

# Influence of Frothers on the Flotation of Black Mountain Ore

Edison Muzenda, Adeshina G. Ikotun, Freeman Ntuli

**Abstract**— Froth flotation is the most widely used industrial process for the separation of finely divided minerals from gangue. However, its effectiveness depends on the type of frothers used. The aim of this study was to evaluate the effectiveness of 2 Senfroth frothers, XP200 and XP 516 on the flotation of black mountain ore to recover copper with sodium mercaptobenzothiazole (NMBT) as a collector. A Denver flotation cell was used in this work. Two dosages (0.5ml and 1ml) of frothers were used. The mountain ore mineralogy analysis showed that the ore contained 0.341% copper feed grade. With 0.5ml of Senfroth XP 200, 1.278% of copper was recovered and 0.055% of copper reported to the tailings. In the case of Senfroth 516, 0.63% of copper was recovered while 0.21% of copper was found in the tailings at 0.5ml dosage. When 1ml dosage was used, Senfroth XP200 recovered 1.759% copper and 0.036% was found in the tailing, while Senfroth 516 recovered 0.932% copper leaving 0.154% in the tailings. Senfroth XP 200 was found to be more effective than Senfroth 516 in the recovery of copper from black mountain ore.

**Keywords**— Black Mountain Ore, Copper Metal, Frothers, Flotation, Recovery.

## I. INTRODUCTION

**F**ROTH flotation is the most widely used industrial process for the separation of finely divided minerals. The flotation process involves chemical treatment on the surface of a finely divided ore in a water pulp to create conditions favorable on the surface for the attachment of mineral particles to air bubbles [1]. The air bubbles then carry the selected minerals to the surface of the pulp to form a stabilized froth, which is removed and recovered. The unattached materials remain submerged in the pulp and are either discarded or reprocessed. Fig. 1 shows the schematic diagram of flotation process. The modification of interfacial properties is necessary in flotation to form a stable bubble/grain aggregate and this modification depends on the collectors and frothers used [1,2]. Collectors are added to impart hydrophobicity to minerals to float them [1]. Sodium mercaptobenzothiazole (NMBT) is a very versatile collector and can be used for the flotation of a number of minerals. In its sodium salt form, it is adsorbed very rapidly onto mineral surfaces thus requiring a very short conditioning period.

Edison Muzenda is with the Department of Chemical Engineering, University of Johannesburg, Doornfontein, Johannesburg, South Africa, 2028 (tel: 0027115596817; fax: 002711596430; email: emuzenda@uj.ac.za)

Adeshina G Ikotun is with the Department of Chemical Engineering, University of Johannesburg, Doornfontein, Johannesburg 2028

Freeman Ntuli is with the Department of Chemical Engineering, University of Johannesburg, Doornfontein, Johannesburg 2028

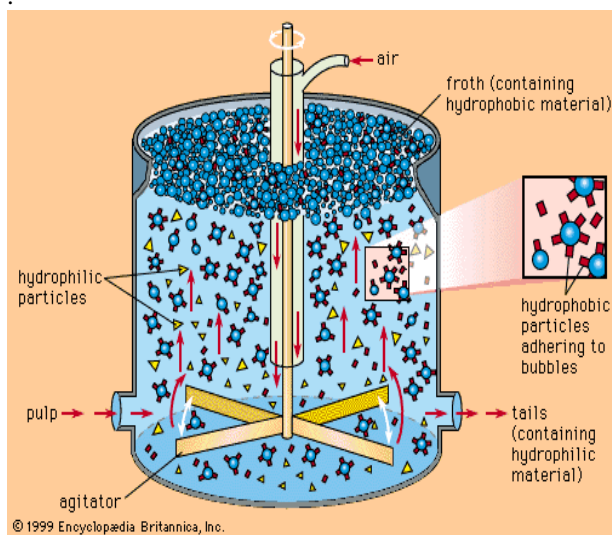


Fig. 1 Schematic diagram of flotation process

NMBT is a very good collector of oxidized and partially oxidized gold ores. Since it does not adsorb on sphalerite, it can be used in differential flotation [3]. According to Absalam and Mehrdardi [4], mercaptobenzothiazole can chelate metal ions such as silver ion and makes their solid-phase extraction possible.

The importance of frothers is enormous, it helps to stabilise bubble formation in the pulp phase, creating a suitable stable froth to allow selective drainage from the froth of entrained gangue and to increase flotation kinetics [1]. Several studies have been conducted on various frothers in the recovery of minerals through flotation [5-10]. In the present study, the effectiveness of Senfroth XP 200 and Senfroth XP 516 frothers was evaluated in the recovery of copper from black mountain ore at constant pH medium with sodium mercaptobenzothiazole as a collector.

Black Mountain Ore is rich in iron and silicon, copper is present in very small quantities. The minerals of economic importance in this ore are chalcopyrite which contains copper, galena with lead, sphalerite with zinc and small traces of silver. Iron sulphides, particularly pyrite, are often associated with copper sulphide minerals in ores. During grinding and conditioning, a variety of surface reactions can take place. For example, activation of pyrite can occur as a result of dissolution of copper species from chalcopyrite [11]. These copper species form hydrophobic species on the pyrite surface with sulphide and collector, and therefore promote pyrite flotation, which subsequently lower the overall copper grade.

II. METHODOLOGY

A. Materials and equipment

The following materials were used in this study: approximately 4kg of Black Mountain ore, frothing agents (Senfroth XP200 and Senfroth 516), collecting agent (NMBT), depressing agent (CaO), 2 liters of water, milling rods and modifying agent (Copper sulphate). Flotation was performed using the Denver flotation cell.

B. Tests procedures

All tests were conducted using the standard flotation procedure. A 1kg sample was rod milled and transferred into a 2 litre flotation cell. This was done immediately after milling to minimize any further oxidation or chemical reactions that may take place. The ore sample was milled for 2 hours using milling rods and then sieved using sieve sizes of less than 106 microns. Spinning riffle was used to evenly distribute the smaller particles with the slightly larger ones, and only particle sizes of less than 75 µm were in this work.

Two frother dosages were used while all other reagents constant such as modifiers, activators, collector and pH modifier were kept constant. The froth was collected after each flotation and washed using water while excess moisture was removed using a filter. The cake was oven dried for 2 hours. The dried cake was then ground and particles were evenly distributed using a spinning riffle. Concentrate and tailing samples were analysed using XRF.

III. RESULTS AND DISCUSSION

A. Composition of Black Mountain Ore

XRF was used to obtain the chemical composition of the black mountain ore used. Table 1 shows that black mountain ore is rich in iron and silicon while copper is present in very small quantities. The small quantities of copper in the ore with a possible low grade make the selection of frothers a very important step.

TABLE 1  
COMPOSITION OF BLACK MOUNTAIN ORE

Components	%
Cu	0.341
Fe	28.237
Pb	3.559
Si	11.439
Zn	3.106
Fe <sub>2</sub> O <sub>3</sub>	40.371
SiO <sub>2</sub>	24.471

B. Flotation with 0.5 ml Dosages of Senfroth XP200

Fig. 2 shows the chemical composition of both the concentrate and tailings after floating using Senfroth XP 200 at a dosage of 0.5ml. 1.278% of copper was recovered in the concentrates while about 0.055% was found in the tailings.

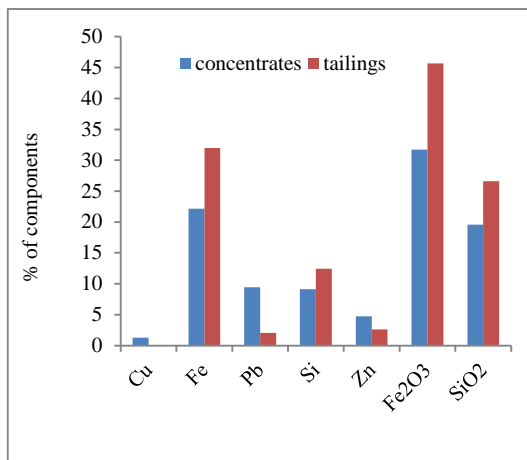


Fig. 2 Sample analysis after floating using 0.05 ml dosages of Senfroth XP200

C. Flotation with 0.5 ml Dosages of Senfroth XP 516

0.63% of copper was recovered using Senfroth XP516 and 0.21% reported in the tailings. This showed that Senfroth XP516 was less effective compared to Senfroth XP200

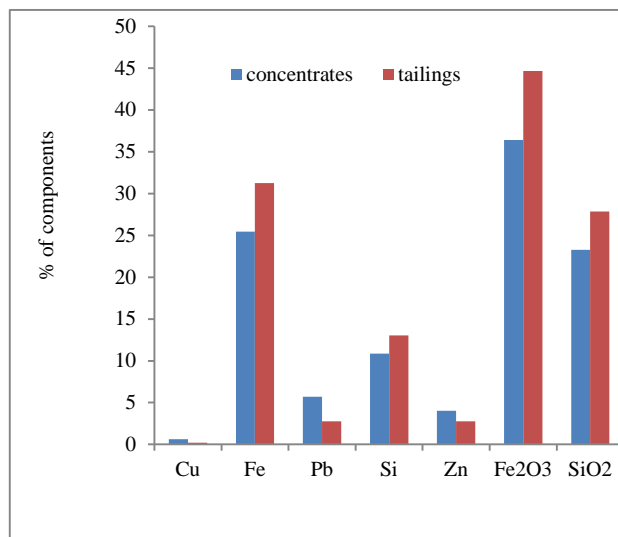


Fig. 3 Sample analysis after floating using 0.5 ml dosages of Senfroth XP516

D. Flotation with 0.1 ml Dosages of Senfroth XP 200

The recovery of copper increased with increase in frother dosage, Figs. 3 and 4. At this dosage, Senfroth has the ability to form more stable bubbles which are referred to as roughers in industry.

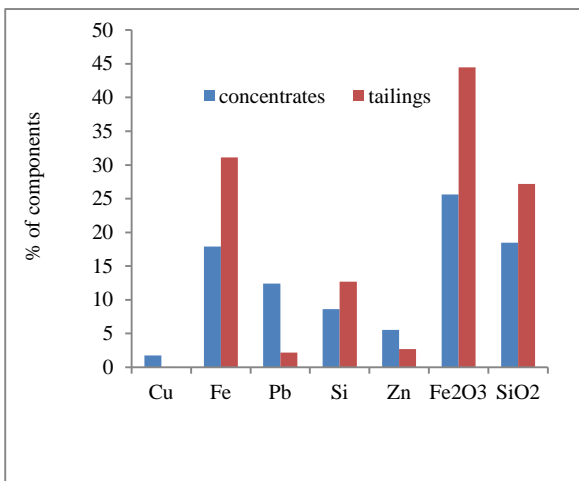


Fig.4 Sample analysis after floating using 0.1 ml dosages of Senfroth XP200

E. Flotation with 0.1 ml Dosages of Senfroth XP 516

Doubling the dosage of Senfroth XP516 did not produce a marked increase in recovery equivalent to that of doubling the dosage Senfroth XP200, Fig. 5.

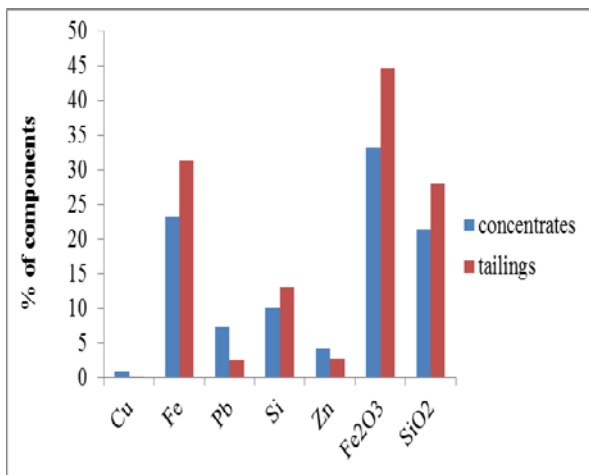


Fig. 5 Sample analysis after floating using 0.1 ml dosages of Senfroth XP516

Mercaptobenzothiazole is a very versatile collector and can be used for the flotation of a number of minerals [12] and it showed a high affinity towards surfaces containing lead and copper but with no selectivity [13]. In this study, the results show that NMBT is an effective collector for the recovery of copper from Black Mountain ore.

IV. CONCLUSION

This study, a short communication has shown that: Black Mountain ore is rich in iron and silicon, NMBT is an effective collector for the recovery of copper from Black Mountain ore through flotation and Senfroth XP 200 was more effective than Senfroth 516.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the financial support from the Department of Chemical Engineering, University of Johannesburg, South Africa.

REFERENCES

- [1] B. A. Wills, and T. J. Napier-Munn, "An Introduction to the Practical Aspects of Ore Treatment and Mineral Recovery," in *Wills' Mineral Processing Technology*, 7th ed. 2006, pp. 267 -352.
- [2] Y.S. Cho and J.S. Laskowski, "Effect of flotation frothers on bubble size and foam stability." *Int. J. Miner. Process*, vol. 64, pp 69-80, 2002.
- [3] P. P. Tebogo, and E. Muzenda , "A Multistage Sulphidisation Flotation Procedure for a Low Grade Malachite Copper Ore," *WASET*, vol. 69, no. 6, pp. 780 – 786, 2010.
- [4] G. Absalan, and M. Ayatollahi Mehrdjardi, "Separation and preconcentration of silver ion using 2-mercaptobenzothiazole immobilized on surfactant-coated alumina," *Separation and Purification Technology*, vol. 33, pp. 95-101, 2003.
- [5] K. Malysa, W. Barzyk, A. Pomianowski, "Influence of frothers on floatability. I. Flotation of single minerals (Quartz and synthetic chalcocite)," *International Journal of Mineral processing*, vol. 8, pp. 329-343, 1981.
- [6] H. H. Guy, R. Jia "An improved class of flotation frothers," *Int. J. Miner. Process*, vol. 58, pp. 35-43, 2000.
- [7] J. S. Laskowski, T. Tlhone, P. Williams, and K. Ding, "Fundamental properties of the polyoxypropylene alkyl ether flotation frothers," *Int. J. Miner. Process*, vol. 72, pp. 289- 299, 2003.
- [8] P.A Harvey, A.V Nguyen, G.J Jameson and G.M. Evans, "Influence of sodium dodecyl sulphate and Dowfroth frothers on froth stability," *Minerals Engineering*, vol. 18, pp. 311-315, 2005.
- [9] F. Melo, and J. S. Laskowski, "Fundamental properties of flotation frothers and their effect on flotation," *Minerals Engineering*, vol. 19, pp. 766-773, 2006.
- [10] Y. K. Xia and F. F. Peng, "Selection of frothers from residual organic reagents for copper-molybdenite sulfide flotation," *Int. J. Miner. Process*. vol. 83, pp. 68-75, 2007
- [11] N. P. Finkelsten, "The activation of sulphide minerals for flotation: a review," *Int. Miner. Process*, vol. 52, pp. 81-120, 1997.
- [12] A. G. Ikotun, E. Muzenda, and F. Ntuli "Performance of sodium mercaptobenzothiazole (NMBT) collector on the flotation of black mountain ore," unpublished
- [13] G. Fairthorne, D. Fornasiero, and J. Ralston, "Interaction of thianocarbamate and thiourea collectors with sulphide minerals: a flotation and adsorption study." *Int. J. Miner. Process* vol. 50, pp. 227-242, 1997.