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# Test Works on Concentrate Grade Improvement using Mineral Depressants

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**Abstract**

Flotation tests were carried out with the aim of investigating the effects of several depressant reagents on the concentrate grade recovery from mixed ore circuit at First Quantum Minerals (FQM) Kansanshi mine. These tests were performed on laboratory scale using Deptanes 90, 280,490, and 590 as depressants. Of all the reagents tested, Deptane 490 and Deptane 280 showed significant improvement in concentrate grade in comparison to other reagents investigated. The optimum dosages for both Deptane 490 and Deptane 280 were 80g/t achieving approximately 38% and 29% grade recoveries, respectively.

***Keywords:*** Froth Flotation; Depressants; Concentrate grade.

## 1. Introduction

Chalcopyrite ($CuFeS_2$), Covelite (CuS), Bornite ($Cu_5FeS_4$), and Malachite (Cu ($CO_3$) $(OH)_2$) are some of the major copper-bearing minerals mined at Kansanshi mine in Solwezi on the North-Western province of Zambia [1].

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The elements normally associated with the occurrence of ores such as chalcopyrite include silver, gold, selenium and tellurium whereas the elements Zinc, cobalt and nickel mostly occur with malachite. At Kansanshi mine, the mined ore is split into three stockpiles namely, oxide ore mixed oxide and sulphide ore and sulphide ore with the average ore grades of 2.2%, 1.3%, and 0.8%, respectively [2]. The oxide and mixed ore are treated via crushing, milling, flotation, leaching and the SX/EW process to produce a sulphidic and gold bearing flotation concentrate as well as electro-won cathode copper. The sulphide ore is treated via crushing, milling and flotation to produce copper concentrate which also contain minor amounts of precious metals.

Generally, concentrate from sulphide ore is produced using flotation process in which the valuable minerals are separated from the gangue (non-valuable) minerals with the aid of flotation reagents[3,4]. Unlike sulphide particles which float easily because they tend to bond with the collecting agent, the oxide particles are difficult to float because they don't easily bond with the collecting agents. Thus to produce concentrate from the mixture of sulphide and oxide ore, the mixture is treated using sodium hydrogen sulphide (NaHS) or sodium sulphide ($Na_2S$) to provide a sulphide coating to the oxide particles enabling them to be collected like sulphides [5]. It is thus very difficult to practically perform flotation processes without the use of reagents. The commonly used flotation reagents include organic and inorganic compounds, acids, alkalis, and various salts. The flotation reagents are broadly classified according to their function as collector, frothers and modifiers.

At Kansanshi mine, however, no modifier reagents are currently used in the treatment of mixed ore. Although in the past the metallurgists at Kansanshi mine were satisfied with the concentrate grades obtained without the use of modifying reagents, preliminary tests results on the mixed oxides and sulphides ore circuit samples indicate that the concentrate grade has been unsatisfactory having decreased from the minimum recommended level grade of about 27%Cu (oxides and sulphides) to a level of about 15%Cu. Based on these test results, several depressant reagents were recommended to the company by suppliers as possible modifiers that would help improve the recovery grades of concentrate. The aim of this research was, therefore, to investigate the effect of depressants addition on the Kansanshi mine mixed ore circuit. This study focused solely on the influence of depressants addition on the concentrate grade recovery rather than the influence of other flotation process parameters.

## 2. Materials and Methods

The depressant reagents Deptanes 90, 280, 490, and 590 used in this study were supplied by Nalco Africa (Pty). The different dosages used in this study were 0g/t, 50g/t, 80g/t, 100g/t, 120g/t, 150g/t, 200g/t, and 100g/t. For the 0g/t test, no reagent was added to the slurry and this was used as a control test.

Flotation experiments were conducted in a 2 liters Denver D12 flotation machine. 1000ml of the process slurry was abstracted from the mixed circuit controlled potential sulphidization cell (CPS) cleaner feed stream and was placed into the flotation cell. The slurry was then agitated at 1200 rpm for about 3 minutes in order to condition it. The laboratory flotation circuit is shown in Figure 1.The concentrate collected were filtered and dried in the oven at 80$^{o}$C. After drying, the concentrate samples were weighed, crashed, packed in small sample containers and submitted to analytical laboratory for analysis. The parameters analyzed for were; Total Copper (TCu), Acid soluble Copper (AsCu), and iron.

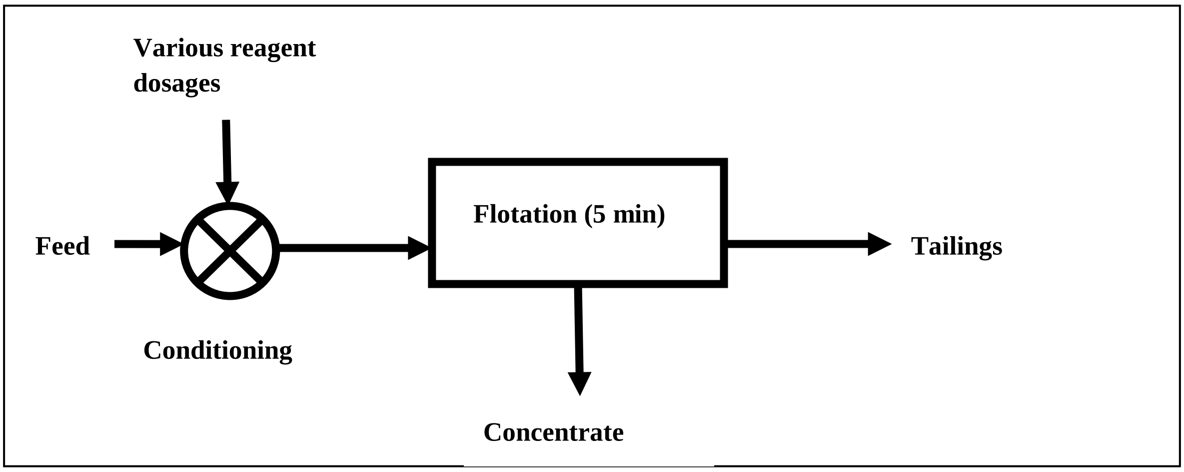


**Figure 1:** Laboratory flotation flow sheet

## 3. Results

### *3.1. Deptane - 90*

The maximum concentrate grades of total copper, iron and dissolved copper obtained using deptane 90 were 19%, 25% and 11%, respectively. These grades were achieved at reagent dosages of 100g/t, 120g/t and 0g/t, respectively. The results are shown in Figure 2. It was also noticed that for the reagent dosage range studied, the variation in reagent dosage had negligible influence of the grade of dissolved copper and a decreasing effect on iron grade recovery.

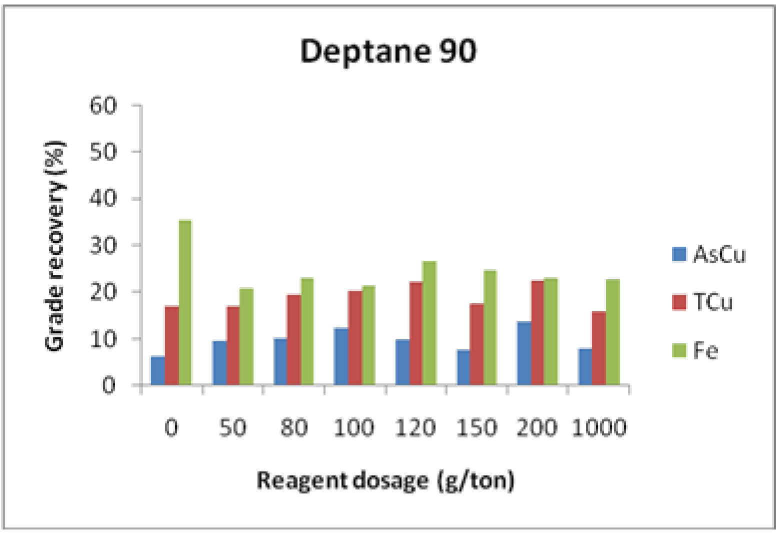


**Figure 2:** Effect of Deptane 90 reagent on the concentrate grades at different dosages

### *3.2. Deptane - 590*

The influence of deptane 590 on the concentrate grade is shown in Figure 3. It can be seen from this figure that variation in the dosage of deptane 590 within the range studied had negligible effect on total copper, iron and dissolved copper grade in the concentrate on average.

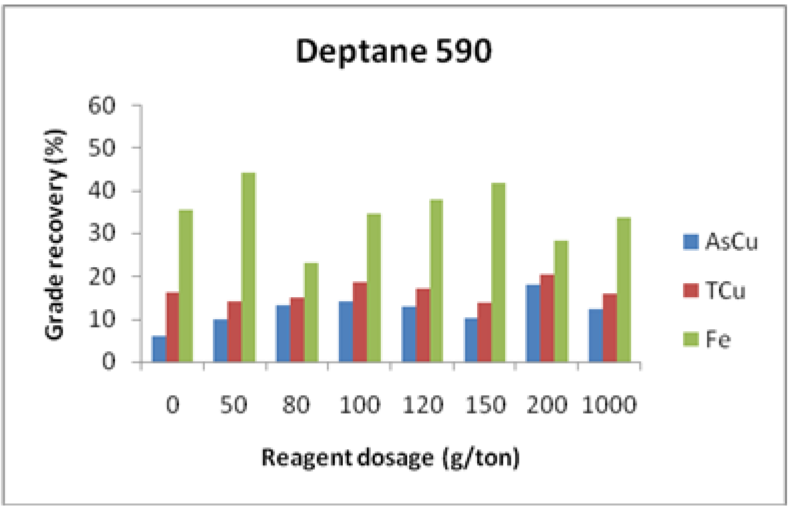


**Figure 2:** Effect of Deptane 590 reagent on the concentrate grades at different dosages

### *3.3. Deptane – 280*

The optimum total copper grade achieved using deptane 280 was obtained at a dosage of 80g/t with the concentrate grade being approximately 29 % (Figure 4). According to this figure, it appears that deptane 280 has greater potential to improve the recovery grade of total copper in the concentrate based on the percentage recovered which was above the currently grade being achieved at the plant. At this dosage, the grade of iron and dissolved copper realised were roughly 23% and 2%, respectively.

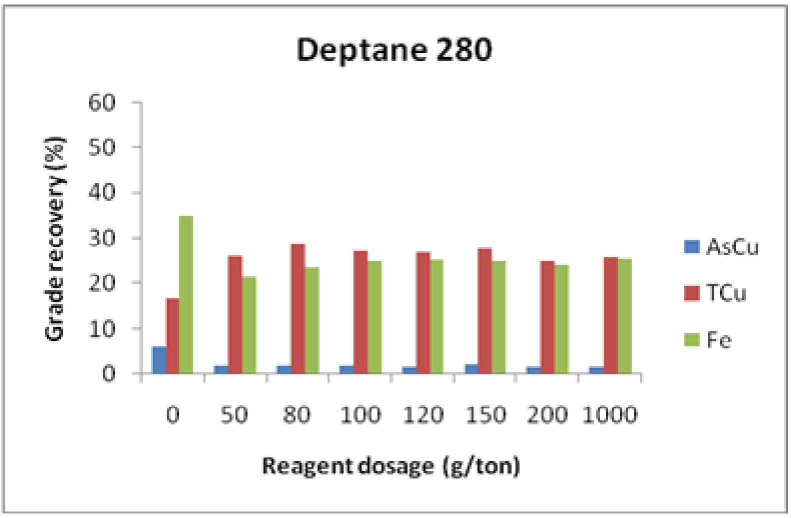


**Figure 3:** Effect of Deptane 280 reagent on the concentrate grades at different dosages

### *3.4. Deptane – 490*

The effect of deptane 490 on the concentrate grade of total copper, iron and soluble copper at different reagent dosages are shown in Figure 5. According to this figure, deptane 490 exhibited greater potential of improving copper grade recovery in the concentrate in comparison to all the other reagents tested. With 80g/t as an optimum reagent dosage, the grade of copper achieved was approximately 38%. At this dosage, the acid soluble copper grade obtained was roughly 8%. The grade of iron obtained using this reagent ranged between 20% and 25% regardless of the reagent quantity used.

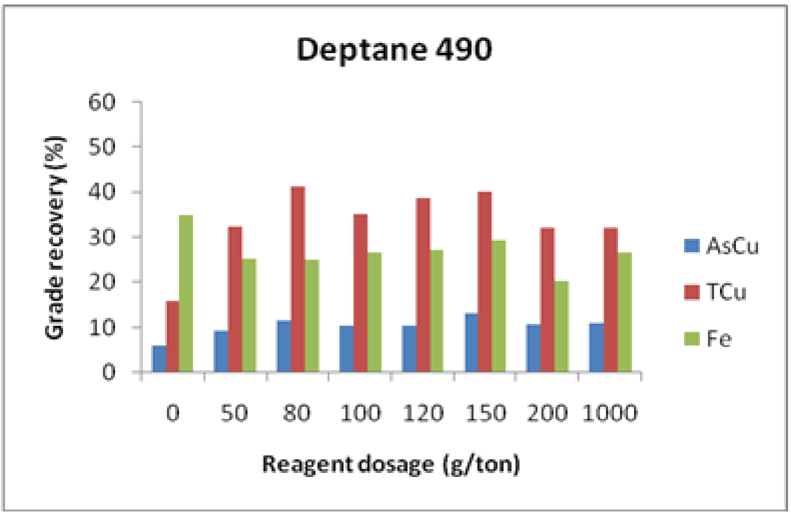


**Figure 4:** Effect of Deptane 490 reagent on the concentrate grades at different dosages

## 4. Conclusions

The flotation of metals (i.e., Cu and Fe) from mixed sulphide and oxide ores obtained from Kansanshi mine was performed using several dosages of modifier reagents. The optimum dosages in terms of total copper recovery by Deptane 280 and Deptane 490 were found to be 80g/t while that of Deptane 90 was 100g/t. However, among all the reagents tested, Deptane 490 and Deptane 280 showed remarkable improvement of the concentrate grades in terms of total copper as compared to other depressant reagents. The total copper recoveries of approximately 38% and 29% (way above 15% being currently obtained at Kansanshi mine) were achieved with 80g/t of Deptane 490 and Deptane 280, respectively. Based on the above results, it was recommended that further studies be done on pilot plant scale to ascertain the possibility of using Deptane 490 and Deptane 280 as flotation reagents at Kansanshi mine.

## Acknowledgements

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