

## **Processing of dust materials from Indian copper plants**

R.K. JANA, B. GORAI and PREMCHAND

National Metallurgical Laboratory, Jamshedpur - 831 007

### **ABSTRACT**

*In the pyrometallurgical processing of copper ore, there is considerable amount of copper losses in the form of dust from the roaster, smelter and converter. Most of this dust is simply charged back into the smelting circuit, thereby reducing the capacity of fresh charge processing. In the present paper separate processing of copper dust sample by sulphuric acid leaching method has been examined with the idea that the resulting leached copper sulphate solution can be used as electrolyte in the copper electrorefining section of the plant. The copper dust sample from Khetri Copper Complex, Rajasthan contained about 22% copper. The XRD analysis of the sample revealed that copper was mainly present in the forms of oxides, sulphates and sulphides. Simple water leaching of the dust sample dissolved copper to the tune of 30%. This implied that about 30% of copper was present in the sulphate form and rest of the copper was in the oxide and sulphide forms for which acid leaching process might be suitable. Sulphuric acid leaching at various concentration and at varied solid : liquid ratio, time and temperature were carried out at atmospheric pressure. The maximum recovery of copper obtained in these experiments was found to be about 52%. Since the sulphuric acid leaching at atmospheric pressure did not yield good results, the dust sample was leached at higher pressure in an autoclave on 200 g scale and the recovery of copper improved to 80%.*

**Keywords :** Waste characterization, Copper plant dust, Copper recovery, Leaching.

### **INTRODUCTION**

In the pyrometallurgical processing of copper concentrate considerable amount of copper loss occurs in the form of dust. It has been found that for treatment of 1000 tons of flotation concentrate, 70-100 tons of dust is formed<sup>(1)</sup>. Amount of

dust in a roaster may be 6% of the weight of the charge. Dust created in the reverberatory furnace settles on the front or skim end of the charge and is discharged with the slag, leading to excessive copper loss. The interior of the furnace leads to eventual spalling and destruction of the brickwork by these dust. Hot dust escaping in the flue lodges in the tubes of the waste heat boilers and considerably interfere with the boiler efficiency. The converters are not so prolific a source of dust as in smelting operation but the actual copper content of the dust is in the order of 30-35% copper compared to 20% in reverberatory furnace and 6-10% in roaster <sup>[1]</sup>. In order to ensure efficient recovery and collection of dust all the plants have dust collecting units like: collection of dust beneath flues, expansion chambers, baloon flues, boiler settling, filtration through cloth bags in a baghouse, electrostatic precipitation in Cottrell treaters etc. <sup>[2]</sup> Since the dust from various operations can amount 10% of the feed <sup>[1]</sup>, its recovery and processing is necessary from economic angle. So far as treatment of dust is concerned, it depends upon the composition of the dust, but usually the dust is simply charged back into the smelting circuit. Most of the dust is fed into the reverberatories but some dust is also charged into roaster or converter. In this process the total production capacity of the plant reduces. Therefore, the need for developing a separate suitable route for dust processing has long been felt <sup>[2-5]</sup>. In the present paper sulfuric acid leaching of dust samples have been examined. This route has the advantage of using leached copper sulphate solution as electrolyte in the copper electrorefining section of the plant after necessary purification of leached solution by solvent extraction route <sup>[6-8]</sup>.

## MATERIALS AND METHODS

Copper dust sample used in the experiments was received from M/s. Khetri Copper Complex, Rajasthan. The sample was ground and mixed thoroughly. Then the representative samples were prepared by coning and quartering method for XRD and chemical analysis. The chemical analysis of the sample was done by conventional method as well as by atomic absorption spectrometer. The XRD analysis of the sample was performed using CoK<sub>α</sub> target in a PHILIPS diffractometer. Leaching tests were carried out on 100 g scale with the help of a magnetic stirrer having speed and temperature controlling options. Pressure leaching experiment was also performed (in an autoclave PARR, USA-Model No. 4521M). Distilled water and LR grade sulphuric acid were used for all the leaching tests. Chemical analysis of leach liquors were done by conventional method as well as by atomic absorption spectrometer.

## RESULTS AND DISCUSSION

The sieve analysis of the ground copper dust is shown in Table 1. It can be

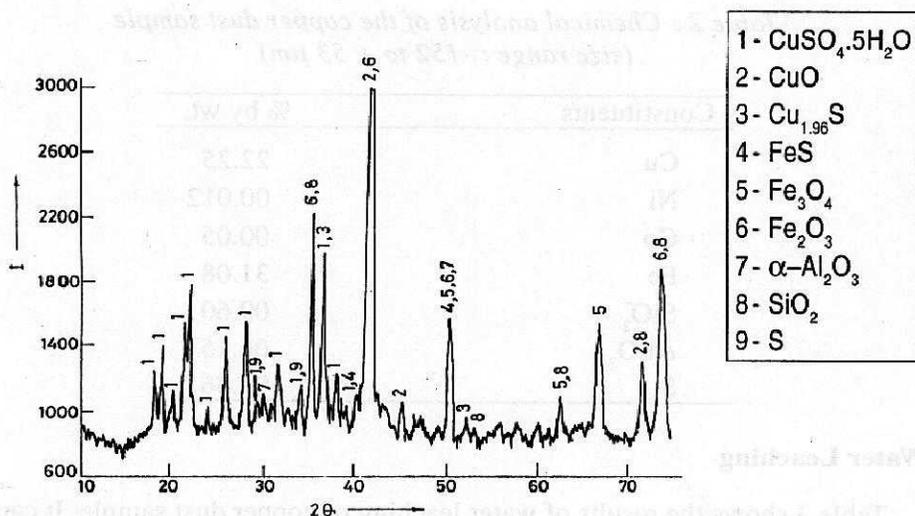


Fig. 1 : XRD pattern of copper dust sample.

seen that most of the samples lies between -152 to + 53  $\mu\text{m}$  size range. Therefore, these fractions were chosen for leaching studies. The chemical analysis of -152 to + 53  $\mu\text{m}$  size copper dust sample is shown in Table 2. It contains about 22% copper apart from considerable amount of iron, silica, alumina and sulphur. The XRD studies of the sample showed that copper in the sample was present in the forms of sulphate, oxide and sulphide. Therefore, water leaching of the sample was first examined to dissolve copper sulphate from the sample [9]. Later on, all the leaching tests were carried out in sulphuric acid so that resulting copper sulphate solution can be used as electrolyte in the copper electro-refining tank. The results of various leaching tests are discussed in the following sections.

Table 1 : Sieve analysis of copper dust sample

Size ( $\mu\text{m}$ )	Weight (%)
+ 211	1.0
- 211 to + 152	1.14
- 152 to + 104	5.15
- 76 to + 76	5.36
- 76 to + 66	80.80
- 66 to + 53	5.70
- 53	0.83

Table 2 : Chemical analysis of the copper dust sample  
(size range : -152 to + 53  $\mu\text{m}$ )

Constituents	% by wt.
Cu	22.25
Ni	00.012
Co	00.05
Fe	31.08
SiO <sub>2</sub>	09.60
Al <sub>2</sub> O <sub>3</sub>	06.15
S	04.46

### Water Leaching

Table 3 shows the results of water leaching of copper dust sample. It can be seen that the recovery of copper in water leaching is about 30% which implies that about one third of the total copper present in the dust sample is probably in the form of copper sulphate which is easily soluble in water. The water leached residue was further treated with 10% sulphuric acid, which yielded copper dissolution to the tune of 18.5%. Thus the total recovery of copper in water leaching followed by 10% sulphuric acid leaching was about 49%.

Table 3 : Results of leaching studies with copper dust sample

Materials	Leachant	Solid:liquid ratio (S:L)	Time (h)	Temp. (°C)	Copper recovery (%)
100 g copper dust sample	Water	1:3	4	30	30.08
Leached residue of above	Sulphuric acid (10% by vol.)	1:3	4	30	18.47
Total					48.55

### Effect of Acid Concentration

The water leaching of copper dust sample did not produce good recovery of copper as most of the copper was in oxide and sulfide forms. Hence sulphuric acid leaching tests were carried out to improve the copper dissolution. The results of the leaching studies with 10% and 20% H<sub>2</sub>SO<sub>4</sub> are given in Table 4. The recoveries are about 42% and 49% respectively. Thus it is evident that on in-

creasing the concentration of acid, recovery of copper did not improve substantially.

*Table 4 : Sulphuric acid leaching of copper dust sample at different concentrations of sulphuric acid*

Sulphuric acid conc. (vol. %)	Solid: liquid	Time (h)	Temp. (°C)	Copper recovery (%)
10	1:3	4	30	42.40
20	1:3	4	30	49.18

**Effect of Time**

The effect of duration of leaching on recovery of copper is shown in Table 5. It can be seen that in the case of 10% sulphuric acid leaching, the recovery of copper did not change much with leaching duration changing from 3 to 4 hours. Similarly on increasing the duration of leaching from 4 to 6 hours in case of 20% sulphuric acid leaching, copper dissolution (about 50%) did not improve appreciably.

*Table 5 : Effect of duration in sulphuric acid leaching of copper dust sample*

Sulphuric acid conc. (vol. %)	Solid: liquid	Time (h)	Temp. (°C)	Copper recovery (%)
10	1:3	3	30	39.79
10	1:3	4	30	42.40
20	1:3	4	30	49.18
20	1:3	6	30	51.14

**Effect of Solid : Liquid Ratio**

Solid : liquid ratio was varied to determine its effect on leachability of copper. The results presented in Table 6 show that recovery of copper remains almost unchanged on increasing the solid liquid ratio from 1:3 to 1:4. The recovery of copper in these cases were about 49%.

*Table 6 : Effect of S:L ratio on sulphuric acid leaching of copper dust sample*

Sulphuric acid conc. (vol. %)	Solid: liquid	Time (h)	Temp. (°C)	Copper recovery (%)
20	1:3	4	30	49.18
20	1:4	4	30	49.44

### Effect of Temperature

Leaching test at elevated temperatures were also carried out to evaluate its effect on recovery of copper. It is evident from Table 7 that on increasing the leaching temperature from 30°C to 65.2°C there is only marginal improvement of copper recovery with the use of both 10% and 20% sulphuric acid.

Table 7 : Effect of temperature in sulphuric acid leaching of copper dust sample

Sulphuric acid conc. (vol. %)	Solid: liquid	Time (h)	Temp. (°C)	Copper recovery (%)
10	1:3	4	30	42.40
10	1:3	4	65.2	50.17
20	1:3	4	30	49.18
20	1:3	4	65.2	50.76

### Pressure Leaching Test

Finally one pressure leaching experiment with 10% sulphuric acid was carried out. The recovery of copper in this case was found to be about 80%. The improvement in copper recovery may be due to the dissolution of the copper sulphide present in the dust sample <sup>[10,11]</sup>.

### CONCLUSION

The copper dust sample contains high amount of copper (22.2%) which needs to be extracted by hydrometallurgical route. However, from the results of the preliminary leaching studies at normal pressure, it is evident that copper recovery can not be achieved more than 51%. This may be due to that a portion of copper is present in the form copper sulphide. Therefore, pressure leaching technique was adopted and improvement in copper recovery upto 80% was achieved.

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### ABSTRACT

Use of chromium in metal plating and leather tanning industries generates a lot of effluent containing Cr(VI) and Cr(III). Besides severe water pollution, substantial amount of chromium is lost due to the presence of various effluent treatment techniques followed over the years. Based on recovery and reuse methodology, the current project is an effort to assess the environmental, economic and safety aspects of chromium extraction technologies for recovery. This paper details the comparison of different technologies for recovery of chromium from effluent. The study includes the recovery of chromium from effluent by precipitation, ion exchange and solvent extraction. The experimental data on precipitation, ion exchange and solvent extraction are presented. The results of solvent extraction with D2EHA and CMX 303 for chromium recovery from spent tanning bath are also discussed.

Keywords: Chromium, Chromium electroplating, Leather tanning, Metal recovery, Solvent extraction.

### INTRODUCTION

Chromium is mainly used in the electroplating and tanning industries for surface treatment as well as finishing of metal, plastics and leather, respectively. As a result of these applications chromium enters in the effluent streams causing harm to the environment. Due to stringent laws coming into existence the awareness of polluting treated effluents and their control are being increased. Besides environmental aspects, substantially large amount of metals are disposed off resulting in enhanced burden on the depleting primary resources like ores and minerals. It is therefore essential to look for not only