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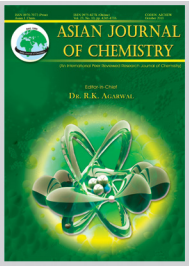

Use of Sodium Metabisulphide as An Alternative Depresant in Selective Flotation of Lead and Copper

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In this study, complex lead-zinc-copper ore located in the territory of Canakkale Province, Yenice County, Kalkim District has been worked on. Physical and mineralogical characteristics of the ore showed that the appropriate ore enrichment method is flotation. The first aim was to determine the optimum flotation conditions for the further studies. The flotation tests to determine the type of depressant were completed to use in selective flotation circuit of lead and copper. Potassium dichromate is widely used as a depressant of this type of ores. However, potassium dichromate is an undesirable chemical with carcinogen impacts and environmental drawbacks. Many alternatives of potassium dichromate is studied in recent years such as sodium metabisulphide. Sodium metabisulphide is less dangerous than potassium dichromate for environment and human health. In this study, the ore was beneficiated using sodium metabisulphide and 89.74 % cumulative recovery with 66.32 % Pb content in the final lead concentrate and 35.67 % cumulative recovery with 24.94 % Cu content in the final copper concentrate was obtained. The positive and negative aspects of sodium metabisulphide with respect to potassium dichromate are discussed regarding the experimental studies.

Key Words: Sodium metabisulphide, Lead flotation, Mining and environment, Human health.

INTRODUCTION

Holding 6.7 % of the world's Pb-Zn-Cu reserves on the basis of metallic content is very important for Turkey in economical point of view[1,2]. Galena (PbS), sphalerite (ZnS) and chalcopyrite ($CuFeS_2$) are the main sulphide compounds in Pb-Zn-Cu mineralization. Flotation method is widely used in Turkey and worldwide to enrich complex Pb-Zn-Cu ores[3-6].

The concentrate to be used in metallurgical process should be separated from impurities and other minerals. The aim of beneficiating complex ores is to have well separated concentrates. Otherwise, the value of the ore decreases economically[5,7].

The selective flotation method is applied to the bulk flotation concentrate of Pb-Cu to achieve more valuable Cu concentrate and to reduce the Cu amount in Pb concentrate[7]. Potassium dichromate is widely used as a depressant of this type of ores in flotation[3-7]. However, potassium dichromate is an undesirable chemical with carcinogen impacts and environmental drawbacks[8].

In this study, the use of sodium metabisulphide ($Na_2S_2O_5$)[9], which has field of use in food sector, instead of potassium dichromate is investigated to minimize the negative impact of mining activities.

EXPERIMENTAL

The complex lead-zinc-copper ore used for experimental studies is taken from the stock of a mining site in Canakkale Province, Yenice County, Kalkim District. The size of the run of mine was reduced to -2 mm in laboratory to be used in experiments.

The chemical analysis of the ore was performed by using Analytic Jena NovAA 30 model atomic adsorption spectroscopy and 3.29 % Pb, 0.62 % Zn, 0.35 % Cu, 3.38 % Fe and 0.57 % Mn content was determined[10]. The figures plotted on the results of chemical and screen analysis[10] and microscopic studies performed by Nikon SMZ1 500 model stereo microscope showed that the ore is liberated below 300 µm in size. Thus, the flotation experiments in different particle sizes as -150, -125 and -106 µm were performed to determine the size of liberation and it was observed that the liberation of the ore is below 125 µm[10]. Hence, the further flotation studies were performed below 125 µm in size.

The optimal bulk flotation parameters for Yenice-Kalkim, Pb-Zn-Cu ore is given in Table-1 and the selective flotation parameters for the bulk Pb-Cu concentrate was discussed.

Sodium metabisulphide and potassium dichromate were compared as depressants in Pb-Cu selective flotation with regard to grade, recovery, economic and environmental aspects.

TABLE-1
OPTIMAL COLLECTIVE (BULK) FLOTATION CONDITIONS

Flotation parameters / Reagent dosage	Pb - Cu collective flotation
Particle size (mm)	-0.125
Solid rate (%)	20
pH	8.5
Na_2SiO_3 (g/t)	1000
$ZnSO_4$ (g/t)	500
Na_2S (g/t)	150
KEX (g/t)	75 + 37.5
AE 70 (g/t)	20
Conditioning duration (min)	15 + 5 + 1
Flotation duration (s)	3 + 2

RESULTS AND DISCUSSION

Potassium dichromate ($K_2Cr_2O_7$) was used as depressant in Pb-Cu circuit in the mineral processing plant designed for the complex Pb-Zn-Cu ore[3-7]. The reduction in the use of potassium dichromate is highly desirable for its carcinogenic effect and heavy metal content[8]. One of the purposes of mining activities should be to minimize the environmental effects. Thus, the use of sodium metabisulphide step forward[10]. The comparison of sodium metabisulphide and potassium dichromate and increasing dosages of sodium metabisulphide with its applicability were investigated in this study.

The first comparison was made by using 500 g/ton sodium metabisulphide and potassium dichromate. The flotation parameters are stated in Table-2 and the results are shown in Table-3.

TABLE-2
EXPERIMENTAL CONDITIONS OF FLOTATION TESTS BY USING $Na_2S_2O_5$

Flotation parameters / Reagent dosage	Pb-Cu collective flotation
Particle size (mm)	-0.125
Solid rate (%)	20
pH	5.5
Dextrin (g/t)	25
$K_2Cr_2O_7/Na_2S_2O_5$ (g/t)	500
5100 (g/t)	50
AE 70 (g/t)	10
Conditioning duration (min.)	5 + 2 + 1
Flotation duration (s)	180

TABLE-3
EXPERIMENTAL CONDITIONS OF FLOTATION TESTS BY USING $Na_2S_2O_5$ AND $K_2Cr_2O_7$

Reagent type	Concentrate	Weight (%)	Grade (%)		Recovery (%)	
			Pb	Cu	Pb	Cu
$Na_2S_2O_5$	Cu	29.65	39.68	9.64	20.29	46.63
	Pb	70.35	42.64	3.02	79.71	53.37
$K_2Cr_2O_7$	Cu	5.84	31.61	9.34	9.34	69.12
	Pb	94.16	56.60	0.82	90.66	30.88

The experimental results and grade-recovery charts are stated for Pb and Cu respectively in Fig. 1.

It is observed that, the desired selectivity could not be achieved. Therefore, the amounts of $ZnSO_4$, the collector and the depressant were decided to be increased. The experimental conditions for flotation tests using $K_2Cr_2O_7$ is given in Table-4.

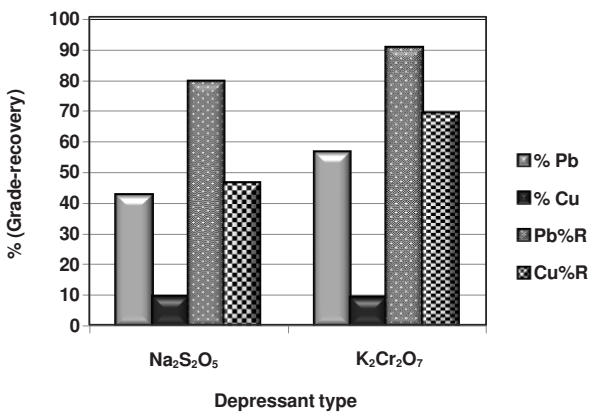

Fig. 1. Effect of depressant type on selective flotation

TABLE-4
EXPERIMENTAL CONDITIONS OF FLOTATION TESTS BY USING $K_2Cr_2O_7$

Flotation conditions / Reagent doasge	Pb - Cu collective flotation
Particle size (mm)	-0.125
Solid rate (%)	20
pH	5.5
Dextrin (g/t)	25
$ZnSO_4$ (g/t)	200
$K_2Cr_2O_7$ (g/t)	1000, 3000
5100 (g/t)	100
AE 70 (g/t)	10
Conditioning Duration (min.)	5 + 2 + 1
Flotation Duration (s)	90 + 90

In the experimental study using 3000 g/ton potassium dichromate as depressant (Table-5 and Fig. 2), Pb grade of 59.77 % with recovery of 90.69 % and Cu grade of 15.86 % with recovery of 75.08 % was achieved. An increase in potassium dichromate dosage was not preferred due to its negative effect on human health and environment.

TABLE-5
EXPERIMENTAL CONDITIONS OF FLOTATION TESTS BY USING $K_2Cr_2O_7$

Reagent dosage	Concentrate	Weight (%)	Grade (%)		Recovery (%)	
			Pb	Cu	Pb	Cu
1000 g/t	Cu	29.51	33.16	12.67	17.46	69.91
	Pb	61.29	70.11	1.74	76.66	19.99
3000 (g/t	Cu	15.83	22.75	15.86	6.93	75.08
	Pb	78.90	59.77	0.90	90.69	21.24

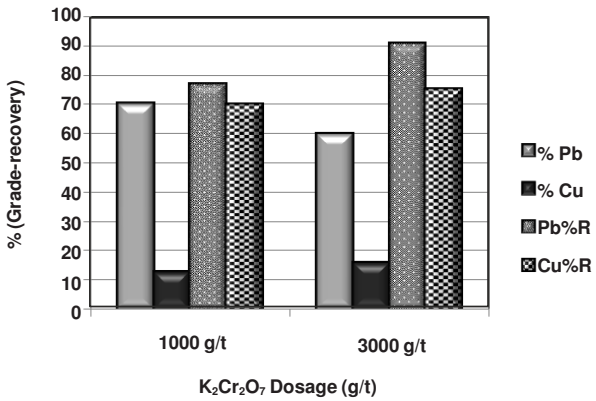

Fig. 2. Effect of $K_2Cr_2O_7$ on selective flotation

The flotation parameters using $Na_2S_2O_5$ is given in Table-6 and the achieved results are shown in Table-7 and Fig. 3.

TABLE-6
EXPERIMENTAL CONDITIONS OF FLOTATION TESTS BY USING $Na_2S_2O_5$

Flotation conditions / Reagent dosage	Pb - Cu collective flotation
Grid size (mm)	-0.125
Solid rate (%)	20
pH	5.5
Dextrin (g/t)	25
$ZnSO_4$ (g/t)	200
$Na_2S_2O_5$ (g/t)	1000, 3000, 5000
5100 (g/t)	100
AE 70 (g/t)	10
Consistency time (min)	5 + 2 + 1
Flotation time (s)	90 + 90

TABLE-7
EXPERIMENTAL CONDITIONS OF FLOTATION TESTS BY USING $Na_2S_2O_5$

Reagent doasge	Concentrate	Weight (%)	Grade (%)		Recovery (%)	
			Pb	Cu	Pb	Cu
1000	Cu	26.02	35.42	8.82	17.39	88.49
g/t	Pb	68.82	60.57	0.25	78.64	6.51
3000	Cu	8.21	13.14	23.35	2.10	83.57
g/t	Pb	90.22	54.95	0.24	96.73	9.30
5000	Cu	7.35	6.20	24.94	0.74	80.07
g/t	Pb	91.19	66.32	0.28	98.70	11.28

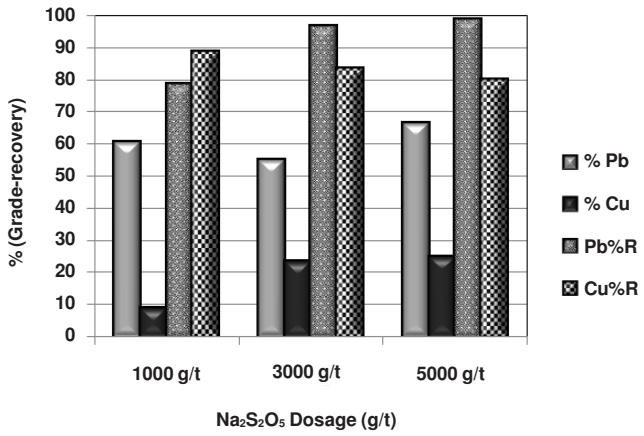

Fig. 3. Effect of $Na_2S_2O_5$ on selective flotation

In the experimental study using 5000 g/ton sodium metabisulphide as depressant, Pb grade of 66.32 % with recovery of 98.7 % and Cu grade of 80.07 % with recovery of 24.94 % was achieved, which has commercial value in the industry.

Conclusion

Potassium dichromate and sodium metabisulphide was used as depressants in Pb-Cu selective flotation tests. In the flotation tests using 3000 g/ton potassium dichromate as depressant, Pb grade of 59.77 % with recovery of 90.69 % and Cu grade of 15.86 % with recovery of 75.08 % was achieved. On the other hand, Pb grade of 66.32 % with recovery of 98.7 % and Cu grade of 80.07 % with recovery of 24.94 % was achieved by using 5000 g/ton sodium metabisulphide as depressant. Both concentrates has commercial value and saleable. The concentrates with higher grade and recovery was achieved with 5000 g/t sodium metabisulphide than 3000 g/t of potassium dichromate.

The cost of potassium dichromate is 1.45 times sodium metabisulphide. Accordingly, the unit cost per consumption is head to head for both compounds. The use of sodium metabisulphide is more economical since 7 % grade and 8 % recovery increase in Pb concentrate and 9 % grade and 5 % recovery increase in Cu concentrate was observed.

The main purpose of this study is to minimize the negative effects of mining activities to human health and environment while maximizing the total yield of the activities. For this purpose, the use of potassium dichromate is not preferable due to its low achievable grade and recoveries, heavy metal content and negative effects on human health and environment regarding the two main criteria.

In conclusion, the use of sodium metabisulfite is more preferable with regard to grade, recovery, economic and environmental aspects.

REFERENCES

1. Anonymous T.R. Prime Ministry, State Planing Organization Lead-Zinc, Cadmium Working Group, 8. FiveYears Development Plan, Ankara, Turkey (2001).
2. A.E. Yüce, E. Baser and B. Ertem, *Geosci. J.*, **18**, 163 (2005).
3. I. Bayraktar Y. Altun, Complex Copper-lead-zinc Ores Properties, the Economic Value and to Enrichment, *Madencilik*, 35/1 (1996).
4. S. Bulatovic, Handbook of Flotation Reagents, Amsterdam: Elsevier edn. 1 (2007).
5. Y. Çilingir, Metallic Ores and Beneficiation Methods (2. Print). Dokuz Eylül University, Faculty of Engineering, Printing Unit, MM/MAD-90 EY 198, Izmir (1996).
6. E. Yigit and S.G. Özkan, Flotation Method and Applications, Istanbul Technical University Publications 4961, Istanbul (2007).
7. S. Atak, Principles and Practice of Flotation, Istanbul Technical University Department of Mining Engineering (1982).
8. SVHC support document Potassium Dichromate, European Chemicals Agency(ECHA), CD Number: 231-906-6, CAS number:7778-50-9, Finland (2010).
9. The National Institute for Occupational Safety and Health (NIOSH), Sodyum Metabisülfit, International Chemical Safety Cards, Atlanta, USA (2002).
10. E. Öztürk, M.Sc. Thesis, Investigation of Selective Flotation Conditions of the Çanakkale Yenice Kalkim Lead Zinc and Copper Ores and Sinking of Lead with the Sodium Metabisulphide, Dokuz Eylül University The Graduate School of Natural and Applied Science, Izmir, Turkey (2010).