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Effect of Process Parameters on Selective Sub-Aerated Flotation Cell of Sphalerite Ore

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Abstract- A sphalerite ore contains 6% Zn, 3.5% Pb and 11% Fe, was subjected to this work. The laboratory work is conducted according to the properties of the ore, the zinc and lead minerals are separated from the gangue minerals by using the variations in the process parameters such as flotation time, collector dosage, frother dosage and pH. The flotation studies were carried out using a laboratory Sub Aerated (Mechanical-cum-Air vertical type) flotation cell of 0.5 liter capacity. Pine oil and Diesel oil were used as frother and collector respectively. About 100gms of the processed sample was conditioned with required amount of collector at 20% pulp density for about five minutes at pH 8 by adjusting with Na_2CO_3 and HCL acid. The optimum speed of the impeller is 950 rpm. Pine oil and Diesel oil were used as frother and collector respectively. The effects of various parameters like pH of the pulp, collector dosage, frother dosage and flotation time were studied in detail. The results also show that the variation in the process parameters will improve the recovery of 76.62% Zn, 69.03% Pb and 24.5% Fe. Based on the flotation studies results the process adopted was recommended for the concentration of zinc and lead ore under consideration.

Keywords- Sphalerite ore, Sub-Aerated flotation cell, Collector dosage, Frother dosage

1. INTRODUCTION:

During the last few decades, low-grade finely disseminated zinc ore deposits have become the main sources of the raw zinc material in many countries. New methods must be developed for the achieve pointed separation at high throughput capacity, especially when treating very fine materials. These methods must be maintain or improve current standards in more economic and environmentally attractive ways [1]. Flotation is a method of concentrating solid minerals in a relatively finely alienated state. In this process the effective specific gravity of some of the ore minerals is substantially decreased by causing air bubbles. These air bubbles attach more or less tenaciously to particles of those particular minerals where upon they float on the separating medium while the unaffected minerals sink. When the selected mineral is separated in the form of froth the operation is called “Froth Flotation” [2]. In Flotation some reagents like frothers, collectors, pH regulators, activators, deactivators and depressants are added to the pulp at the appropriate dosage [3]. Frothers act upon the gas-liquid interface, not at the surface of solids. They are organic compounds whose molecules each contain one polar group and one non-polar group. The frother molecules are therefore amphipathic one part of the molecule has an affinity for water, the other has an affinity for gas or repulsion for water. The molecules concentrate at the gas-liquid interface with the non-polar part oriented towards the gas and polar part towards the water and also frothers must not be too soluble or too insoluble. At present process is the best and almost universally employed for the concentration of finely ground ores (less than 150 microns) of great variety of oxide ores, native ores non-metallic, and sulphide and non-sulphide minerals [4].

The process of flotation explained by different authors [5-10] is based on manipulating the surface properties of minerals so that the mineral of interest acquires, a hydrophobic surface i.e., lacks affinity for water. The minerals to be rejected have, or are made to have, a hydrophilic surface i.e., a strong affinity for water. When air bubbles are introduced, the hydrophobic minerals attach themselves to the bubbles and are carried to the surface and skimmed away. Understanding of froth flotation is confined by limited study of various aspects of the process, namely hydrodynamics, surface chemistry, and kinetics [11-14]. The process of froth flotation can be extended beyond metal sulphides to non sulphides and non metallic minerals, coal, oil recovery, soil cleaning, waste water treatment and recycling [5,9] The mineral’s behaviour during froth flotation is controlled by its surface properties and these are the function of its chemistry, structure and the surface species formed by reactions during processing [15-20]. Although the basic methods remains the same but the reagents used vary from one process to another [20-22]. A critical part of the process is interaction of the mineral with the reagents used to float the sulphide minerals.

The present study was undertaken to investigate the effect of the process parameters on recovery of zinc, lead and iron from Sphalerite ore by using sub -aerated flotation cell.

2. MATERIALS AND METHODS

2.1 Study area: All experiments were carried out in Department of Chemical Engineering, Andhra University, Visakhapatnam, Andhra pradesh, India.
2.2. Sample collection and process: Sphalerite ore used in this study was obtained from the Rampura Agucha Mine located in Bhilwara District, Rajasthan.
2.3. Physical process: Sphalarite ore lumps are first broken into small pieces in a disintegrator, then the pieces are ground to the required size first in Roll crusher and then in a ball mill up to -150µm feed is to be obtained. From the –150 mesh feed we can separate different size fractions varying from 0.5mm to 0.1mm using Ro-tap sieve shaker and -150 µm mesh size fractions is taken.
2.4. Chemical process: 0.1 gm of sample was taken and mixed with 5 ml of HNO_3 and conc. HCl respectively allowed for digestion in microwave accelerated reaction system. In the microwave heating programme the power level of 400 W, ramp time of 15 min, pressure of 800 psi, temperature of 200^0C and hold time of 15 min was maintained. These digested samples were run in Inductively Coupled Plasma Atomic Emission Spectroscopy (ICPAES) for elemental analysis such as zinc %, lead % and Iron % in sphalerite ore.
2.5. Sub -aerated flotation process: All flotation studies were carried out using a laboratory Sub Aerated (Mechanical-cum-air vertical type) flotation cell of 0.5- liter capacity. In this experiment Pine oil & Diesel oil were used as frother and collector respectively. About 100 gm of the processed sample was conditioned with required amount of collector at 20% pulp density for about five minutes at pH 8 by adjusting with Na_2Co_3 and acid (HCl). The slurry was dilute and floated with frother for five minutes. Both froth and tailings were collected, dried, weighed and analyzed for zinc, lead concentrations. Initially, experiments were carried out to determine the most efficient dosage of collector subsequently the effect of frother dosage was evaluated at constant collector dosage. The optimum speed of the impeller is 950 rpm. The pH of the pulp was measured by using the pH meter at constant temperature for all experiments. While doing the entire experiments the constant air flow rate of 2.4 liter/minute was supplied by using two air pumps of each having a capacity of 1.2 liter/minute into conditioned sphalerite pulp in the flotation cell. The range of variables measured in the present study as shown in the Table 1.

Table: 1 Range of Variables used for flotation

Variables	Minimum	Maximum
Flotation time	4 min	20 min
PH	6.5	10
Collector Dosage	0.3 lit/ton	1.5 lit/ton
Frother Dosage	0.2 lit/ton	1.0 lit/ton

3. RESULTS AND DISCUSSIONS

3.1. Effect of Flotation time

The experiment was conducted using 100 gm of sphalerite ore of –150 mesh was used as a feed, pine oil as frother and diesel oil as a collector. The percentage of metal recovery with flotation time was as shown in the figure 3.1, it can be observed that the metal recovery increases with increase in flotation time up to 16 minutes, and then it reached constant the metal recovery. In this case also it can be observed that 16 minutes was the optimum time for flotation. Hence in the present study all experiments were conducted using flotation time of 16 minutes, our results were correlated with, previous reports of [23] they reported that, 80% of lead recovery obtained from the Galena ore at flotation time of 8 min. [24] reported that 80% of mineral recovery from the Pb/Zn ore at flotation time of 16 min.

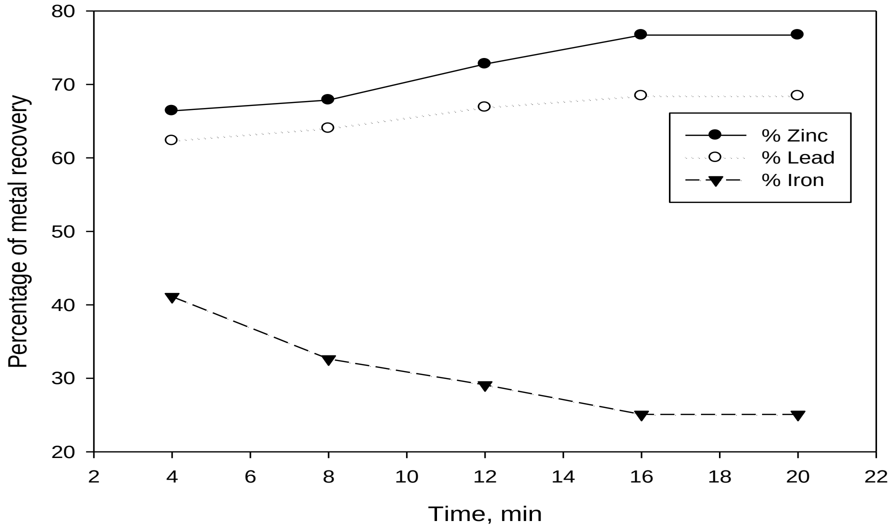

Figure 3.1: Effect of time on percentage recovery

3.2. Effect of Collector dosage:

The effects of variation of collector dosage (Diesel oil) were studied on flotation of Zinc, Lead and iron bearing minerals. As shown in the figure 3.2, for the flotation of minerals the diesel oil dosages were varied, from 0.3 lit/ton to 1.5 lit/ton. As the collector dosage increases, the metal recovery increased up to optimum at collector dosage of 1.2 lit/ton, further rise in collector dosage recovery of minerals gradually decreased. Hence these results indicate that the collector dosage of 1.2 lit/ton is the best for up gradation of metal within the range of present study. [24] reported that 50% of the mineral recovered from Zinc-lead ore by using diesel oil (200g/ton) as a collector. [26]reported that 78% of the mineral recovery from Pb-Zn carbonaceous sulphide ore by using potassium amyl xanthate (150g/ton) as a collector.

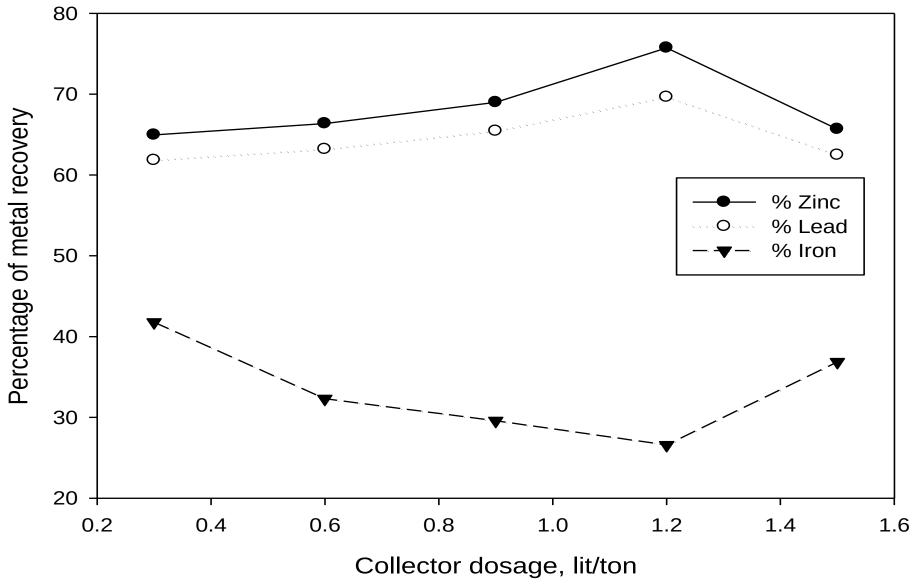

Figure 3.2: Effect of collector dosage on percentage recovery

3.3. Effect of frother dosage:

Pine oil is widely used as frother, for Zinc, Lead and iron bearing minerals, as shown in the figure 3.3, for the flotation of minerals the pine oil dosages were varied, from 0.2lit/lton to 1 lit/ton. As the frother dosage increases, the metal recovery increased up to optimum at frother dosage of 0.6 lit/ton, further rise in the frother dosage recovery of minerals gradually decreased. Hence these results indicate that the frother dosage of 0.6 lit/ton is the best for up gradation of metal within the range of present study. [27] reported that 78.5% of the mineral recovery from the zinc sulphide ore by using 800gm/ton MIBC (Methyl iso butyl chloride) as a frother. [28] reported that 86% of the mineral recovery obtained from Zinc sulphide ore by using down froth 250 (15 g/ton) as a frother.

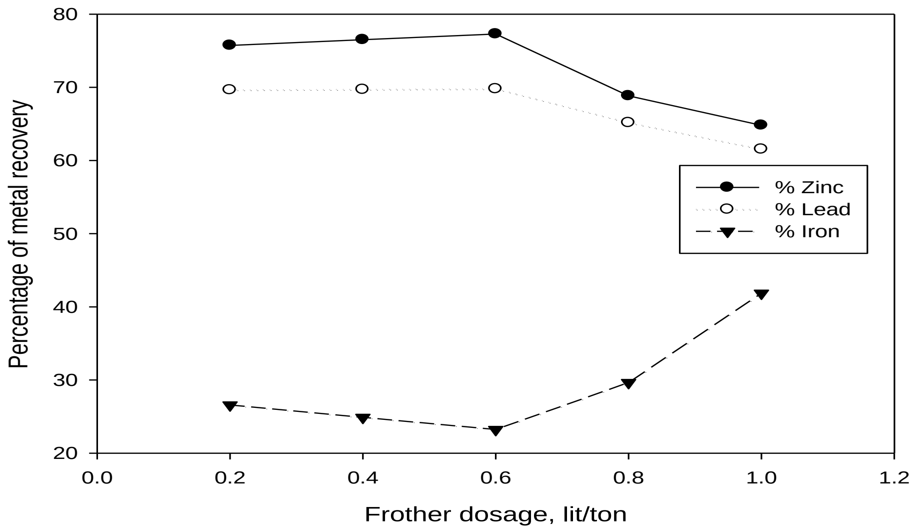

Figure 3.3: Effect of frother dosage on percentage recovery

3. 4. Effect of pH:

As shown in the Figure 3.4 , the variation of metal recovery with changing the pH ranged from 6.5 to 10 , it can be concluded that , pH had moderate effect on metal recovery . However the metal recovery increases with increase in pH up to 8, further increase in pH decreased the metal recovery. Hence, in the present study all the experiments were conducted by maintains pH at 8. [29] Reported that 80% of the mineral recovery from the Lead –zinc sulphide ore at pH of 7.2. [27] reported that 75.8% of the mineral recovery from zinc ore at pH of 8.

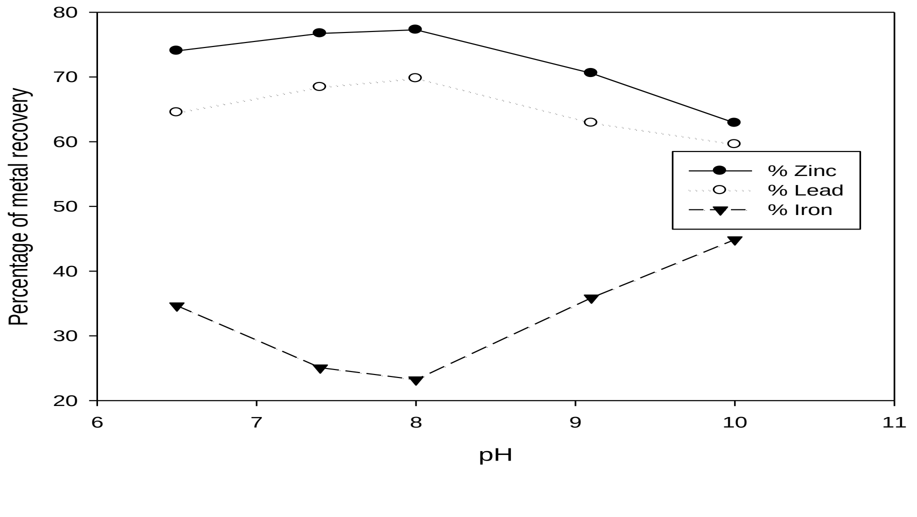

Figure: 3.4 Effect of pH on percentage recovery

The effect of variation of flotation parameters was studied on flotation of spalerite ore. A careful study of table 2 indicates that the present study all the experiments were conducted by maintains time at 16 min, Collector dosage at 1.2 lit/ton, Frother dosage 0.6 lit/ton and pH at 8. By using this optimum values for the flotation process the zinc, lead and iron concentration were observed to be average of 22.88%, 12.83% and 4.22% respectively.

Table: 2 Optimum parameters values with concentration and recovery percentage

Parameters	**Optimum value**	**Concentrate**			**Tailings**			**Recovery**		
		% Zn	% Pb	%Fe	% Zn	% Pb	%Fe	% Zn	% Pb	%Fe
Time, min	16	22.29	12.76	4.32	1.76	1.36	22.81	76.72	68.43	25.08
Collector dosage, lit/ton	1.2	22.73	12.52	4.52	1.82	1.32	22.87	75.73	69.62	26.58
Frother dosage, lit/ton	0.6	23.38	13.09	4.02	1.70	1.30	23.19	77.28	69.78	23.23
Ph	8	23.12	12.95	4.04	1.74	1.36	23.17	76.77	68.31	23.36
Average		22.88	12.83	4.22	1.75	1.33	23.01	76.62	69.03	24.56

4. CONCLUSION:

The sphalerite ore contains 6% Zn, 3.5% Pb and 11% Fe were subjected to Sub-aerated flotation cell for upgrading the mineral percentages, by using the process parameters such as flotation time, collector dosage, frother dosage and pH. These studies proved that the process parameters improved the mineral recovery(76.62% Zn, 69.03% Pb and 24.56% Fe) at optimum conditions such as basic pH 8 at 16 min by providing the collector dosage (Diesel oil) 1.2 lit/ton and frother dosage(pine oil) 0.6 lit/ton. The sub-aerated flotation method provides a valuable data that is helpful in establishing the trends on the effect of these variables on the metallurgical performance and also improving the minerals quantity with low cost effect and environmental friendly.

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