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Experiment study on recovering lead and zinc from a flotation tailings in inner mongolia by flotation

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ABSTRACT

The most valuable elements in a flotation tailings in Inner Mongolia were lead, zinc and silver, and the main lead and zinc minerals were oxide minerals such as cerussite, sardinianite, smithsonite and hemimorphite, and so on and the content of lead and zinc sulfide minerals such as galena, sphalerite were small. The flotation tailings was used as the research object and the indexes of the lead grade of lead concentrate for 48.30%,the recovery for 65.41%,and the zinc grade of Zinc concentrate for 42.24%,the recovery for 84.69%,. total recovery of silver in lead and zinc concentrate for 55.53% were obtained on the condition of mesh of grind for -0.074 mm95.3% and at suitable conditions by flotation flowsheet of the step-by-step flotation, that was floating sulfide minerals of zinc, oxide minerals of lead and oxide minerals of zinc one by one. Lead, zinc, and silver in the tailings were recovered effectively, from which excellent economic benefits can be obtained.

Key words: Lead and zinc oxide ore; flowsheet of the step-by-step flotation; flotation after Sulfide; desliming

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INTRODUCTION

The distribution of lead and zinc resources was very wide, and there were many different kinds of oxide of lead zinc. The main oxide Mineral of lead which has industrial application value were cerussite($PbCO_3$) and sardinianite ($PbSO_4$),and the main oxide mineral of zinc which has industrial application value were smithsonite ($ZnCO_3$) and hemimorphite ($Zn4Si_2O_7$ (OH) $_2 \cdot H_2O$).The oxide mineral of Lead and zinc in China was very rich and was a kind of very potential metal resources. It was very important of rational utilization of the lead zinc resources[1-3]. With the development of the industry, the mining of ore, grade of ore declining , a lot of tailings and the low grade oxidized ore were stockpiling, and failing to be used to the full. Although a great deal of flotation studies was done on the oxide ore of lead-zinc, The flotation recovering of oxide minerals of lead-zinc especially oxide minerals of zinc can not obtain satisfactory results because of the oxide ores of lead and zinc containing many minerals, complex structure of mineral, nostable associated components, and containing a lot of clay and limonite, high soluble salt content[4-6].

The main usful elements in a flotation tailings in Inner Mongolia were lead, zinc and silver, and the main lead and zinc minerals were oxide minerals. The content of sulfide minerals of lead and zinc especially sulfide mineral of lead were small,so It was difficult to get concentrate of sulfide mineral of lead.The flotation tailings was used as the research object（the flotation tailings was named run-of-mined ore because it was processing object in this experiment) to recover resource of lead-zinc.The flowsheet of the step-by-step flotation ,that was floating sulfide minerals of zinc, oxide minerals of lead and oxide minerals of zinc one by one was used and the concentrate of sulfide minerals of zinc, concentrate of oxide minerals of lead and concentrate of oxide minerals of zinc were obtained,and concentrate of sulfide minerals of zinc and concentrate oxide minerals of zinc can be combined into a concentrate of zinc.The indexes of the lead grade of lead concentrate for 48.30%,the recovery for 65.41%,and the

zinc grade of Zinc concentrate for 42.24%,the recovery for 84.69%,. total recovery of silver in lead and zinc concentrate for 55.53% were obtained on the condition of mesh of grind being -0.074 mm 95.3% and suitable conditions. Results show that using flotation method to recover the lead, zinc, silver was feasible and can obtain certain economic benefits. It has reference significance for the development and utilization of oxide mineral lead and zinc.

PROPERTIES OF RUN-OF-MINED ORE

MULTI-ELEMENT CHEMICAL ANALYSIS OF RUN-OF-MINED ORE

The multielement chemical analysis results of run-of-mined ore were shown in Table 1.

Table 1 The multielement chemical analysis results of run-of-mined ore

elements	Pb	Zn	TFe	S	SiO_2	Al_2O_3	CaO	MgO	Ag*
content（%）	0.58	2.59	1.21	4.04	4.22	2.66	27.90	17.94	23.82

** unit：g/t*

The results of table 1 show that the most valuable elements in the run-of-mined ore were lead, zinc and also associated with the valuable elements of silver.

PHASE ANALYSIS OF RUN-OF-MINED ORE

Phase analysis of run-of-mined ore were shown in Table 2.

Table 2. Phase analysis of run-of-mined ore（%）

	Mineral of lead				Mineral of zinc		
	sulfide	oxide	Total Pb		sulfide	oxide	Total Zn
grade	0.05	0.53	0.58	grade	0.40	2.19	2.59
distribution	8.62	91.38	100.00	distribution	15.44	84.56	100.00

From the table 2,we can see that the valuable components of the material of lead and zinc mainly exists in oxide, proportion of lead in oxide minerals of lead was 91.38% and proportion of zinc in oxide minerals of zinc was 84.56%, so the test was given priority to recycling oxide minerals of lead and zinc.

COMPOSITION AND ITS CHARACTERISTICS OF RUN-OF-MINED ORE

The main metal oxide mineral were cerussite,smithsonite, hemimorphite, sardinianite, limonite, fiber,and so on. The content of metal sulfide mineral was small ,these were galena, sphalerite, pyrite and pyrrhotite, etc. Nonmetallic minerals were quartz, chlorite, carbonate, silicon line stone, sericite, cordierite, epidote, barite, etc. The valuable components were cerussite, sphalerite and oxide minerals of zinc. Metal minerals mainly exist in colloidal structure and honeycomb structure.The metasomatic phenomenon was obvious between metal mineral.

Minerals of lead (cerussite, galena and sardinianite) were aggregate of anhedral form, uneven degree of dissemination,and the residual structure of oxidation.galena was in strong oxidizing environment, protection shell was formed at the same time oxidizing, so that the galena was still in good condition exists in inclosure of lead carbonate. Sphalerite was xenomorphic granular,and was replaced by goethite and lepidocrocite along the edge with the malcrystal only.The oxide minerals of zinc were mainly smithsonite and hemimorphite. calamine were anhedral irregular particle aggregation and mainly distributed in the fissure of sphalerite or Contact between limonite and pyrite.Hemimorphite distributed directional, bundle, fibrous and plate or strip aggregation, mostly was in fissure of sphalerite or near a fine vein of quartz.

Quartz existed in anhedral allotriomorphic granular and granular. clinochlore existed in lepidoblastic texture and aphanitic, and was stained to brown by the iron mineral. Carbonate was anhedral granular. fibrolite was fiber crystalloblastic texture and radial crystalloblastic texture. Trace and Sericite were lepidoblastic texture and stained by iron. Other non-metallic minerals, such as cordierite, epidote, barite and so on, mainly showed anhedral particle.

FLOTATION TEST

The most valuable elements in the run-of-mined ore were lead, zinc and silver, and the main lead and zinc minerals were oxide minerals and the content of sulfide minerals of lead and zinc were small. The processing technology of this kind of ore in general can be divided into technics of "floating lead at first and floating the zinc later" and technics of " floating sulfur minerals at first and floating the oxide minerals later " two categories[7-8]. It was easy to cause loss of zinc because the flotation of " technics of floating lead at first and floating the zinc later " was according to the order of sulfide minerals of lead, oxide minerals of lead, sulfide minerals of zinc and oxide minerals of zinc and mineral of zinc should be depressed during the process in floating minerals of lead, and the flotability of

metal mineral in tailings was poorer. Therefore, technics of "floating sulfur minerals at first and floating the oxide minerals later" was used in this experiment , namely flotation according to the order of sulfide minerals of lead , sulfide minerals of zinc, oxide minerals of lead and oxide minerals of zinc. The feasibility of recovering the valuable components from the ore will be investigated

MESH OF GRIND TEST

The run of mine ore of the test was fine and the content of monomer of metal mineral in the sample was very low because it was tailings in mineral processing.Further grinding must be done for improving degree of liberation of the metal mineral and recovering metal minerals. The flowsheet used in the experiment was shown in Fig. 1. The experimental results were shown in Fig. 2.

use con.as Concentrate,use PbS as sulfide minerals of lead, use ZnS as sulfide minerals of zinc, use PbO as oxide minerals of lead,use ZnO as oxide minerals of zinc.

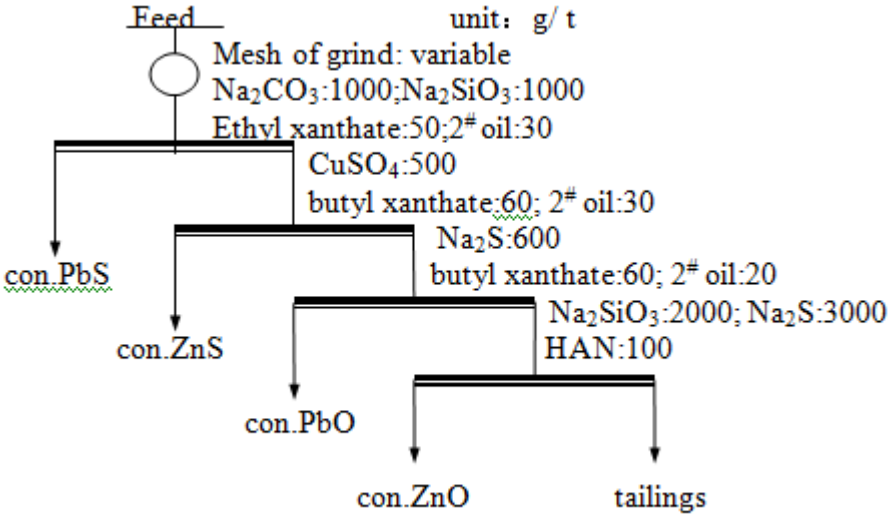
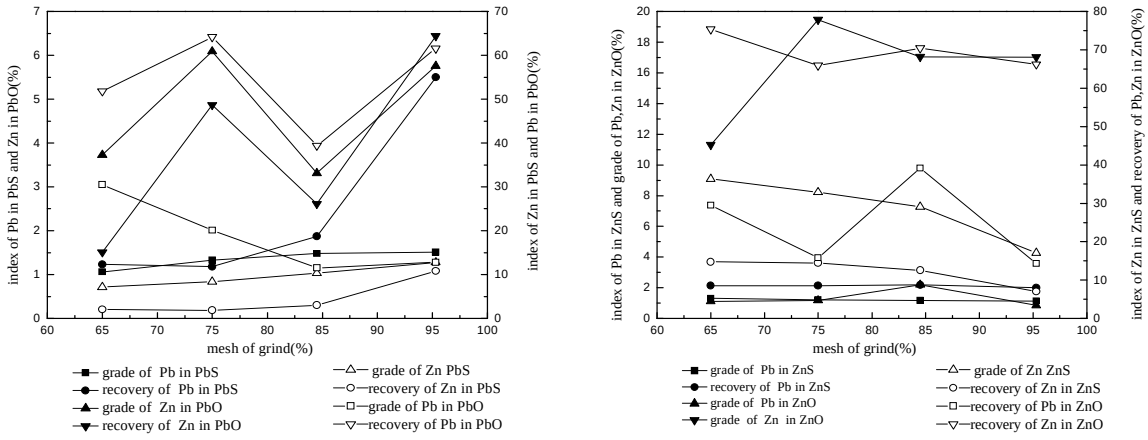


Fig.1: Flowsheet of Mesh of grind test



A B

Fig.2: The results of mesh of grind test,A:con.Pb(PbS and PbO),B: con.Zn(ZnS and ZnO)

The test result of mesh of grind shows that with the improvement of mesh of grind, the recovery of concentrate of lead and zinc tends to increase, the containing content of lead in zinc concentrate declines gradually. It was advantageous to improve the mesh of grind for concentration of lead and zinc because of high the degree of liberation of the metal mineral of lead-zinc. The mesh of grind for -0.074 mm 95.3% was used in the succeeding test.

The experimental results also showed the grade and recovery of lead in concentrate of lead sulfide were small, and

the grade of zinc in concentrate of lead sulfide increased significantly, a lot of zinc was lossed in concentrate of lead sulfide.This was mainly due to the content of sulfide mineral of lead was low in the ore and it was difficult to liberate galena from sphalerite because of small particle size of sulfide mineral of lead and close symbiosis with sphalerite.The process of sulfide minerals of lead will be removed in order to reduce the lossing of zinc.

THE DOSAGE OF SODIUM SULFIDE TEST IN FLOATING OXIDE MINERALS OF LEAD

Sodium sulfide was one of the common activator of flotation of oxide mineral of lead[9].The dosage of Sodium sulfide influences the results of separation oxide minerals of lead. The experimental flowsheet and conditions of dosage of sodium sulfide in lead oxide flotation were shown in fig. 3,the results were shown in fig. 4.

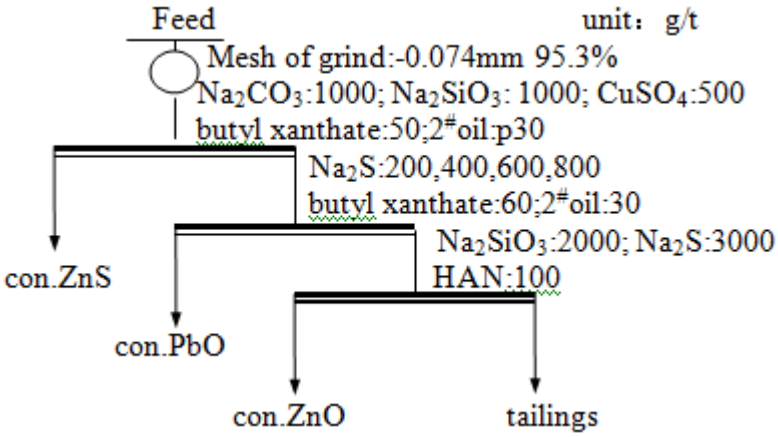


Fig.3:The test flowsheet and conditions of dosage of sodium sulfide

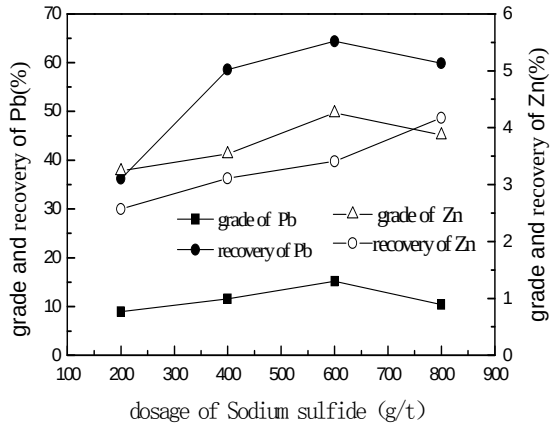


Fig. 4:the results of the dosage of sodium sulfide in oxide minerals of lead flotation

The test result of fig. 4 shows that when the dosage of sodium sulfide was from 200 to 600g/t, the grade and recovery of lead concentrate were improving with the increasing of dosage of sodium when the dosage of sodium sulphide was more than 600 g/t, grade and recovery of lead concentrate were decreasing with the increasing of dosage of sodium sulfide. When the dosage of sodium sulfide was 600 g/t, grade and recovery of lead concentrate reaches biggest. grade and recovery of zinc in concentrate of Lead oxide were also on the increasing trends with the increasing of dosage of sodium sulfide. Therefore, dosage of sodium sulphide for 600 g/t was suitable.

DESLIMING TEST BEFORE FLOATING OXIDE MINERALS OF ZINC

Seperation of oxide minerals of zinc by flotation wa s difficult Because of more clay mineral and slime ease going into oncentrate by foam entrainment in flotation[10-11].In general,the desliming technology before floating oxide minerals of zinc can reduce the influence of slime and improve enrichment ratio,so the desliming test was done to investigate the index of desliming yield effect on concentrate of oxide minerals of zinc. The experimental flowsheet and conditions of desliming yield before floating oxide minerals of zinc were shown in fig. 5,the test results of desliming yield were shown in fig. 6.

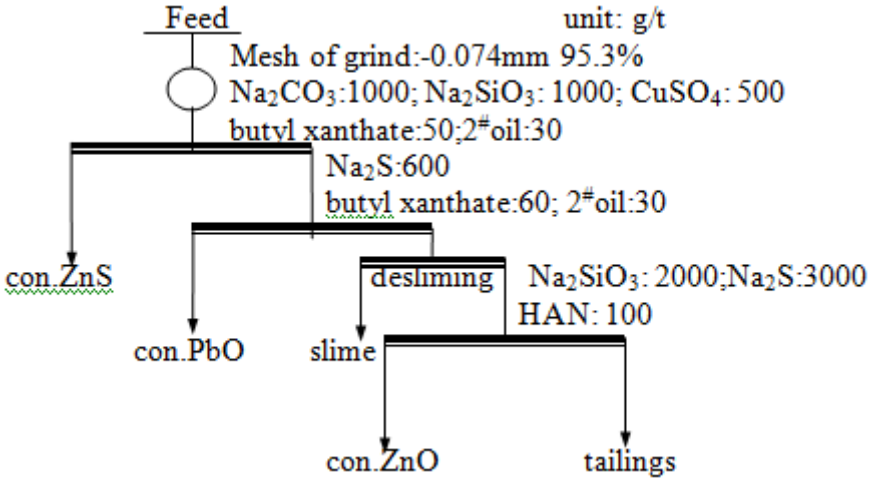


Fig.5:The experimental flowsheet and conditions of desliming yield

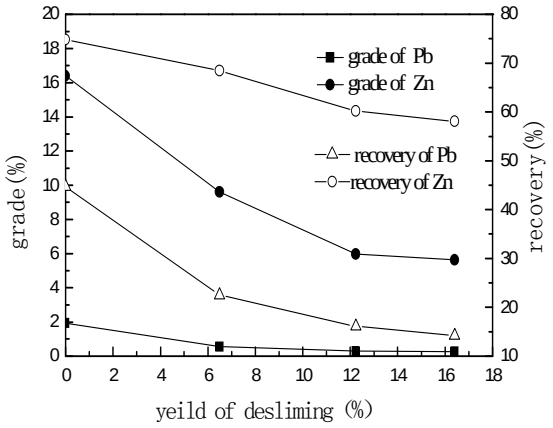


Fig. 6:the test results of desliming yield

The test results from fig. 6 show that the desliming was not beneficial effect on flotation of zinc oxide.The grade and recovery of zinc in zinc concentrate was decreasing significantly with the increasing of desliming.the desliming was not be used before floating of oxide minerals of zinc.

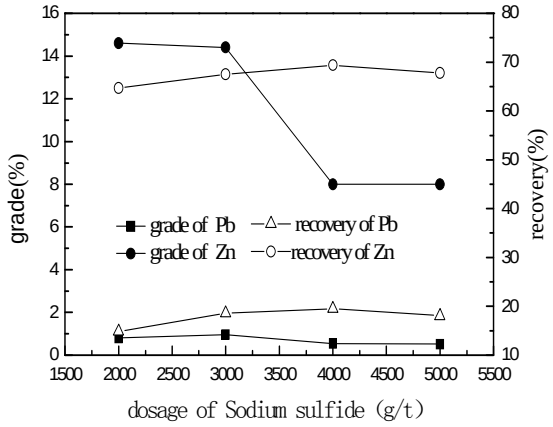


Fig. 7:the test result of dosage of sodium sulfide

3.4 The dosage of sodium sulfide test in floating of oxide minerals of zinc

It was potent and common to use sodium sulfide as adjustor to activate oxide mineral of zinc.The influence of

dosage of sodium sulfide on flotation of oxide mineral of zinc was examined in the test. The test flowsheet of dosage of sodium sulfide was shown in fig. 5, the test result of dosage of sodium sulfide was shown in fig. 7.

Form fig. 7,we can see that when the dosage of sodium sulfide was more than 3000 g/t, zinc recovery was high and stable,and zinc grade of concentrate reached the highest when the dosage of sodium sulfide was 3000 g/t, grade of zinc concentrate decreased with increasing dosage of sodium sulfide when dosage of sodium sulfide was more than 3000 g/t. Therefore, the dosage of sodium sulfide of 3000 g/t was suitable.

COMPREHENSIVE OPEN-CIRCUIT TEST AND CLOSED-CIRCUIT TEST

The flowsheet and conditions of open-circuit test were shown in fig. 8(returning product as Middling. two times cleaner be used in flotation oxide minerals of zinc,the third cleaner only be used in close-circuit test），the results of open-circuit test were shown in table 3.

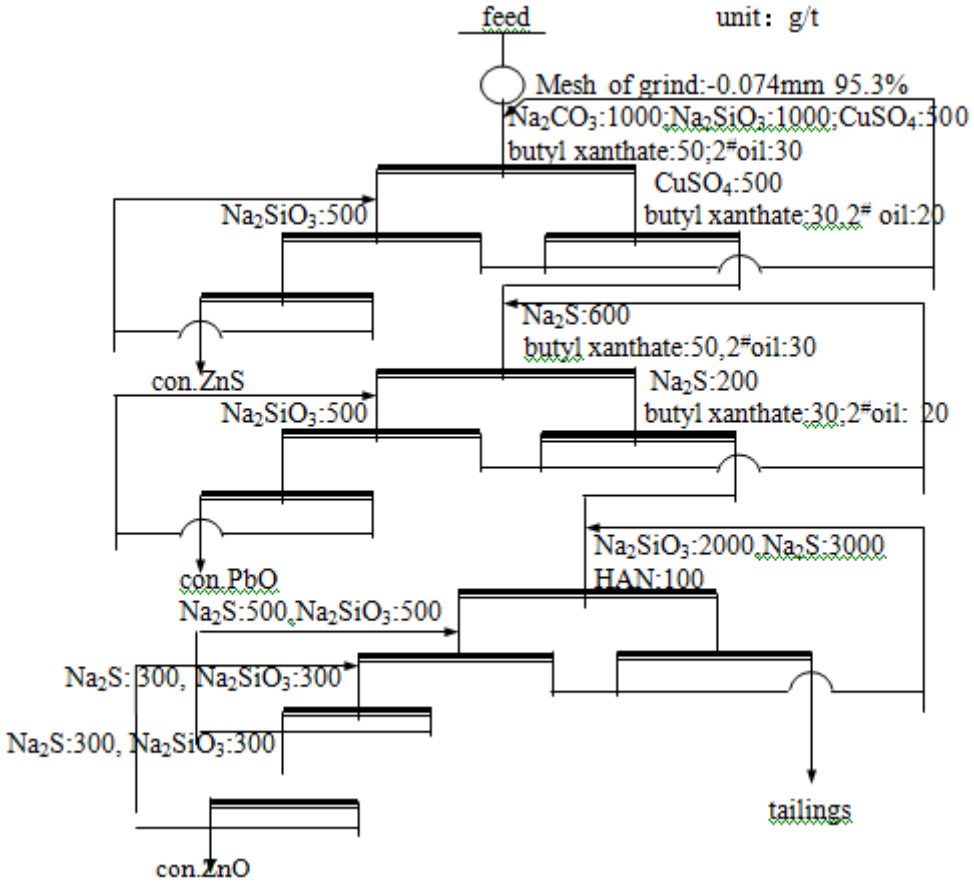


Fig.8:Flowsheet of close-circuit test(returning product as Middling in open-circuit test)

Table 3 The results of open-circuit test

product name	yeild （%）	grade （%）		recovery （%）	
		Pb	Zn	Pb	Zn
con.ZnS	0.65	1.13	46.00	1.35	11.36
con.PbO	0.51	49.00	5.31	45.94	1.05
con.ZnO	3.58	1.17	39.40	7.70	54.89
Middling	35.61	0.87	2.62	39.19	28.28
tailings	59.65	0.053	0.19	5.82	4.42
run-of-mined ore	100.00	0.54	2.57	100.00	100.00

Test results of Fig. 8 show that grade of lead oxide and zinc sulfide concentrate were high reach to the requirements of the concentrate quality, grade of zinc oxide concentrate was lower slightly, grade of concentrate can be improved by increasing the time of cleaner.

the close-circuit flotation test was done on the base of open-circuit test. In order to ensure the grade of zinc concentrate for greater than 40%, a time cleaner was added to floating oxide minerals of zinc in the Closed-circuit flotation test. The flowsheet and conditions of close-circuit test were shown in fig. 8, the results were shown in table

4.

Table 4 The results of open-circuit test

Product name	productivity（%）	grade（%）			recovery（%）		
		Pb	Zn	Ag（g/t）	Pb	Zn	Ag
con.ZnS	0.76	1.32	45.80	226	1.91	13.93	8.26
con.PbO	0.71	48.30	4.73	462	65.41	1.34	15.78
con.ZnO	4.25	1.59	41.60	154	12.89	70.76	31.49
tailings	94.28	0.11	0.37	9.80	19.79	13.97	44.47
run-of-mined ore	100.00	0.52	2.50	20.78	100.00	100.00	100.00

The closed-circuit test results show that higher grade of concentrate of sulfide minerals of zinc, concentrate of lead and concentrate of oxide minerals of zinc can got through recovering minerals of lead and zinc in the samples by flotation. Concentrate of sulfide minerals of zinc and concentrate of oxide minerals of zinc can be combined into a concentrate of zinc. The index of yield of concentrate of zinc for 5.01%, grade of concentrate of zinc for 42.24%, total recovery of zinc for 84.69% was obtained. The silver was recovered at the same time recovering lead and zinc by the flotation and total recovery of silver was 55.53%.

CONCLUSION

(1) Lead and zinc minerals in test sample mainly exists in the form of oxide, sulfide minerals of lead was little and it was difficult to get of concentrate of lead. Sulfide minerals of Zinc was not high too, but the flotability of sulfide minerals of Zinc was better. The concentrate of higher grade of sulfide minerals of zinc can be got by flotation.

(2) The index of better lead and zinc concentrate was got and silver was recovered too. Comprehensive recovery of valuable elements was realized through the experiment.

(3) The experiment proved that recovering of the lead, zinc, silver in the tailings using flotation method was feasible. The good economic benefit can be obtained through the reasonable development of the tailings resource.

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