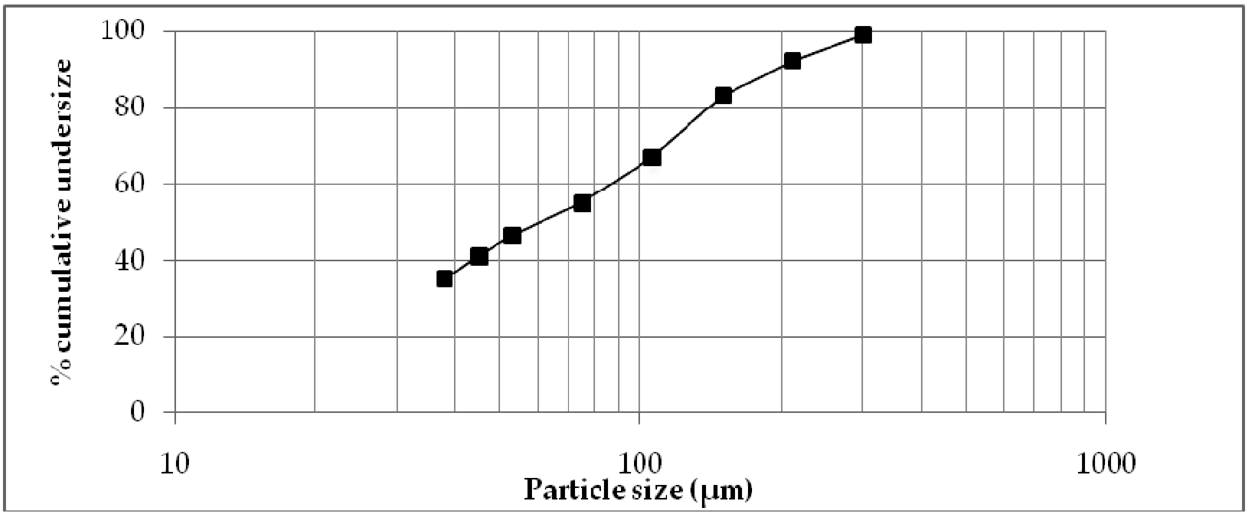

Fig. 1 Granulometric distribution of the ore.

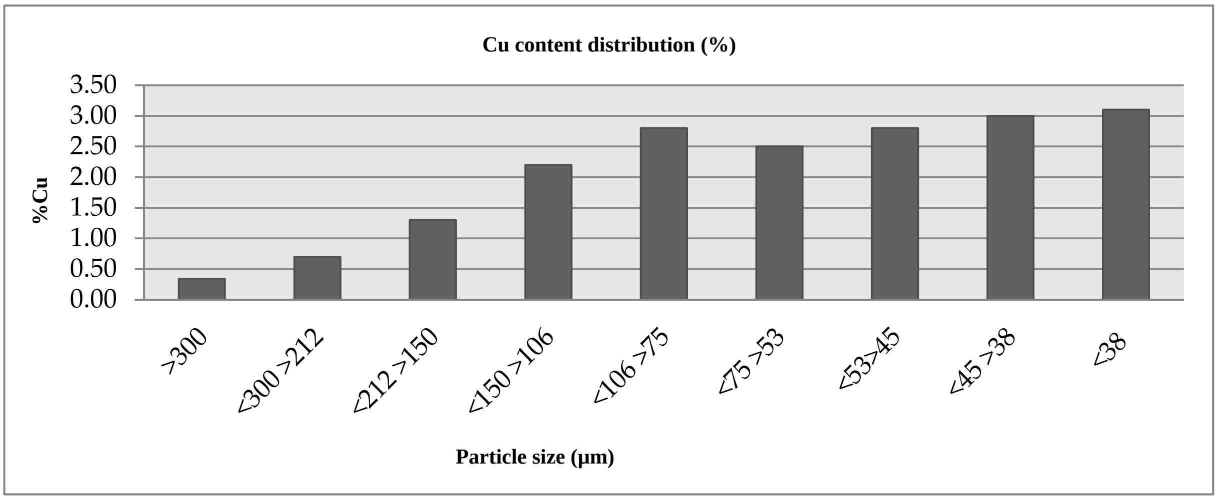

Fig. 2 Granulochemical distribution of Cu.

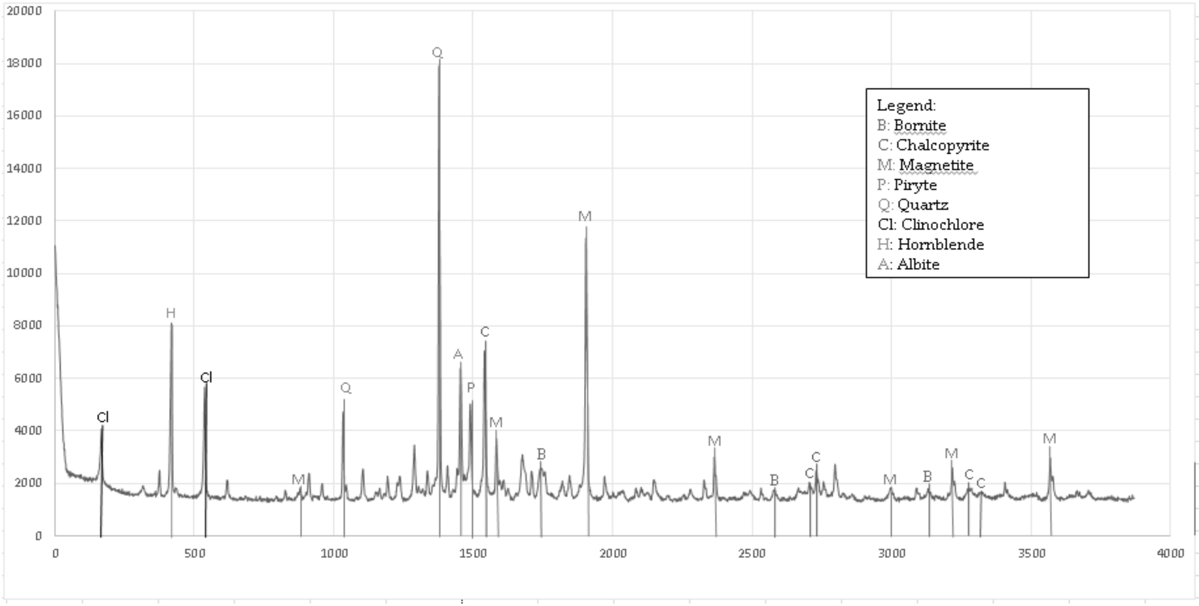

Fig. 3 X-ray diffractogram of the sample.

2.2 Palm Oil

The palm oil used during this work was obtained commercially and its acidity and saponification were determined according to American Oil Chemists' Society (AOCS). All analyses were made in the laboratories from the company Indústrias Químicas Ltda. (HIDROVEG), from Rio de Janeiro.

Due to its high acidity presented by the palm oil it was needed to decrease it. The present free fatty acids could lead to fatty acid salts (anionic collectors) once in an alkaline environment. It would bring a dual behaviour to the oil, acting as collector auxiliary and as collector.

Table 1 shows the palm oil before and after the acidity reduction.

2.3 Flotation Tests

Tests were performed in a flotation machine (Denver D-12), laboratory scale, and a cell with 1.5 L capacity. Pulp, 38% solid in weight, pH 10.5, regulated with lime, was conditioned to 800 rpm for 3 minutes using the following reagents: Potassium amyl xanthate (PAX) (8 $g.t^{-1}$) and Aero 7294 A (5 $g.t^{-1}$) as collectors, emulsified nonpolar oils (different dosages) as collector auxiliary and 30 $g.t^{-1}$ of methyl isobutyl carbinol (MIBC) as frothers (added in this order). After conditioning, cell rotation was increased to 1200 rpm, air was injected and then the ore was floated over 7 minutes. Table 2 presents flotation tests performed and utilized reagents dosages.

Table 1 Acidity and saponification of the palm oil.

Palm oil	Before	After	Methods
Acid value (mg KOH/g)	9.33	2.60	A.O.C.S TE IA-54
Saponification value (mg KOH/g)	195.37	193.97	A.O.C.S TG IA-64

Table 2 Standard flotation (STD) and extension flotation tests using emulsified palm oil (PO) and diesel oil (DO) on different dosages.

Number	Test	Reagent (g/t)				
		PAX	Aero 7294A	MIBC	Palm oil	Diesel oil
1	STD	8	5	30	-	-
2	POP	-	-	30	80	-
3	PO-60	8	-	30	60	-
4	PO-80	8	-	30	80	-
5	PO-100	8	-	30	100	-
6	PO-120	8	-	30	120	-
7	DOP	-	-	30	-	80
8	DO-60	8	-	30	-	60
9	DO-80	8	-	30	-	80
10	DO-100	8	-	30	-	100
11	DO-120	8	-	30	-	120

Collector auxiliaries (PO and DO) were emulsified in oil/water solution at 6000mg·L^{-1} by mechanical shaking for 10 minutes to ensure uniformity to emulsion.

By the end of tests the obtained products (concentrate and tailing) were filtered and dried in stove at a maximum temperature of 100°C for approximately 12 hours. After drying, they were sent to the laboratory of chemical analysis to Copper content determination.

3. Results and discussion

At Fig. 4 it's noticed a Cu content increase to PO dosages over 60 g.t^{-1}, and at the 120 g.t^{-1} dosage was reached the best results, with 17.9% Cu at floated. For the tests in which were added DO, gains are also noted in Cu content (14.8% in 120 g.t^{-1}) compared to STD tests (13.4%). However, all tests utilizing DO as collector auxiliary presented lower Cu contents when compared to PO tests

Fig. 5 shows Copper metallurgical recovery to tests with PO and DO addition. Generally, tests using emulsified PO and DO presented a increase on Cu recovery, but almost inexpressive relating to STD.

At tests in a dosage of 60 g.t^{-1} to PO and DO o ensaio com dosagem de para OD e OP were obtained more satisfactory metallurgical recovery values, 97.9% e 96,88%, respectively, against to 96.59% from STD.

Fig. 6 shows that emulsified palm oil addition at rougher stage provided, statistically, the same metallurgical gains compared to STD tests, but presented gains until 4.5% at metal of interest content.

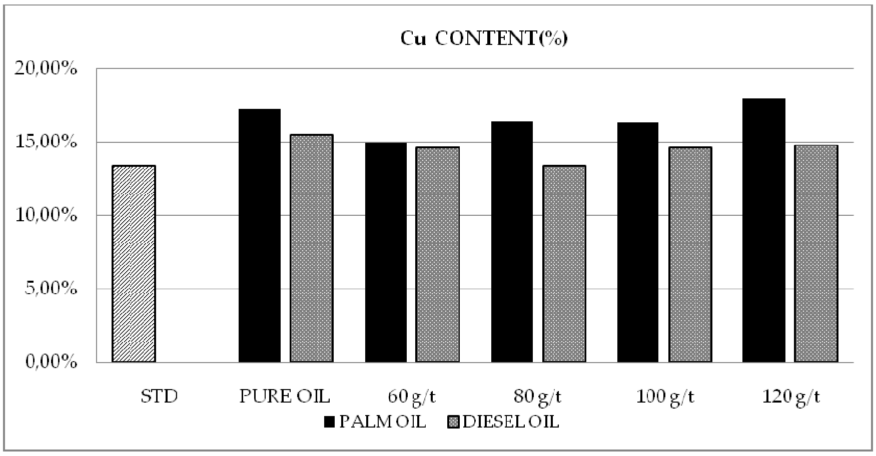

Fig. 4 Cu content in the floated.

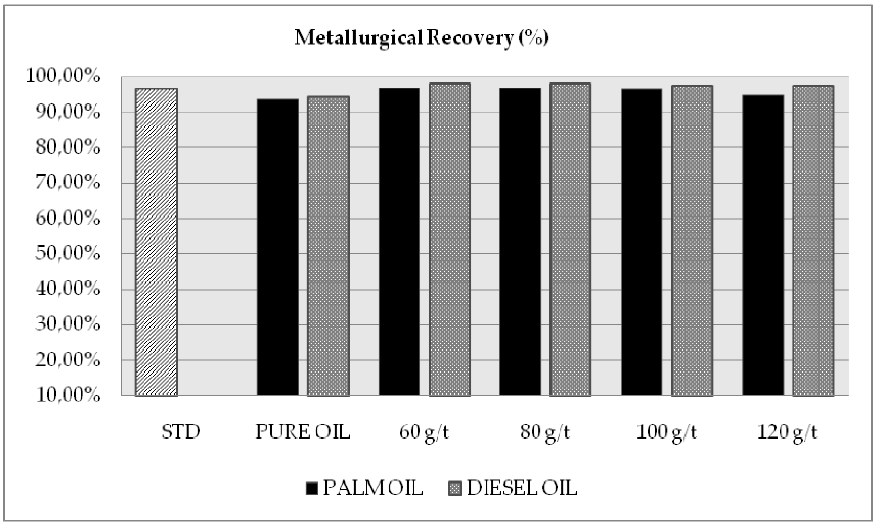

Fig. 5 Cu metallurgical recovery on the extention and standart flotation tests.

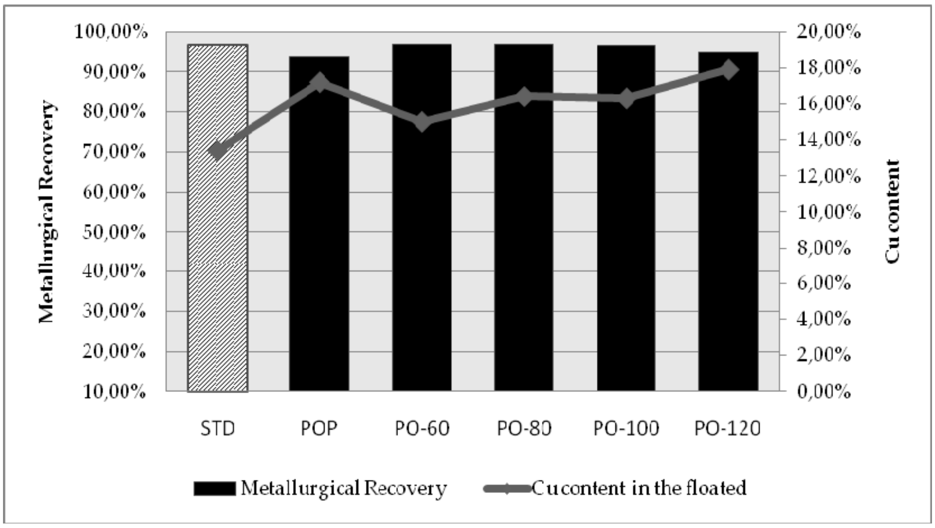

Fig. 6 Metallurgical recovery and copper content in the floated at tests utilizing PO.

Metallurgical recovery and Copper content in the concentrate results were near to the values obtained at Sossego's plant in the rougher stage of flotation, that are average 13 to 17% concentration content and 94 to 96% to metallurgical recovery (Nankran et al., 2007).

4. Conclusion

Results found during this work show that the flotation of copper sulphate with the addition of palm oil presents the same metallurgical recovery, but with a higher Cu content in the floated if compared with the studies that utilized diesel emulsified diesel oil to the standard tests.

Considering the similarity of the results between the two nonpolar oils, it can be seen that the OP (as well other Amazonian oils) shows a potential as collector auxiliary. However, deeper studies are needed to a possible total or partial substitution of the DO.

The use of PO, as a substitute for the DO during copper sulphate flotation leads to a higher hydrophobicity of the mineral particles and aggregation of the fine particles, as well a better attachment bubble/particle.

Acknowledgements

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Nomenclature

STD Standard flotation test
PO Palm oil
DO Diesel oil

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