Performance evaluation of different reagent regimes in flotation of a sulphide ore from Botswana

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Copper-nickel sulphide ores are depleting, and mineralogical studies have revealed their occurrences as complex and low grade, deemed to be of uneconomic value. As such, in rendering values from these ore bodies, careful control of conditions is essential in maximising recovery i.e., selection of the most efficient reagent regime, independent or possibly a mixture of such chemicals in a flotation process favours recovery rates. In this study the use of different collector and frother systems in flotation of two sulphide ores from Botswana is evaluated, based on best collecting and frothing properties, respectively. Three frothers used from AECI Mining Chemicals (RSA) were Senfroth200, Senfroth 150 and BetaF, and collectors in the form of xanthates and a group of senkols, formulated by a combination of xanthates, thiocarbamates and/or di-thiophosphates. While frothers are mostly applied in flotation of all minerals, collectors in question are limited to flotation of sulphide ores therefore it was necessary to conduct mineralogical analysis of ores to validate the presence or association of sulphide minerals with insignificant amounts of oxides prior to froth flotation. Four collectors: potassium amyl xanthate (PAX), sodium ethyl xanthate (SEX), Senkol 38, and sodium iso-butyl xanthate (SIBX) were all tried with the above three frothers in froth flotation of sulphide ores. The study revealed that the overall best metallurgical response was from floating with Senkols 38 as the collector and BetaF rather than xanthates with other frothers. Although flotation with Senkol 38 as a collector in the regime yielded high recovery rates, low grade in concentrates with this type of collector were recorded. Generally, Cu recoveries for all reagent regiment combination were from 76% - 98%. Nickel recoveries were calculated to be in the ranges of 57% - 81%, Fe recoveries were from 22% - 51% while sulphur in the concentrate was from 30% - 78%.

Key words: Flotation, collectors, frothers, sulphide minerals, recovery

INTRODUCTION

The modern mining sector is considered as cost-driven; it therefore demands efficient and cost-effective methods for ore processing. According to research, beneficiation of simple ore bodies is fairly easy and faster when compared to complex ores[1]. In addition, processing of low grade and highly disseminated ores present problems which affect grade and recovery. Froth flotation is one accepted common practice that has found an extensive application in mineral processing to treat base mineral ores. It has permitted processing of these low grade and complex ores otherwise deemed to be uneconomic[2]. While flotation may seem applicable to render low grade ores valuable, it presents its own problems arising from weak frothers, poor selectivity of collectors and the need to suppress other minerals through the use of depressants etc. In most cases the answer to this is careful selection and adjustment of reagent regime during flotation processes, taking the type of ore and its mineral associations into consideration

A conducted research compared the flotation recovery rates of PGMs using nanoparticles frothers against conventional Sasfrothers. The results were significantly comparable[2]. The mineral concentration capacity increased with reduced nanoparticle dosages while the opposite was noted when Sasfrothers were applied. In addition, other conducted experimentations on mixed oxide sulphide copper-cobalt minerals using different xanthates, thiols, thiocarbamates and blends of collectors, where dithiophosphates proved to be the strongest with a carollite recovery rate of 94%, followed by 90% copper sulphide and 70% copper oxide just to mention a few[3]. Given the above research works it is evident that minerals react differently to different reagents therefore reagent regiment has an effect on recovery outcomes in flotation processes. This paper focusses on evaluating the metallurgical response of local ores to existing commercial reagents, specifically xanthates in froth flotation.

METHODOLOGY

In this section, tests compared the effects of using potassium amyl xanthate (PAX), sodium ethyl xanthate (SEX), sodium isobutyl xanthate (SIBX) and Senkol 38 (a blend of xanthates, thiocarbamates and thiophosphates) in the froth flotation of different ores from local mines using three different frothers. The reagents in question, obtained from AECI Mining Chemicals (RSA), were frothers (Senfroth200, Senfroth 150 and BetaF), collectors in the form of xanthates and a group of senkols, formulated by a combination of xanthates, thiocarbamates and or/ di-thiophosphates. In flotation tests, conditioning times for reagents were 5 minutes. Times for flotation tests were 20 minutes and skimming off intervals were also 5 minutes while pH was maintained at 8.6 – 8.8.

Whilst frothers are mostly applied in flotation of all minerals, the collectors in question are limited to flotation of base metal sulphide minerals[4], therefore it is necessary to conduct mineralogical analysis prior to flotation.

SUMMARY OF RESULTS

The mineralogical analysis according to SEM was as follows; pyrrhotite (42.3), talc (0.2), chalcopyrite (1.6), pyrite (15.1), pentlandite (3.4), other nickel bearing minerals ~ 0.01, other copper bearing minerals (~0.02), Fe oxides (2.9), pyroxene (9.2), mica (0.2), olivine (1.6), chlorite (7.7), serpentine (13.1), feldspar (0.2), amphibole (0.5), carbonates (1.2), quartz (0.5), trace elements (0.3).

From Table 1, it is evident that recovery rates greatly depend on choice of flotation reagents. Senkol 38 used with BetaF in the reagent regime yielded high recovery rates; low grade in concentrates with this type of collector were recorded. Results indicated that main copper minerals were easy to float compared to other minerals. Although flotation with Senkol 38 as a collector yielded high recovery rates, low grade in concentrates with this type of collector were recorded

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Table 1. Flotation tests - recovery rates

Frother	Dosage g/t	Collector	Dosage g/kg	Mass Pull %	Recovery %			
					Cu	Ni	Fe	S
Beta Frother	25	PAX	50	13.6	82	71	28	43
		SEX		19.2	97	58	22	44
		SIBX		23.3	98	82	45	58
		SENK38		24.8	95	66	52	78
Senfroth 150		PAX		12.1	92	67	41	60
		SEX		11.8	88	60	32	77
		SIBX		13.9	91	70	36	61
		SENK38		23.8	95	75	46	31
Senfroth 200		PAX		17.5	96	66	35	75
		SEX		16.3	90	67	38	60
		SIBX		15.8	87	65	39	63
		SENK38		12.7	77	57	36	72

Senk30 – Senkol 38

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