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STUDIES ON HYDROMETALLURGICAL EXTRACTION OF ZINC BY SULPHURIC ACID TREATMENT

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Abstract: The recovery of metals from the ores include the process of adequately concentrating the metals from their ores. The process of obtaining pure metals from excavation of ores is known as mineral leaching. The present work discusses about the leaching of Zinc from impurities using sulphuric acid as solvent. The parameters studied were; weight of zinc present in the zinc ore, concentration of sulphuric acid and amount of sulphuric acid. Experiments were carried out at room temperature. Sulphuric acid was used in the concentration of 2% to 4%. The amount of zinc used was 5 gm to 25 gm. Zinc removal was measured by using the standard zinc concentration curves. The % recovery of Zinc increases with the higher concentration of sulphuric acid; whereas it decreases with the particle size. Zinc recovery was observed to be around 95% for 2%, 3% and 4% concentrated sulphuric acid under the room temperature condition.
Keywords: Extraction, Hydrometallurgical, Leaching, Sulphuric acid, Zinc

1. INTRODUCTION

Metals need to be adequately concentrated from viable source of desired metals known as ores. The process of obtaining pure metals from excavation of ores is referred as mineral leaching [1-3]. In the recovery of noble metals, included gold, silver and platinum different leachants are used namely, sodium cyanide, thiourea, chlorine, sulphuric acid and aqua regia, and optionally a leaching aid, such as chloride ions [4-6]. Other economically important zinc ores usually show a closed spatial relation to the lead ores, where land based resource is large but irregularly distributed [7-9].

2. EXPERIMENTAL SETUP

It consists of round bottom flask, rubber stopper, funnel, filter paper and specific gravity bottle. The chemicals used are zinc sulphate, sulphuric acid and sand. The process variables considered are amount of solute (ZnSO4) present in complex, concentration of solvent (Sulphuric acid) and amount of solvent used as follows:

- H2SO4 concentration (2%, 3%, and 4%).
- Amount of solute present in complex (5gm, 10gm, 15gm, 20gm, and 25gm).
- Amount of solvent used (75ml, 100ml, 125ml, and 150ml).

3. EXPERIMENTAL PROCEDURE

It starts with preparation of the ore material of sand and zinc sulphate in 1:1, 1:2, 1:3, 1:4, and 1:5 ratios. Sulphuric acid with concentrations of 2%, 3% and 4% have been prepared. Initially, 1:1 ratio of prepared ore material is fed into the round bottom flask. Then the sample mixture is stirred thoroughly until no lumps are present in the mixture. Then 75 ml of 2% sulphuric acid is measured and then poured into the round bottom flask and stir it again until maximum solute is dissolved in the solvent. After completion of stirring, the mixture is separated using filter paper. The filtrate is collected in specific gravity bottle and weighed. Readings of specific gravity bottle with filtrate for every sample is tabulated and their corresponding specific gravities have been calculated. Verification of specific gravities has been done using specific gravity vs weight ZnSO4 of calibration chart in Figure 1 and Table 1. The % recovery of ZnSO4 for the sample is calculated [10-11].

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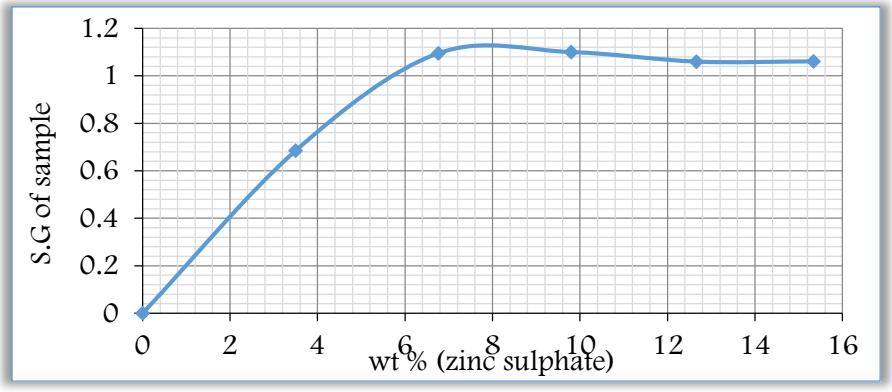

Figure 1: Calibration plot

Repeat the procedure for different volumes (100 ml, 125 ml and 150 ml) of solvent of different concentrations, also for different compositions (1:2, 1:3, 1:3, 1:4 and 1:5) of solute (Table 2, 3, 4, 5).

Table 1: Calibration chart

S.No.	H_2SO_4 (gm)2% conc.	ZnSO4 (gm)	Wt % (zinc sulphate)	SG. Of sample
1	138	5	3.50	0.685
2	138	10	6.76	1.095
3	138	15	9.80	1.100
4	138	20	12.66	1.060
5	138	25	15.34	1.061

Table 2: Model observations and calculations

Sample number	Wt. of sand taken (gm)	Wt. of zinc sulphate taken,(gm) W*	H_2SO_4 added (ml) 2% conc.	Vol. of separated clear solution (ml)	SG of clear solution
1	20	5	75	70	1.044
2	20	10	75	71	1.057
3	20	15	75	72	1.062
4	20	20	75	73	1.071
5	20	25	75	74	1.155

Table 3: Calculations

S.No.	Wt. of sand taken (gm)	Wt. of zinc sulphate taken,(gm) W*	H_2SO_4 added (ml) 2% conc.	SG of clear solution	Wt % of zinc sulphate in clear solution (from calibration chart) X	Total weight of clear solution Y	Wt of zinc sulphate W=X*Y	%recovery =100*(W/W*)
1	20	5	75	1.044	6.089	73.08	4.45	89
2	20	10	75	1.057	11.593	75.047	8.7	87
3	20	15	75	1.062	14.713	76.464	11.25	75
4	20	20	75	1.071	18.163	78.183	14.2	72
5	20	25	75	1.155	24.57	85.47	21	64

Table 4: Amount of zinc sulphide recovered

No.	Weight of ZnSO4, (gm)	Amount of zinc sulphide recovered, gm											
		2% H2SO4,ml				3% H2SO4 ,ml				4% H2SO4 ,ml			
		75	100	125	150	75	100	125	150	75	100	125	150
1.	5	4.45	4.55	4.7	4.75	4.55	4.65	4.65	4.75	4.55	4.65	4.7	4.75
2.	10	8.7	8.9	9.1	9.4	8.9	9.1	9.2	9.3	9	9.3	9.4	9.5
3.	15	11.25	12.45	13.2	13.35	12.3	13.2	13.65	13.8	12.75	13.35	13.8	14.1
4.	20	14.2	16.4	17.8	18.2	16.2	17.4	17.8	18.8	17.8	18.2	18.6	19
5.	25	16	21	22.75	23	18	21.75	23.5	23.75	22.25	22.75	23.25	23.75

Table 5: Percentage recovery of zinc sulphide

No.	Weight of ZnSO4, (gm)	Percentage recovery of zinc sulphide											
		2% H2SO4,ml				3% H2SO4,ml				4% H2SO4, ml			
		75	100	125	150	75	100	125	150	75	100	125	150
1.	5	89	91	94	95	91	93	93	95	91	93	94	95
2.	10	87	89	91	94	89	91	92	93	90	93	94	95
3.	15	75	83	88	89	82	88	91	92	85	89	92	94
4.	20	72	82	89	91	81	87	89	94	89	91	93	95
5.	25	64	84	91	92	72	87	94	95	89	91	93	95

4. RESULTS AND DISCUSSIONS

The graphs are drawn between amounts of solvent used vs. percentage recovery.

From Figure 2, it is clear that as amount of solvent increases, the percentage recovery of solute, Zn, increases. Also as concentration of solvent increases, the percentage recovery of solute, Zn, increases. The percentage recovery of solute is obtained for the different concentrations of sulphuric acid are given below:

— For 1:1 ratio of ore material, the highest percentage recovery of zinc is obtained for 150 ml of 2% H2SO4 at room temperature is 95.
— For 1:1 ratio of ore material, the highest percentage recovery of zinc is obtained for 150 ml of 3% H2SO4 at room temperature is 95.
— For 1:1 ratio of ore material, the highest percentage recovery of zinc is obtained for 150 ml of 4% H2SO4 at room temperature is 95.

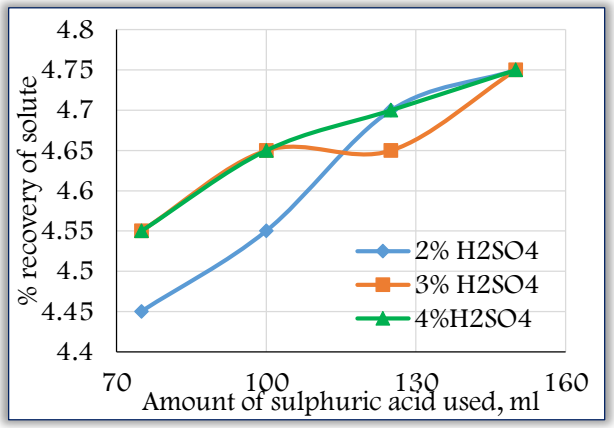

Figure 2: Amount of solvent used vs % recovery of solute (for 5gm of solute)

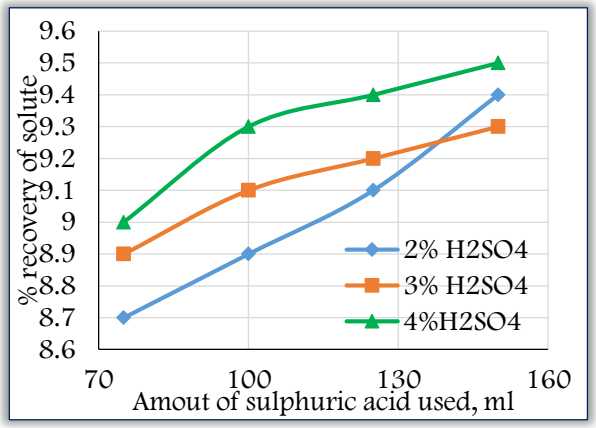

Figure 3: Amount of solvent used vs % recovery of solute (for 10gm of solute)

From Figure 3, it is clear that as amount of solvent increases, the percentage recovery of solute, Zn, increases. Also as concentration of solvent increases, the percentage recovery of solute, Zn, increases. The percentage recovery of solute is obtained for the different concentrations of sulphuric acid are given below:

— For 1:2 ratio of ore material, the highest percentage recovery of zinc is obtained for 150 ml of 2% H2SO4 at room temperature is 94.
— For 1:2 ratio of ore material, the highest percentage recovery of zinc is obtained for 150 ml of 3% H2SO4 at room temperature is 93.
— For 1:2 ratio of ore material, the highest percentage recovery of zinc is obtained for 150 ml of 4% H2SO4 at room temperature is 95.

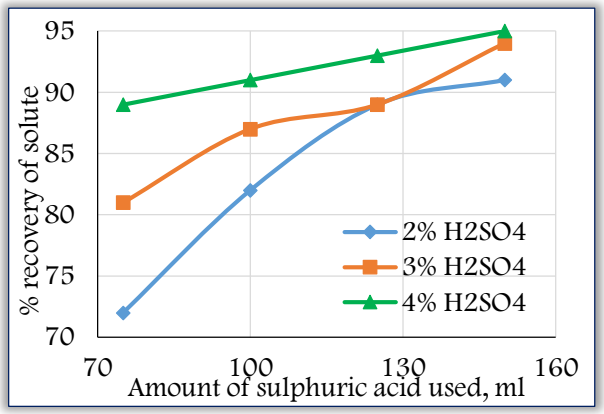

Figure 5: Amount of solvent used vs % recovery of solute (for 20gm of solute)

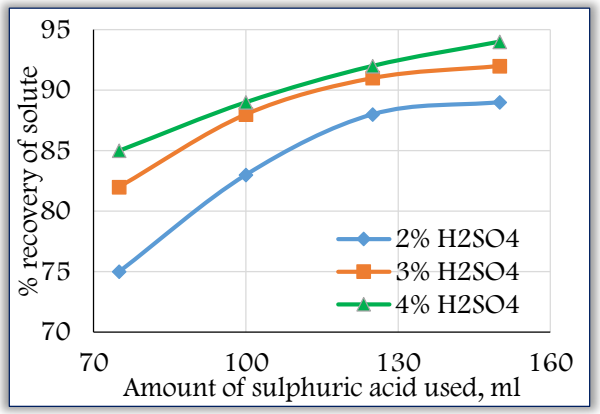

Figure 4: Amount of solvent used vs % recovery of solute (for 15gm of solute)

From Figure 4, it is clear that as amount of solvent increases, the percentage recovery of solute, Zn, increases. Also as concentration of solvent increases, the percentage recovery of solute, Zn, increases. The percentage recovery of solute is obtained for the different concentrations of sulphuric acid are given below:

— For 1:3 ratio of ore material, the highest percentage recovery of zinc is obtained for 150 ml of 2% H2SO4 at room temperature is 89.
— For 1:3 ratio of ore material, the highest percentage recovery of zinc is obtained for 150 ml of 3% H2SO4 at room temperature is 92.
— For 1:3 ratio of ore material, the highest percentage recovery of zinc is obtained for 150 ml of 4% H2SO4 at room temperature is 94.

From Figure 5, it is clear that as amount of solvent increases, the percentage recovery of solute, Zn, increases. Also as concentration of solvent increases, the percentage recovery of solute, Zn, increases. The percentage recovery of solute is obtained for the different concentrations of sulphuric acid are given below:

- For 1:4 ratio of ore material, the highest percentage recovery of zinc is obtained for 150 ml of 2% H2SO4 at room temperature is 91.
- For 1:4 ratio of ore material, the highest percentage recovery of zinc is obtained for 150 ml of 3% H2SO4 at room temperature is 94.
- For 1:4 ratio of ore material, the highest percentage recovery of zinc is obtained for 150 ml of 4% H2SO4 at room temperature is 95.

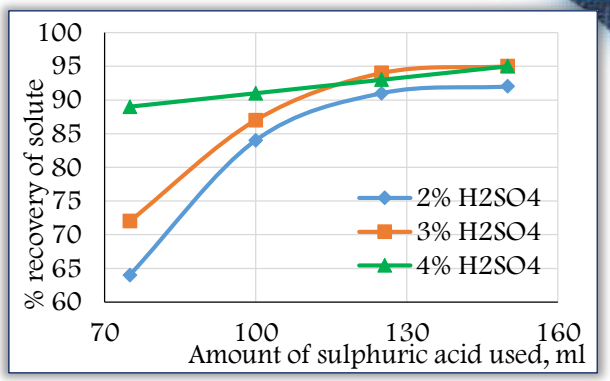

Figure 6: Amount of solvent used vs % recovery of solute (for 25gm of solute)

From Figure 6, it is clear that as amount of solvent increases, the percentage recovery of solute, Zn, increases. Also as concentration of solvent increases, the percentage recovery of solute, Zn, increases. The percentage recovery of solute is obtained for the different concentrations of sulphuric acid are given below:

- For 1:5 ratio of ore material, the highest percentage recovery of zinc is obtained for 150 ml of 2% H2SO4 at room temperature is 92.
- For 1:5 ratio of ore material, the highest percentage recovery of zinc is obtained for 150 ml of 3% H2SO4 at room temperature is 95.
- For 1:5 ratio of ore material, the highest percentage recovery of zinc is obtained for 150 ml of 4% H2SO4 at room temperature is 95.

Also we observe that, for smaller amount of solute present in the complex, lower concentrated solvent is enough to achieve maximum recovery of solute and vice versa.

5. CONCLUSION

The present study evaluated the possibility of selective leaching of zinc from complex by using sulphuric acid as a solvent at different concentrations of different volumes at room temperature. The parameters studied were; weight of zinc present in the zinc ore, concentration of sulphuric acid and amount of sulphuric acid. Experiments were carried out at room temperature. Sulphuric acid was used in the concentration of 2% to 4%. The amount of zinc used was 5 gm to 25 gm. Zinc removal was measured by using the standard zinc concentration curves. It is observed that the leaching efficiency increased remarkably as the concentration of sulphuric acid increases from 2% to 4%. The optimal conditions found for the highest metal removal (95%) are 150 ml of 4% sulphuric acid.

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