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Increasing The Zinc Recovery In The Flotation Circuit Of The Bama Plant Using Improvement In The Reagent Distribution Regimen

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Abstract: The particle size distribution plays an important role in the flotation due to the impact on the particle-bubble collision, attachment, and detachment. In the flotation process, fine particles have low collision performance to the bubbles and coarse particles have low attachment performance to the bubbles. Therefore, in the flotation, most of the valuable minerals losing are observed in ultrafine and coarse particles. In order to increase the recovery of coarse particles, a proper amount of chemical reagents must be distributed in the circuit; hence the distribution regimen of chemical reagents in the circuit is very important. In this research, in the zinc flotation circuit of the Bama lead and zinc company, the reagent distribution regimen has been modified in order to improve the recovery of zinc in the coarse particles. Therefore, different reagent distribution regimens were compared using a design experiment (Taguchi L9) in the laboratory scale. The results showed that using 30 g/t of the AERO3477 as collector in the rougher stage, along with 15 g/t of the potassium emyl xanthate (PEX) as collector and 7 g/t MIBC as frother in the scavenger stage, the recovery of fine and coarse particles were increased about 3.2 and 5.4 %, respectively. Also, using this reagent distribution regimen at the Gushfil plant of the Bama company was increased the recovery of fine and coarse particles as 2.5 and 3.9 %, respectively, and the zince grade of the final concentrate was increased about 1.4 %, and finally the plant profits was increased about 500000 USD, yearly.

Keywords: Flotation, Liberation degree, coarse particle, Reagent distribution.

INTRODUCTION

Flotation is the most important mineral separation technique [1]. In this method, based on the particle surface properties, particles with sizes range from 20 to 200 mesh are attached to bubbles in a solid, liquid and gas systems. The appropriate particle size for flotation is determined according to the degree of liberation

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of valuable minerals, economic factors and many other factors. This method is not suitable to be used for very fine and coarse particles. Recovery of very fine particles is very low, because of low probability of particle – bubble collision, and the recovery of coarse particle because of high probability of particle-bubble detachment is low. Hence, there is an optimum size range for flotation, and continual research to expand the size range [2-7].

It is shown that, in the fine size range, where recovery is lower than medium particle size, increases with time; and in the coarse size range, where recovery is again lower but less affected by time and the positive impact of reagent addition on the recovery of coarse particles is seen in the recovery-size data (Figure1) [3].

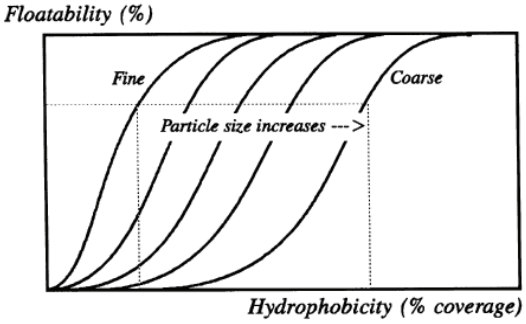

Figure 1. The relationship between particle size, floatability and reagent addition (hydrophobicity) [3]

One important strategy to accommodate the different needs of fine and coarse particles is reagent distribution along the bank. Low collector concentration at the head of the bank is sufficient for the fast floating particles and upon their removal further collector dosage down the bank can target recovering the slower floating coarse particles [1].

MATERIAL AND METHODS

In order to accomplish this research, a sample of about 100 kg was collected from the plant feed and, after crushing in a roller crusher, the sample was divided and 20 samples of one kg were selected for tests. In the next step, to determine the appropriate grinding time (based on the particle size distribution of the plant products), four samples were ground at a laboratory rod mill for 12, 16, 20, and 25 min. The size distribution of these samples were compared to determine the best grinding time, based on the particle size of plant products (d80=75 mic.).

In order to determine the best conditions for the recovery of zinc metal in small and coarse particles, 9 flotation tests in the laboratory scale were performed using the Taguchi experiment design (L9). Before zinc flotation tests, with a constant conditions lead of all samples were recovered using lead flotation tests, and then tails of these tests (lead flotation tests) was floated based on the Taguchi experiment design (L9) to determine the best conditions for zinc recovery.

In each tests of Taguchi design experiments, zinc were recovered in two stages of rougher and scavenger as same as the plant. In these tests, the type and dosage of collector in the rougher stage, and the dosage of collector and frother in the scavenger stage were selected as four variables and each variables were considered in three levels. It is noted that, all zinc flotation tests were carried out at pH about 9 and the preparation times for activator (copper sulfate), collector, and frother were 2, 3 and 1 min., respectively.

The concentrations and tails of all tests were sieve analyzed in three ranges (fine: smaller than 38 microns, medium: between 38 and 75 microns and coarse: more than 75 microns) and the grade and recovery of zinc in the each ranging size were determined. Finally, the results were analyzed using DX7 software.

After laboratory studies, four tests based on the results, and plant conditions were selected to perform in the zinc flotation circuit of the Gushfil plant of the Bama company (industrial scale). It is noted that one of the four tests was selected as same as the common conditions of the circuit. During the industrial tests, all

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reagent dosage carefully measured and samples were collected to compare the results.

FINDINGS AND ARGUMENT

Determine the necessary grinding time

The result of grinding of the four samples in various times showed that 24 min. is the necessary grinding time. Because after the time. grinding in the laboratory rod mill, the d80 of the product was 75 mic. (same as the plant product size).

Therefore, before flotation tests, all samples were ground 24 min. with the laboratory rod mill. Furthermore, distribution of lead and zinc in the grounded samples showed that about 7% of lead are distributed in the coarse particles (+75mic.), while 14% of zinc are distributed in the coarse particles. Hence, recovery of coarse particle in the zinc flotation circuit is more important than the lead flotation circuit.

Determination of the best reagent distribution regimen in the laboratory scale

The results of the flotation tests (L9 Taguchi) showed that the higher recovery of zinc in the coarse particles was resulted using 30 g/t (high level) Aero 3477 as collector in the rougher stage and 15 g/t (intermediate level) Aero 3477 as collector along with 7 g/t (low level) frother in the scavenger stage (test No.8). Also, the higher recovery of zinc in the fine particles was resulted using 15 g/t (intermediate level) Aero 3477 as collector in the rougher stage along with 7 g/t (low level) Aero 3477 as collector and 30 g/t (high level) frother in the scavenger stage (test No.4). It should be noted that reagent dosage and distribution regimen in one of the tests (test No.2) was similar to the zinc flotation circuit. Therefore, the comparison between tests No.2 and No.8 showed that the zinc recovery in the coarse, fine, and medium particle size can increased about 3.2, 4.5, and 1.9 %, respectively, without any change in the zinc content of final concentrate, using a modification in the reagent distribution system (Figure 2).

In addition, data analysis of the tests using DX7 software showed that frother dosage in the scavenger stage has no effective impact on the zinc recovery, and using 30 g/t Aero 3477 as collector in the rougher stage along with 15 g/t PEX as collector in the scavenger stage can maximize the recovery of zinc in the coarse particles, effectively. Hence reagent dosage and distribution regimen of test No.8 was selected as one of the industrial scale tests. Furthermore, the variance analysis of the tests (L9 Taguchi) showed that the recovery model for fine and medium particles is not significant. Therefore, effect of all factors on the zinc recovery in the medium and fine particles are not significant. While variance analyses for coarse particles showed that collector type in the rougher stage and PEX dosage in the scavenger stage have significant effect on the zinc recovery.

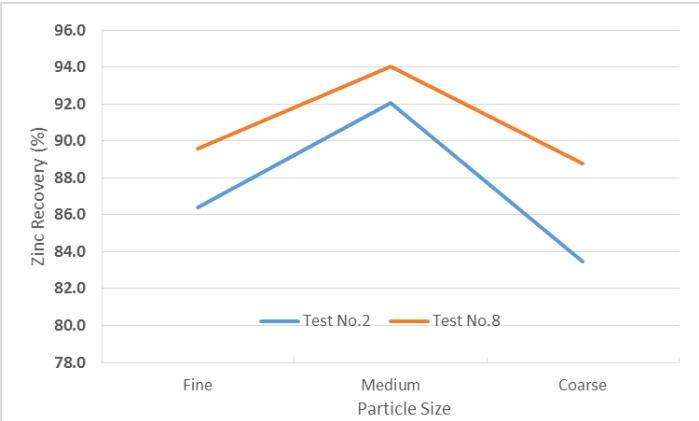

Figure 2. Zinc recovery in the laboratory tests (best conditions: test No.8; plant conditions: test No.2)

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The results of industrial scale tests

The results of the industrial scale tests in the zinc flotation circuit of the Gushfil plant of the Bama company showed that the recovery of zinc in the particles with medium sizes was not affected by all factors (Figure 3). While, the highest zinc recovery in the fine and coarse particles was resulted in the test No.2 (30 g/t Aero 3477 as collector in the rougher stage and 15 g/t PEX in the scavenger stage). It should be noted that, conditions of test No.1 (7 g/p Aero 3477 as collector in the rougher stage along with 30 g/t PEX as collector in the scavenger stage) was similar to the normal conditions of the plant.

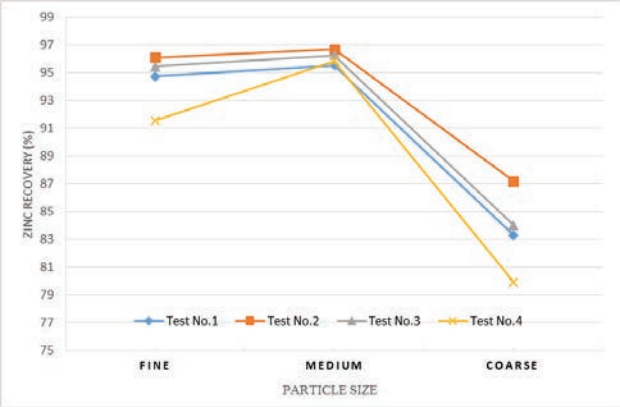

Figure 3. Zinc recovery at various reagent regimens and dosages in the industrial tests

The zinc content of final concentrate showed that highest zinc assay was produced at test No.3 ((7 g/p Aero 5100 as collector in the rougher stage along with 30 g/t PEX as collector in the scavenger stage)). Comparison between tests No.1, 2, and 3 show that lower zinc grade and recovery produced at the normal conditions of the circuit (test No.1), therefore the plant reagent dosage and distribution regimen must be modified. Furthermore, comparison between tests No.2, and 3 show that the zinc recovery at the test No.2 is higher than test No.3 and the zinc grade of final concentrate at the test No.3 is higher than the test No.2; hence the reagent dosage and distribution regimen similar to tests No. 2, and 3 can be used in the zinc flotation circuit. But, based on the economic conditions, and minimum acceptable zinc assay of final concentrate, test No.2 has higher economic impact.

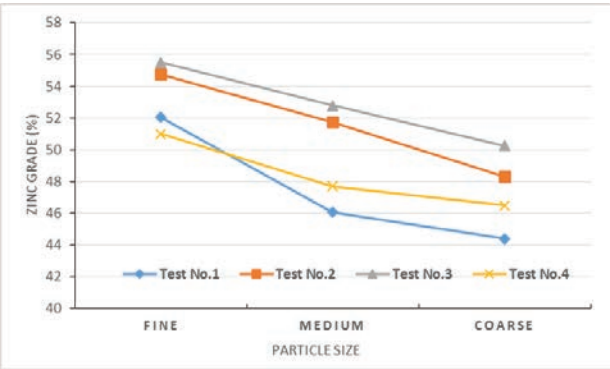

Figure 4. Zinc grade at various reagent regimens and dosages in the industrial tests

Finally, the results of modification in the reagent regimen and dosage (using 30 g/t Aero 3477 as collector in the rougher stage along with 15 g/t PEX in the scavenger stage) in the zinc flotation circuit of the Gushfil

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plant of the Bama company, showed increases about 2.5, and 3.9 % the zinc recovery in the fine and coarse particle sizes, respectively. Therefore, the total zinc recovery was increased as 3.2%, in addition to an increase of about 1.4% in the zinc assay of the final concentrate. The modifications was increased the profits of the Bama company about 500000 USD, yearly.

CONCLUSIONS

- Small scale tests, using the L9 Taguchi experimental design, showed that the best reagent dosage and distribution in the zinc flotation circuit of the Gushfil plant of the Bama company for increasing the coarse particle recovery is 30 g/t Aero 3477 in the rougher stage as collector, along with 15 g/t PEX as collector and 7 g/t frother in the scavenger stage.
- The highest recovery of zinc in the fine particles was resulted using 15 g/t Aero 3477 as collector in the rougher stage, along with 7 g/t PEX as collector and 30 g/t frother in the scavenger stage, based on the laboratory tests.
- The variance analysis of the Taguchi design experiment (L9), showed that only type of collector in the rougher stage, and PEX dosage in the scavenger stage have significant effect on the zinc recovery.
- The industrial tests was resulted an increase about 3.2% in total zinc recovery along with 1.4 % in zinc content of final concentrate using 30 g/t Aero 3477 as collector in the rougher stage, along with 7 g/t PEX as collector in the scavenger stage.
- The yearly benefit of modification in the reagent dosage and distribution regimen in the zinc flotation circuit of the Gushfil plant of the Bama company is about 500000 USD.

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