The European Journal of Mineral Processing and Environmental Protection
Vol. 4, No. 1, 1303-0868, 2004, pp. 30-35

ejmp&ep

Technical Note

Cyanide elimination from lead-zinc flotation

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Received 6 August 2002; accepted 15 April 2004

ABSTRACT

Application of cyanide in Lead-Zinc (Pb/Zn) flotation dates back from 1922 when Sheridan-Grisvold process was introduced using the cyanide as depressant for the sphalerite and pyrite. The cyanide was proven to be a very efficient depressant and it is still used extensively in flotation. There is a patent on a series of SKIK reagents, which have a double effect in the flotation process; as the grinding media corrosion inhibitors and as very selective collectors for base metals. A new "Metoha Technology" has been developed based on testing SKIK reagents with Pb/Zn ores. The "Metoha Technology" enables efficient flotation of Pb/Zn minerals without any addition of NaCN for sphalerite and iron sulphides depression. Detailed laboratory tests on the Pb/Zn ores from the "Sase" Mine in Srebrenica, Republic of Srpska using the SKIK-BZ2000 reagent, show that due to its introduction, the reagent regime was simplified and significantly cheaper. Upon its introduction in the process, NaCN, $ZnSO_4$, PEX and PAX in the total quantity of 450g/t were completely eliminated and only 233g/t of the SKIK-BZ2000 reagent was used. The industrial testing at the "Sase" Concentrator have confirmed the laboratory results. In the same time, the grinding media consumption was reduced by 13%. Apart from obvious economic and technological benefits, the "Metoha Technology" has solved the environmental problem by elimination of the cyanide from the process. The precipitated cyanide in the tailing dams is source of the underground water pollution and immense hazard for the environment in the case of dam damage or collapse. The the SKIK reagents applied in the "Metoha Technology" are also less toxic than the conventional collectors such as xanthate, and ditiophosphate.

Keywords: Cyanide; Environmental; Flotation; Lead; Zinc

1. INTRODUCTION

The wide range of chemicals called "the reagents" are used in the flotation process. Each of these chemicals in some degree affects the environment and causes pollution. The reagents used in the flotation of non-ferrous metals such as cyanides, xanthates, fosokrezol and others are all strong poisons, so that substances produced by their decay, become harmful to people and the environment.

During the twenties, a depressing action of the cyanide was discovered on ferro and zinc sulphides for the selective flotation of lead and zinc minerals. The cyanide has thus become an irreplaceable depressant for selective flotation because of its excellent depressing properties. However, cyanide is also a permanent health hazard because it can turn into poisonous gas in the acid media (Draskic, 1986).

The process of the lead and zinc flotation concentration is carried out in the base environment and the cyanide is not separated in the gaseous form. However, it precipitates in tailing dumps where it is potentially very dangerous as it can reach surrounding water courses through dams or surrounding rocks (Acic *et al.*, 2001).

Since it is much simpler and more economical to solve pollution problems by removing the causes or by bringing their influences down to a minimum than by solving all the consequences they create, the experts of "The Metoha Technology" company have synthesised new flotation reagents SKIK-BZ2000÷2080 the use of which eliminates cyanide and other toxic reagents from the flotation processes for non-ferrous metals ores (Magdalinovic *et al.*, 1981; 1996; 2001; 2002; Petkovic *et al.*, 2002).

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Researchers at the Mineral Processing Department of the Technical Faculty Bor have carried out a full laboratory testing programme with the lead-zinc ore from the "Sase" Mine, Srebrenica. Having achieved positive results, industrial testing of the SKIK-BZ2000 reagent, was also conducted to verify the laboratory test results. The results form the laboratory and industrial testing are presented in this paper.

2. RESULTS AND DISCUSSION

The properties of the sample from Srebrenica deposit, taken for the laboratory testwork is shown in Table 1.

Table 1
Chemical assays of the sample

Element / compound	Content, %
Pb	4.55
Zn	3.92
Fe	6.5
SiO_2	60.76
Al_2O_3	2.86
Natural pH value of the sample	6.91
Sample density	2629kg/m^3
Bond's work index	15.5kWh/t

The flotation tests were performed in the Denver laboratory flotation machine, with a cell volume of 2.8dm^3 and the impeller speed of 1250rpm.

The SKIK-BZ2000÷2080 series reagents are a mixture of collectors, mercaptobenzotiazol salts and corrosion inhibitors which depend on the non-ferrous mineral type. The grinding media corrosion inhibiting feature as well as some non-ferrous minerals collecting feature are determined by their chemical composition and the structure. For each ore, a special collector of the SKIK BZ2000÷2080 series (group of products) is made. For instance, for the "Sase" Srebrenica ore, the reagent is named BZ2000.

The SKIK-BZ2000 inhibiting properties and particularly its collecting feature on galena were tested. Special attention was paid to the selectivity to sphalerite and iron sulphides. For these tests, the flowsheet and technological parameters from the Srebrenica Concentrator were simulated.

The SKIK inhibiting action in the grinding process was tested at pH=8.2. Test results indicated that the grinding ball consumption could be reduced by 13 percent.

Experiments denoted as S-1 were carried out with a conventional reagent regime containing sodium cyanide and zinc sulphate as a depressant, PEX as a galenite collector and PAX as a sphalerite collector. Test details are shown in Figure 1.

Figure 2 shows the flowsheet of the experiments S-2 carried out with the SKIK as collector for galena and sphalerite, but without any sodium cyanide or zinc sulphate addition. In both cases, copper sulphate was used as an activator for sphalerite flotation. The test results are presented in Table 2.

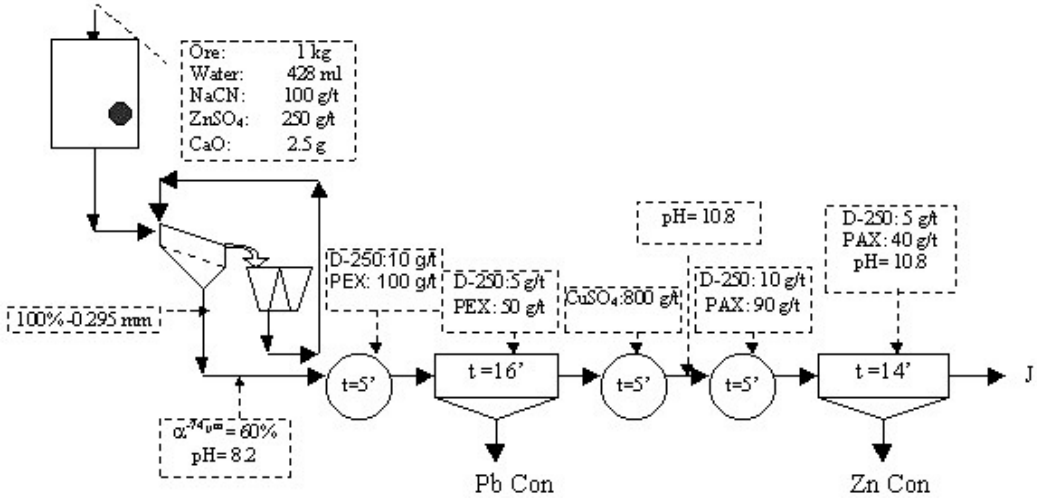

Figure 1. Technological scheme and the reagent regime in the experiment S-1

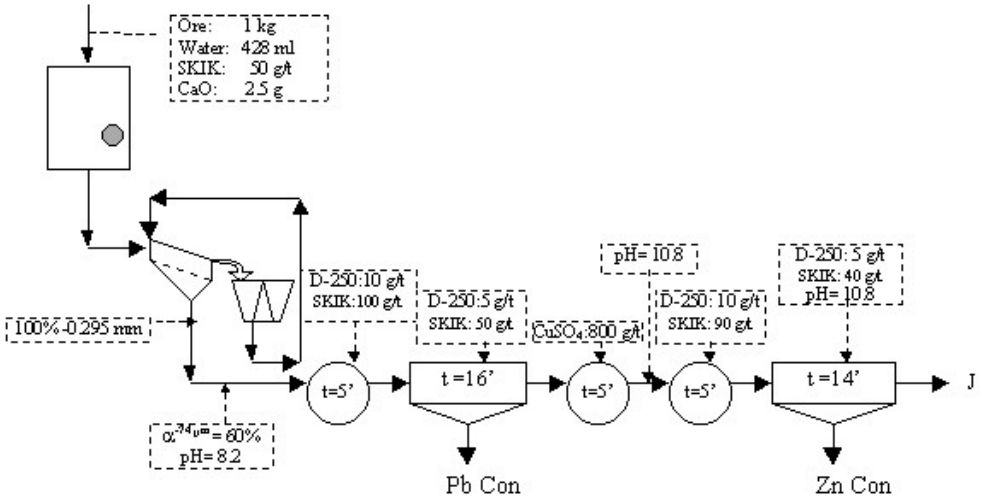

Figure 2. Technological scheme and the reagent regime in the experiment S-2

Table 2
The summary of the laboratory test results

Parameters	Product	Reagent Regime	
		Conventional NaCN; $ZnSO_4$; PEX; $CuSO_4$; PAX (S-1)	New SKIK SKIK; $CuSO_4$ (S-2)
Mass (%)	Pb con.	20.88	14.10
	Zn con.	11.86	10.13
Pb assay (%)	Pb con.	19.98	28.08
	Zn con.	1.13	1.89
	Tailings	0.30	0.34
	Feed	4.51	4.41
Zn assay (%)	Pb con.	13.30	6.45
	Zn con.	9.99	24.04
	Tailillings	0.27	0.26
	Feed	4.14	3.54
Lead recovery, I_{Pb} (%)	Pb con.	92.55	89.91
Zinc recovery, I_{Zn} (%)	Zn con.	28.59	68.76

Results shown in Table 2 clearly indicate that the SKIK-BZ2000 reagent is a strong galena collector and also very selective to sphalerite. Therefore, it is possible to eliminate the sodium cyanide as a depressant from the Pb/Zn ores flotation, with very significant economic and even more environmental benefits, as the sodium cyanide is a very strong poison. The technological results achieved with the SKIK-BZ2000 reagent were superior to ones achieved with conventional reagents. This was later confirmed in the industrial trial in the "Sase" Srebrenica Concentrator.

3. INDUSTRIAL TESTING

The objective of the industrial testing was to compare the performance of the plant using SKIK-BZ2000 reagent with those obtained with currently applied reagents. The plant flowsheet is presented in Figure 3 and the existing reagent regime in Table 3. The reagent regime used for industrial testing with SKIK-BZ2000 is given in Table 4.

Table 3
The existing flotation reagent regime at Sase concentrator

Reagent	Dose, g/t	Place of introduction
Lime	6900	- rod mill - zinc rougher
NaCN	69	- rod mill (55g/t) - lead rougher (14g/t)
$ZnSO_4$	214	- rod mill (200g/t) - lead roughing (14g/t)
PEX	73	- lead rougher and scavenger
$CuSO_4$	545	- zinc rougher
PAX	90	- zinc rougher and scavenger
Fosokrezol	13	- lead rougher
D-250	60	- lead rougher - zinc rougher

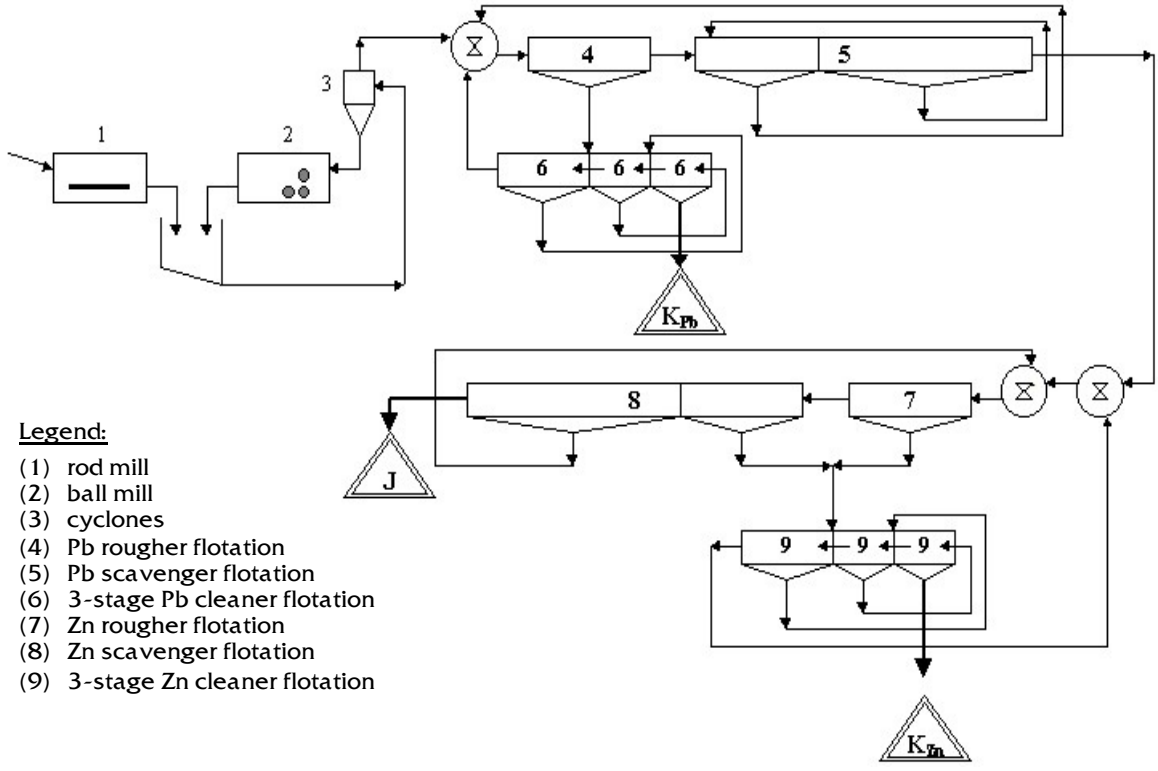

Figure 3. Simplified process flowsheet for Sase Mine, Srebrenica-Republic of Srpska

Table 4
The reagent regime during the industrial testing with SKIK-BZ2000 reagent

Reagent	Dose, g/t	Place of introduction
Lime	6900	- rod mill - zinc rougher
SKIK	51	- rod mill
	79	- lead rougher
	34	- lead flotation scavenger
	41	- zinc rougher
	28	- zinc flotation scavenger
$CuSO_4$	545	- zinc rougher
D-250	60	- lead rougher - zinc rougher

Table 5
Summary of the industrial testing results with the existing reagent regime and the SKIK reagent regime

Product	Existing conventional reagent regime		With the SKIK reagent	
	Pb (%)	Zn (%)	Pb (%)	Zn (%)
Feed (U)	4.69	2.44	3.28	2.17
Lead concentrate (Pb con.)	77.01	2.36	67.98	3.48
Zinc concentrate (Zn con.)	9.89	45.89	3.25	46.85
Tailings (J)	0.64	0.76	0.46	0.77
Mass recovery (M %)	4.87	3.55	4.06	2.82
Metal recovery (I %)	80.01	66.79	84.16	60.89

Table 5 shows test results obtained with the existing (conventional) reagents compared with the SKIK-BZ2000 reagent. It can be seen that the SKIK-BZ2000 was very selective collector for the flotation of galena and sphalerite. By its application in the "Sase" Srebrenica concentrator, the reagent regime was significantly simplified. The NaCN, $ZnSO_4$, PEX, PAX were not used. The most important environmental aspect was that NaCN, a strong poison, was removed from the process.

Four reagents (NaCN, $ZnSO_4$, PEX, PAX) were completely eliminated in an total of 446g/t, and replaced by 233g/t SKIK-BZ2000, which had a very important economic benefit.

Direct comparision of the results (mass M% and metal I% recovery) does not reflect clearly efficiency of the SKIK-BZ2000 reagent because both lead and zinc grade in the feed ore were higher during testing with the conventional reagents. This caused that mass and metal recovery of the zinc concentrate was lower for the SKIK-BZ2000 test. Judging by lead and zinc content in the tailings, it is expected that for the same feed content overall results would be significantly better with the SKIK-BZ2000 reagent.

Based on the presented results, the benefits from application of the SKIK reagent were as follows:

- Better lead recovery by 4.15% although the lead content in the feed was 1.4% lower;
- Almost 1% higher zinc grade in the zinc concentrate;
- Much lower lead content in the zinc concentrate (with conventional reagents in the zinc concentrate Pb is 9.89%, while with the SKIK reagent BZ-2000, Pb content is 3.25%);
- Similar zinc content in the tailings (0.76%; 0.77%) with significantly lower zinc content in the feed (0.37%).

4. CONCLUSIONS

The laboratory and industrial test results presented in this work indicate that the SKIK-BZ2000 is a very selective collector for lead/zinc ores, more selective than the conventional collectors (PAX, PEX) tested.

Owing to the introduction of the SKIK-BZ2000 in the flotation process of the lead/zinc mine Sase, four currently used reagents such as NaCN, $ZnSO_4$, PEX and PAX were eliminated from the process. This can be important for all lead/zinc mines because NaCN, a strong poison, does not have to be used any more.

Very favourable technological results were also achieved. Most of the results with the SKIK reagent were favourable compared to the existing classical reagents.

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