

BENEFICATION OF LEAD & ZINC ORES

LEAD and Zinc are very important non-ferrous base metals used in the metallurgical and chemical industries. So far the only workable lead-zinc deposit exists in Zawar mines of Rajasthan. Recently some more lead-zinc deposits are also being developed in the Agnigundala area in Guntur district of Andhra Pradesh.

Lead and Zinc minerals are usually present as sulphides, the most common being galena (PbS) and sphalerite (Zn S) and they are preconcentrated by gravity methods, employing Heavy Media Separation, Jigging and Tabling depending upon the liberation size and ultimately concentrated by Xanthate flotation only. Usually lead sulphides are selectively floated from the ore followed by activation and separation of zinc in case of complex lead-zinc ores. Bulk flotation followed by separation of lead and zinc differential flotation is not quite uncommon. Table 3.5 at the end of this chapter, summarizes the beneficiation results of lead & zinc Ores studies.

A. LEAD ORES FROM ANDHRA PRADESH

Two samples have been tested in NML for the concentration of lead sulphides from the low grade lead ore of Bandalamottu Block of Agnigundala area.

Sample No. 1

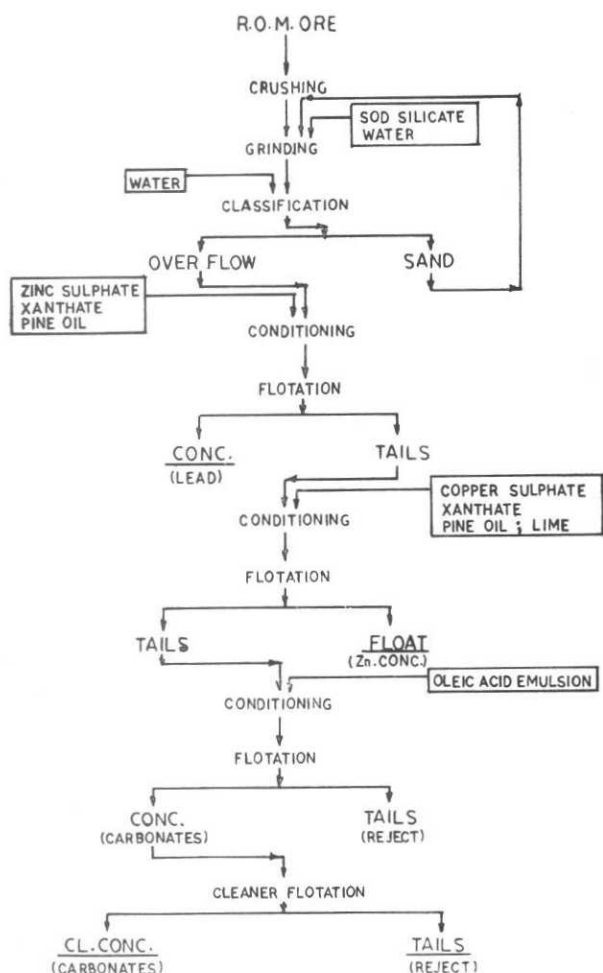
The sample was received from G.S.I. for beneficiation studies. The ore was composed of lumps from 10 to 70 mm in size and analysed as follows :

<i>Constituent</i>	<i>Assay %</i>
Pb	6.20
Cu, Zn & As	Trace
S	1.87
Fe	4.77
SiO ₂	11.55
CaO	22.86
MgO	13.82
Ag	11.5 gms/tonne.

Galena followed by minor amounts of pyrite, goethite and traces of sphalerite were the metallics observed in a matrix of dolomitic limestone. Galena was fairly liberated at 48/65 mesh size, although very fine interlocked galena grains were observed even at 150 mesh size.

Rougher flotation tests with a feed ground to 64.2% -200 mesh, 0.06 kg/tonne of Pot. Ethyl. Xanthate and 0.1 kg/tonne of cresylic acid yielded a galena concentrate analysing 60.4% Pb with 98.1% Pb recovery. Use of higher xanthates in the rougher flotation did not show any improvement. After one cleaning of the sample concentrate with 0.025 kg/tonne of xanthate, the concentrate analysed 73.9% Pb with 95.2% Pb recovery. Similar rougher flotation tests with 3.0 kg/tonne of lime in the grinding circuit to depress the pyrite, and by one cleaning of the rougher concentrate, the product analysed 78.6% Pb with 86.9% Pb recovery.

Tabling tests with a sized 48 mesh feed produced a combined table concentrate analysing 68.06% Pb with 62.1% Pb distribution. When the



Flowsheet 3.6—General flowsheet for beneficiation of lead zinc ores

table rejects and slime were floated under optimum conditions, the flotation concentrate thus obtained analysed 69.69% Pb with 28.7% Pb distribution in it. When the table and flotation concentrates were combined, the product analysed 68.45% Pb with 90.0% Pb distribution in it.

Sample No. 2

The 100 tonne sample composed of lumps upto 250 mm down to fines was received through M/s. H. C. Ltd., for batch and pilot plant scale investigations. Complete chemical analysis of the sample was as follows:

Constituent	Assay %
Pb	3.20
Cu	0.04
Zn	0.03
SiO ₂	16.20

Constituent	Assay %
Al ₂ O ₃	2.54
CaO	18.42
MgO	17.00
S	0.80
Fe	4.90
Ag	6.50 gms/tonne
CO ₂	31.50

Tabling tests with sized —10 mesh and —28 mesh feeds produced combined concentrates respectively assaying 6.53% Pb with 77.7% distribution and 7.58% Pb with 72.1% Pb distribution. Tests with —48 mesh sized feed followed by flotation of the table rejects and slime produced a combined table concentrate assaying 58.28% Pb with 61.7% distribution and a flotation concentrate assaying 68.79% Pb with 9.2% Pb distribution was produced. Combined table and flotation concentrate analysed 59.4% Pb with 70.9% Pb distribution in it.

Rougher flotation tests with 75.4% —200 mesh grind with 0.05 kg/tonne of pot. ethyl. xanthate and 0.04 kg/tonne of cresylic acid yielded a concentrate analysing with 0.015 kg/tonne of xanthate, the concentrate analysed 72.5% Pb with 82.0% Pb distribution. Use of lime in grinding circuit has slightly improved the grade, but the tailing losses were higher.

As the host rock was dolomitic limestone, fatty acid flotation tests were conducted on the rougher galena tails for the recovery of the limestone. Rougher flotation with 1.5 kg/tonne of sod. silicate and 1.0 kg/tonne of oleic acid emulsion, followed by two cleanings 0.5 kg/tonne of sod. silicate and 0.5 kg/tonne of oleic acid emulsion produced a concentrate analysing 42% CaO and MgO with 48.6% CaO + MgO distribution in it.

Pilot Plant Tests

Continuous pilot plant scale tests were also conducted with the ore. The ROM ore was crushed in a primary jaw crusher (50 mm gap) followed by a cone crusher (19 mm gap) operating in closed circuit with a vibrating screen and then stored in the ore bin.

The crushed ore was fed to a ball mill (183 cm × 91.5 cm) through a constant weight feeder. The ball-mill discharge was sent to the

rake classifier which will feed back the over-size that is sand to the ball mill. The classifier overflow was pumped to the conditioner and then to a battery of 12 Nos. Denver No. 8 cells for roughing. Cleanings were done in a set of 6 Nos., 3 Nos & 3 Nos. of Denver No. 7 cells. The cleaner tails were recirculated to the ball mill. The final concentrate was taken to the thickener when it was dewatered and the solids were filtered on a vacuum disc filter.

Continuous pilot plant scale tests indicated that with 75 to 78% -200 mesh grind, 0.06 kg each of xanthate and cresylic acid per tonne were optimum where in the concentrate analysed 71.5% Pb with 89.3% Pb distribution in it.

B. RAJASTHAN ORES

Rajasthan ores contained lead and zinc sulphides. At Zawar the Hindusthan Zinc Ltd. are processing the ores for the production of lead and zinc concentrates. Other complex lead and zinc ores occur at Dariba-Rajasthan area.

(i) Zawar Ore

Heavy media separation tests were conducted on the zawar ore for their preconcentration. The ore received for the tests consisted of 75 mm lumps with small amounts of fines. Complete analysis of the sample was as follows:

Constituent	Assay%
Pb	1.96
Zn	4.34
CaO	16.51
MgO	11.99
SiO ₂	28.45
Al ₂ O ₃	1.83
Fe	2.89
S	2.81

Examination of the sample under microscope revealed that sphalerite and galena were associated with dolomitic limestone.

HMS tests conducted with +10 mesh sized feed at medium specific gravity of 2.7, rejected 34.5% of the feed with 10.03% Zn distribution in it. When the HMS concentrate was mixed with the -10 mesh untreated fines, the product analysed 3.3% Pb and 6.08% Zn with 100% Pb and 89.97% Zn distribution in it.

(ii) Balaria Ore

The sulphide ore deposit of Balaria, Rajasthan contained chiefly of zinc and was received from M/s. H. Z. Ltd. Udaipur for HMS tests. Complete chemical analysis of the sample was as follows:

Constituent	Assay%
Zn	5.10
Pb	0.006
CaO	17.61
MgO	13.07
SiO ₂	21.29
Al ₂ O ₃	4.203
Fe	5.38
Cu	0.06
S	3.76
LOI	27.50

Microscopic examination of the ore revealed that sphalerite and minor amounts of pyrite, pyrrhotite, galena and marcasite were the sulphides present in association with the dolomitic limestone. Fair liberation of the sulphides was expected at 150 mesh size.

HMS tests conducted with crushed ore to 70 mm, 50 mm and 25 mm after removing the -10 mesh fines at specific gravity 2.7 of the medium, 20% of the 70 mm feed, 27% of the 50 mm feed and 32.9% of the +25 mm feed were rejected, resulting in heavier fractions analysing 6.02% Zn with 81.13% Zn distribution and 6.72% Zn with 73.5% Zn distribution. Respective losses in the float products at medium specific gravity of 2.7 were 8.01%, 11.17% and 14.91% Zn.

C. LEAD-ZINC ORE FROM NEPAL

A sample of germanium bearing lead-zinc ore was received from the Director, National Chem. Laboratory for the concentration of germanium, lead and zinc. The sample consisted of lumps ranging in size from 50 mm to 125 mm and analysed as follows:

Constituent	Assay%
Pb	12.25
Zn	40.89
S	22.74
CaO	2.89
SiO ₂	3.89
MgO	2.36
GeO ₂	0.034

TABLE 3.5—BENEFICIATION RESULTS ON LEAD ZINC ORES

State and Locality	Feed Assay %	Beneficiation Method	Conc. assay %	Conc. recov. %	Remarks
I. Andhra Pradesh					
1) Bandalamottu block, Agni-gundala area	6.2 Pb 36.68 CaO+MgO 11.5 gms/Ag/ton	Rougher xanthate flotation with one cleaning	73.9 Pb 85 gms/T/Ag	95.2 Pb	Core sample
2) "	3.2 Pb 35.42 CaO+MgO 6.5 gms/Ag/T	Rougher xanthate flotation with 3 cleanings Soap flotation of carbonates	72.5 45.5 CaO+MgO	82.0 Pb 78.0 CaO+MgO	Pilot plant scale tests showed slightly higher recov. By product
II. Rajasthan					
3) Zawar	1.96 Pb 4.34 Zn	HMS tests at 2.7 sp. gr. for +8 mesh and mixing the conc. with -8 mesh fines	3.30 Pb 6.08 Zn	100.0 Pb 99.97 Zn	Pre-concentration to reject 34.5% of the feed by HMS
4) Balaria	5.1 Zn 0.006 Pb	HMS tests at 2.7 with ore crushed to 75 mm, 50 mm and 25 mm after removing -10 mesh fines	2.12 Zn 2.15 Zn } Tail 2.4 Zn }	97.99 Zn 88.83 Zn 85.01 Zn	Pre-concentration not practicable
III. Nepal Pb-Zn Ore					
	12.25 Pb 40.89 Zn 0.034 GeO ₂	Differential flotation of Pb and Zinc	60.87 Pb 0.081 GeO ₂ 60.66 Zn 0.112 GeO ₂ 60.25 Zn	81.8 Pb & 200% GeO ₂ 57.2 Zn & 66.3 GeO ₂ 89.99 Zn	GeO ₂ in the first zinc float only Total Zn recovery Total Zn Conc.

Pb concentrate obtained by differential flotation with a feed ground to 69.1% -200 mesh 3.0 kg/tonne of Sod. Carbonate, 0.5 kg/tonne of Sod. Cyanide, 1.0 kg/tonne of zinc sulphate, 0.06 kg/tonne of pot. ethyl xanthate and 0.18 kg/tonne of cresylic acid—analysed 60.87% Pb, 16.5% Zn and 0.081% GeO_2 with 81.8% Pb, 6.5% Zn and 20.0% GeO_2 concentration in it. Subsequent three different zinc floats collected with 2.0 kg/tonne of CuSO_4 , 0.25 kg/tonne of pot. ethyl. xanthate, and 0.54 kg/tonne cresylic acid analysed respectively 60.66% Zn, 61.80% Zn and 55.72% Zn with respective zinc recoveries of 57.2%, 28.2% and 4.5% in them. The GeO_2 content respectively in the three products was 0.112% with 66.3% recovery, 0.006% with 1.7% recovery and 0.005% with 0.2% recovery in them. Magnetic separation of the tailing indicated the marginal loss of 3.8% GeO_2 in the magnetic portions and 8.0% GeO_2 in the non-magnetic portions. Use of higher xanthates did not show any improvement on the results.

Over all test results indicated the association of germanium with zinc minerals that too which

float off as first concentrate. The first float of zinc concentrate was pale in colour also.

References

- 1 Concentration of low grade galena from Bandalamottu Block, Agnigundala Area, Andhra Pradesh—NML IR. No. 518/69—S. K. Banerjee & P. I. A. Narayanan.
- 2 Batch and pilot plant studies for the concentration of galena from a low grade lead ore from Bandalamottu Block, Agnigundala Area, A.P. for M/s. H.C.L.—NML IR. No. 709/72.
- 3 Pre-concentration of lead-zinc ore from zawar employing heavy media separation—NML IR. No. 260/63—S. K. Banerjee, S. K. Dhar, G. V. Subrahmanya & P. I. A. Narayanan.
- 4 Heavy Media Separation studies with the zinc ore from Balaria—Rajasthan—NML IR. No. 728/73—P. N. Pathak, D. M. Chakravarty, S. K. Banerjee.
- 5 Concentration of Germanium, from lead-zinc ore from Nepal—NML IR. No. 84/56—G. P. Mathur, S. B. Dasgupta & P. I. A. Narayanan.