

EXTRACTION OF LEAD METAL FROM INDIGENOUS GALENA

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Extraction of lead metal from indigenous lead ore (galena) has been successfully carried out by smelting (precipitation) method. Effect of different fluxing agents on the distribution of lead metal in the slag-matte-system was studied by analysing the slag and matte for their diffused lead content while lead for its iron contamination. The appropriate amount of different components of the charge containing 1 kg of the ore (65% PbS) are found to be 50-75 g common salt, 100-110 g soda ash and 160-165 g iron scrap, smelting temperature ranging from 900°C-1000°C with a time period of 1½ to 2 hr. Optimum recovery of the metal ranged from 95-98% with a purity of 98.5 to 99.12% Pb, the impurity being mainly iron.

The availability of lead ore, iron scrap, various fluxing agents employed and the specific properties of the end-product ensure the feasibility of the process.

Introduction

Lead metal plays an important role in many industries as metallic lead, its alloys and chemical compounds. Its use is well recognised in the metallurgy of precious metals like silver and gold, where it is employed as a collector in the Park's process.¹

Lead ores always have many impurities which complicate the smelting process reactions. These impurities must be separated by the formation of slag. In addition to slag, another substance "matte" is usually formed between the slag and the heavy lead metal. The specific gravity of the metal and the matte is not sufficiently divergent to allow their complete separation. Addition of fluxes such as common salt, soda ash, lime, etc., is necessitated to decrease the specific gravity the matte for its separation from the metal.

The smelting of lead ore is based on three principles,² (i) the reduction of ore by C or CO, (ii) the roast-reaction and (iii) the precipitation method.

The present studies have been carried out for the extraction of lead metal from indigenous galena³ by the precipitation method. Typical analysis of the ore used runs as under: PbS 64.8%, SiO₂ 28.1%, Al₂O₃ 1.8%, CaCO₃ 2.8%.

Experimental

The ore was ground to pass through a coarse screen, the largest to pass through being of the size of 1/4 in. The charge comprising 1 kg (650 g PbS) of ore with necessary fluxing materials and iron scrap which consisted of mild steel or wrought iron or tinned scrap, but not cast iron, was added in a graphite crucible No. 6. The

crucible was lowered into a natural gas-fired furnace, the heat was turned on and after a period for warming up furnace, the operating temperature was noted with an optical pyrometer. After ½ hr the crucible was again examined. The fusion was closely watched and great care was taken to mix the contents of the crucible thoroughly together.

The freed lead gravitated to the bottom of the crucible. The slag and matte were laddled off with an iron spoon and the contents of the crucible poured into moulds. The matte and slag were taken separately. The slag and the matte from different batches smelted at different temperatures for different periods and were weighed and analysed for their lead contents, while the lead metal was analysed for its iron contamination. The results are shown in Tables 1-4.

Results and Discussion

For all practical purposes maximum extraction of metal is the prerequisite of a good commercial concern. Galena when fused with varying amounts of iron scrap and fluxing materials gave products whose analysis gave some interesting results. The amount of lead ore being kept constant, increased additions of iron scrap led to increased percentage recovery of lead. This percentage attained an optimum value when PbS in the ore and iron scrap were in their molar proportion (PbS:Fe 239:56 approx.). A slight excess (0.2-1.6%) in the amount of scrap iron is held as mechanical suspension in the lead metal as Pb-Fe compound (Table 1). The metal obtained by the direct precipitation method has to be got rid of its iron burden by further treatment. This iron can be removed by the addition of calculated amounts of PbS or sulphur which forms the sulphide of iron leaving 99% pure metal. Here the

TABLE 1.—EXTRACTION OF LEAD METAL FROM GALENA.

Ore taken, 1 kg. (650g PbS); soda ash, 100 g, common salt, 50 g; time, 1½ hr.,
temp 950–1000°C.

Iron in lead %	Lead in matte %	Wt of slag formed g	Lead in slag %	Recovery of lead %	Remarks
0.2	3.81	282	0.8	87.04	Lead metal is soft.
0.31	3.50	290	0.65	92.00	do
0.42	3.29	305	0.51	95.05	do
0.76	2.92	311	0.46	96.00	Somewhat hard metal.
0.85	2.64	315	0.38	96.90	Harder lead metal due to Fe-Pb alloy formation.
1.02	2.40	319	0.32	97.33	do
1.12	2.12	323	0.31	97.86	do
1.61	1.86	332	0.24	98.40	do

TABLE 2.—EFFECT OF VARIATION OF SODA ASH AND COMMON SALT ON THE EXTRACTION OF LEAD FROM GALENA.

Ore, 1 kg (650 g PbS); iron, 160 g; time of heating 1½ hr, Temp 950–1000°C.

Soda ash g	Common salt g	Recovery of lead obtained %
50	50	83.48
100	50	92.36
150	50	96.10
200	50	96.80
250	50	97.33
300	50	98.22
100	100	89.71
100	150	87.38
100	200	85.96
100	250	85.25
100	300	84.72

TABLE 3.—EFFECT OF VARIATION OF TIME OF HEATING AND TEMP. OF SMELTING ON THE EXTRACTION OF LEAD.

Ore, 1 kg (650 g PbS); soda ash, 150 g. common, salt 50 g Iron, 160 g.

Time in hr	Temp °C	Recovery of lead %
1½	800	71.05
1½	850	75.84
1½	900	88.80
1½	1000	95.91
1½	1100	90.59
1½	1200	86.14
1	900	81.70
2	900	92.36
3	900	90.00

TABLE 4.—EFFECT OF VARIATION OF LIME AND COMMON SALT ON THE EXTRACTION OF LEAD FROM GALENA,

Ore, 1 kg (650 g PbS) Iron, 160 g; time 1½ hr.

Lime g	Common salt g	Iron in lead %	Lead in matte %	Wt of slag g	Lead in slag %	Recovery of lead %	Temp
200	0	0.61	13.21	380	6.12	69.27	1000–50°C
300	0	0.56	11.13	400	5.71	5.71	1100°C
400	0	0.51	10.72	422	4.42	75.50	1150°C
350	50	0.57	11.21	416	4.61	78.59	100°C
325	75	0.60	10.52	410	4.42	81.39	1050°C
300	100	0.42	7.64	370	3.63	86.14	1050°C
200	200	0.31	7.91	385	3.81	85.20	1000°C
100	300	0.30	8.40	390	3.24	83.65	950°C
0	400	0.29	8.93	410	3.90	81.71	950°C

iron sulphide formed is collected in the matte. The principal advantage of matte is that it will take care of a large amount of the base material. Soda ash or other suitable fluxing materials is, therefore, added to aid the separation of metal from matte. In some of the experiments the matte showed an appreciable amount of lead. The matte can be attended to and dealt with by a reduction treatment with iron separately. Slag containing up to 1% lead may be discarded.

Table 2 shows the effect of variation of the amounts of soda ash and common salt, other parameters of the reaction being constant. Addition of soda ash has a two-fold function. It enhances the separation of occluded lead and promotes the decomposition of $PbSiO_3$. Table 2 shows that increase of soda ash with the optimum amount of NaCl beyond a reasonable limit (Compositions 3-6) is not of much help as compared to its amount used. On the other hand, increase of common salt beyond that for optimum extraction adversely affects the extraction and only increases the bulk of the slag and matte. It is, therefore, appropriate to add soda ash in the approximate equivalent proportion of the amounts of SiO_2 or Al_2O_3 present in the ore. In order to cut down the cost of the process by using minimum amount of soda ash, it is required that the ore must be of high grade (not less than 70% PbS). This can be done by reducing its siliceous materials by concentration of the ore.

Total replacements of soda ash by common salt do not give as good results as otherwise. Keeping in view the marked difference in the costs of soda ash and common salt, partial replacement of soda ash firstly, compensates for the loss suffered in the recovery of lead metal. Secondly, common salt assists the separation of slag from the metal and matte, and tends to promote the fusion of siliceous matter of the ore.

The effect of temperature and time on the percentage yield of lead metal is shown in Table 3. Results show that the operating temperature lies in the range of 900-1000°C. With the lowering of fusion temperature below 850°C the percentage of extracted metal also declines. Moreover, higher temperature attainment increases the cost

of high temperature production accompanied by a loss due to volatilization and slagging as well.

Table 3 also shows the effect of duration of heating on the percentage extraction. Normally 1½-2 hr are sufficient for good extraction after warming up of the furnace. The richer the ore is, the shorter the time required. On an average 4 meltings can be done per 12 hr.

Another study was undertaken to determine the effect of other fluxes, like lime, on the fusion temperature and percentage extraction of metal. Although as a result of the present studies it was possible to replace soda by lime, yet the fusion temperature was fairly high.

Summary

An attempt has been made to extract lead from indigenous galena (PbS 65%) by precipitation method, using iron scrap soda ash and common salt. For an optimum extraction 160-65 g iron scrap, 100-110 g soda ash and 50-75 g common salt are required for one kg of the ore.

Experiments were carried out with a view to replacing soda ash by common salt. The results obtained showed the possibility of partial replacement of soda ash by common salt, giving approximately equivalent results. Replacement of soda ash by lime, however, required a higher fusion temperature with lesser recovery.

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