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Salvaging the values from the rejects of a by-product recovery plant

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ABSTRACT

Two samples of table tailings (-147 μm and -74 μm in size) from refractory linings of the precious metal recovery (PMR) plant of Indian Copper Complex (ICC), Ghatshila were received to study the possbility to recover residual values of precious metals from them. Analyses, as reported by ICC, were 0.021% Au and 0.39% Ag for the -147 μm sample and 0.023% Au and 0.47% Ag for the -74 μm sample. Multi-Gravity Separator (MGS) studies, with varying design and operating variables, showed three-fold upgradation — assay of Au improved from 0.023% to 0.076% and assay of Ag improved from 0.47% to 1.53%. The -74 μm sample yielded better results with MGS than the -147 μm sample.

Keywords : Multi-Gravity separator, Precious metals, Gold/Silver, recovery, Residual values.

INTRODUCTION

By-products are extremely important in the economics of copper production, particularly for very low-grade operations. Copper mining is now a very marginal operation and many major operations have been forced to shut down. In many cases it is the by-products, such as gold, silver etc., which have made deposits economically workable [1]. In fact, gold production of India, has significantly gained through recovery of gold as by-product from copper slime and receipt of gold against shipment of copper anode slimes abroad for toll-smelting[2]. On the other hand, silver is recovered only as by-product in the country from copper slime, lead concentrate, zinc concentrate, refining of gold and also from shipment of copper anode slime abroad. Economically viable native silver deposits are not reported as yet [3]. Recovery of precious metals from electronic scrap is also reported elsewhere [4,5].

Recovery of precious metals (Au, Ag etc.) is being done at Precious Metal Recovery (PMR) plant of ICC, Ghatshila from de-nickeled and de-selenised slime after treatment of copper concentrate through pyrometallurgical processes and electro-refining. At the PMR plant, recovery of telurium (Te) is done as the first stage of operation. Then from its residue, Au and Ag are bulk-recovered pyro-metallurgically, and separated through hydro and electro-metallurgical processes. Refractory bricks of the furnaces, used to recover Au and Ag from the residue after recovery of Te, are to be changed periodically. These rejected refractory bricks contain significant quantities of the precious metals. Presently, a part of these metals are being recovered by grinding and then tabling of the rejected bricks. The table tailings, however, contain more than 200 ppm of Au, about 0.4% Ag and other metals in varying quantities. Attempts have been made to recover the precious metals from these table tailings which were preserved awaiting development of suitable technology to recover the residual values worth several million rupees.

There are many plants where minerals are recovered in secondary circuits by treating the tailings. The working costs for treating the old tailings dumps are much lower than those of conventionally mined ores. Such operations have been set up in many old mining areas where large tonnages of mill tailings, amenable to processing, are available [6,7].

The world is now becoming aware of the limited availability of its resources at a reasonable price, and of the ever-increasing developmental costs of large new mines. Reprocessing of old tailings on a large scale must be worth examining very seriously, wherever sufficient quantities of such reclaimable rejects are available. Two samples of table tailings (-147 μm and -74 μm in size), assaying 0.021% Au and 0.39% Ag (for the former, i.e., Sample - I) and 0.023% Au and 0.47% Ag (for the latter, i.e., Sample - II), were received to study the possibility of recovering the residual values of precious metals from them. Both the samples contained mainly SiO_2, Cr, Mg etc., as gangue. The density differential between the values and the gangue, and the particle size of the samples strongly indicated the possibility of employing Multi-Gravity Separator (MGS) for this purpose. This equipment has been very promising in tackling the problem of many fines and ultrafines. MGS can be operated at variable 'g' depending on the characteristics of the slurry to be treated. Use of MGS for management of mineral waste and pollution and for concentration of complex lead zinc ore in preference to conventional froth flotation has recently been reported [8,9].

Efficacy of MGS to recover precious metals from rejected refractory brick powder has been discussed in the present paper. Through beneficiation experiments, using MGS, it was possible to achieve three-fold upgradation of Au and

Ag. The -74 µm sample yielded better results than the -147 µm sample due to better liberation of the constituents in the former.

RAW MATERIALS

Two table tailing samples, whose size analyses are given in Table 1 and assay values of precious metals are given in Table 2, were received to study the possibility to recover valuables from them. Table 1 shows that Sample I had 50% -40 µm size particles in it whereas Sample II contained 87.6% -40 µm particles. But both the samples contained more than 200 ppm of Au and nearly 0.4% Ag. Assay values of Au and Ag were slightly higher in Sample II than in Sample I (Table 2).

Table 1 : Size analyses of as received samples

Size in µm	Sample - I Wt %	Sample - II Wt %
- 150 + 100	16.25	–
- 100 + 80	18.24	–
- 80 + 60	4.65	3.8
- 60 + 40	10.42	8.6
- 40 + 20	19.72	25.7
- 20 + 10	10.74	4.6
- 10 + 5	8.06	28.4
- 5 + 1	10.09	24.5
- 1	1.83	4.4
	100.00	100.0

Table 2 : Chemical analyses of as received samples

	Sample - I	Sample - II
Au %	0.0209	0.0228
Ag %	0.385	0.466
Cu %	0.425	0.556
Ni %	0.831	1.145

EXPERIMENTAL

The multi-gravity separator is used to separate two minerals from each other or to separate a group of heavy minerals from lighter minerals provided there is a reasonable difference in specific gravities. The design and operating parameters which affect separation are rotational speed of the drum, slope of drum with the horizontal, wash water flow rate, amplitude and frequency of the shake, feed rate and feed pulp density. For any particular application, optimum combination of the above parameters is to be chosen depending on the nature of the material to be treated and the specifications of the concentrate to be produced [9].

Beneficiation experiments were carried out on sample-I and sample-II using MGS under the following conditions: (i) Speed of the rotating drum from 160 to 240 rpm; (ii) Flowrate of wash water from 2 to 7 lpm; (iii) Amplitude of shake of the scrapper assembly from 12.7 to 25.4 mm; (iv) Frequency of shake of the scrapper assembly from 4.8 to 5.7 cps; and (v) Slope of the drum with horizontal from 2 to 4 degree. For all test runs feed pulp density and feed rate were kept at 25% and 30 kg/h respectively.

RESULTS AND DISCUSSION

Granulometric and chemical analyses (Tables 1 & 2) of the samples (Sample I and Sample II) showed that assay of Au and Ag was marginally higher in sample II than that in sample I and sample II contained more than 57% -10 µm particles whereas sample I contained nearly 20% below 10 µm size particles.

Beneficiation experiments carried out with sample I, under varying design and operating parameters, produced concentrate having 0.04% Au and 0.77% Ag with nearly 50% recovery of both Au and Ag. Assay of Au and Ag could be improved upto 0.054% and 1.494% respectively by changing the operating parameters but recovery of Au and Ag dropped to 35%. Assays of Au and Ag obtained in concentrates and tailings after beneficiation studies with sample I are plotted in Fig. 1. Tailings contained nearly 150 ppm of Au.

Results of MGS studies with sample II are plotted in Fig. 2. Different test runs with different sets of design and operating variables produced concentrate having 0.076% Au and 1.35% Ag with 34% and 29% recovery of Au and Ag respectively. Tailing was found to contain less than 150 ppm of Au in it. Further improvement in the assays of Au and Ag (0.1% Au and 2.19% Ag) could be achieved but with poor recovery of both Au and Ag. Different sets of MGS parameters were chosen for sample I and sample II, to suite their specific characteristics. With identical operating conditions sample II produced better concentrate than sample I, as shown in Figs. 3&4, presumably because of better liberation of Au and Ag at finer sizes. Precious metals being much heavier than gangue (Mg, Cr, SiO_2), the separation efficiency improved with improved liberation of heavier from lighter materials.

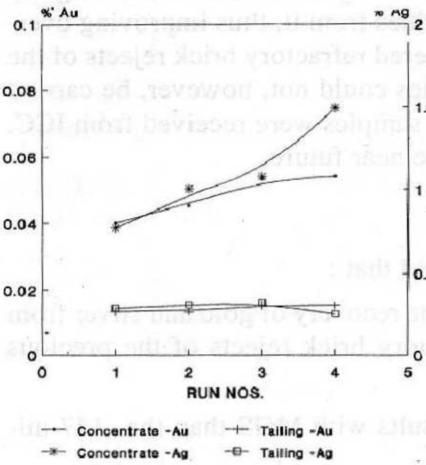

Fig. 1 : Assay of products with sample I using MGS at varying conditions.

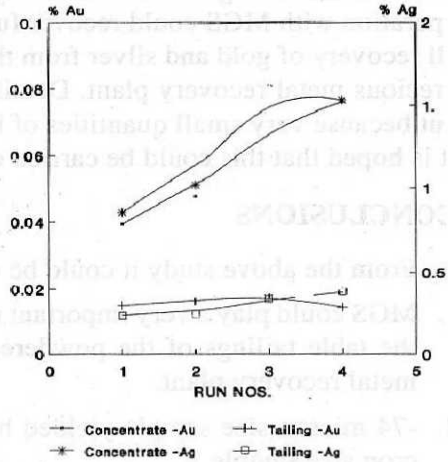

Fig. 2 : Assay of products with sample II using MGS at varying conditions.

As far as MGS design and operating parameters were concerned, careful selection of rotational speed and slope of the drum alongwith controlled wash water were found to be very important in controlling the quality of the concen-

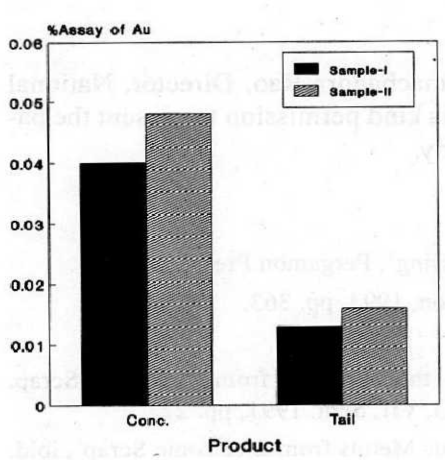

Fig. 3 : MGS studies on samples I & II under identical condiitions (for gold).

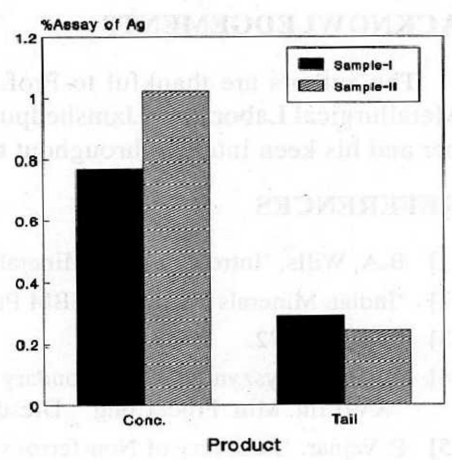

Fig. 4 : MGS studies on samples I & II under identical condiitions (for silver).

trate. As the tailings contained nearly 150 ppm of gold in it, a second stage of operation with MGS could recover further values from it, thus improving overall recovery of gold and silver from the powdered refractory brick rejects of the precious metal recovery plant. Detailed studies could not, however, be carried out because very small quantities of both the samples were received from ICC. It is hoped that this could be carried out in the near future.

CONCLUSIONS

From the above study it could be concluded that :

1. MGS could play a very important role in the recovery of gold and silver from the table tailings of the powdered refractory brick rejects of the precious metal recovery plant.
2. -74 micron size sample yielded better results with MGS than the -147 micron size sample.
3. Threefold improvement in the grade of Au and Ag with nearly 45% recovery of both Au and Ag could be achieved. Even fourfold improvement in grade could be obtained. This, however, led to considerable sacrifice of recovery.
4. Tailings contained nearly 150 ppm Au. Two or three stage operation should improve recovery of these values further.
5. MGS studies after further grinding should also improve grade and recovery of the concentrate.

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