ACID LEACHING OF SPHALERITE CONCENTRATE

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ABSTRACT

The acid leaching of sphalerite with sulphuric acid has been investigated. It was found that the leaching efficiency of zinc increased with temperature and, acid concentration and attains a maximum of 93.6% at 200 °C using dilute acid. This method avoids zinc ferrite and silicate formation provides accomplishment of the process in a single stage, and is economic.

РЕЗЮМЕ

В работе проводилось исследование кислотной обработки сфалерита с помощью серной кислоты. Было найдено, что способность цинка к щелочению увеличивается с повышением температуры и концентрации кислоты и достигает максимума при 93.6% концентрации и при температуре в 200°C. Этот метод не влияет на цинковый феррит и на образование силикатов, а осуществление процесса просто и экономично.

Introduction

Sphalerite is present in economic amounts in many localities of the Eastern Desert of Egypt. Here, zinc deposits include polymetallic sulphide deposits (zinc and copper sulphides, and, to a lesser extent, lead and iron) and lead-zinc mineralization (composed mainly of galena and sphalerite with some pyrite). Oxidation and alteration products of the sulphides include smithsonite, cerussite, hemimorphite, zinc sulphate and limonitic and hematitic ochres. Studies on extraction processes of zinc received little attention (Amin 1955; Barakat – El-Shazly 1956; El-Shazly 1957; El-Shazly – Afia 1958; Hume 1934; Said 1962).

Technological processing methods of sphalerite for extraction of zinc from it includes the following stages: roasting of the concentrate, leaching of the roasted mass with sulphuric acid and then electrolysis. The main disadvantages of roasting of sphalerite concentrate are the formation of zinc ferrite, especially when the concentrate contains high amount of iron, and also the formation of some silicates. The zinc ferrite is insoluble during acid leaching and causes considerable loss of zinc. As a result of silicate formation, the obtained solutions contain considerable amount of silicic acid, which greatly influences their settling and filteration. Also, these methods include two stages, roasting of the ore and acidic leaching, which is uneconomic in industry (Forward – Veltman 1959; Plaksin 1963; Ralston 1941; Yaroslavtsev – Smirnov 1964).

The direct acid leaching of sphalerite concentrate with sulphuric acid is more suitable. This process is carried out in various ways under oxidizing conditions at atmospheric pressure or in autoclaves (Bjorling 1954; Ellis 1959; Forward 1953; Forward Veltman 1959; Forward – Halpern 1956/57) Forward – Mackiw 1955; Plaksin 1963; Ralston 1941, Snurmikov et. al. 1969; Tronev – Baudin 1939; Yaroslavtsev – Smirnov 1964).

The present work represents a study of a single stage leaching of sphalerite concentrate with sulphuric acid of different concentrations in air current at different temperatures.

Experimental work:

This research was carried out with sphalerite concentrate, having mineralogical and chemical composition as given in Tables I and II respectively.

Table I.

Mineralogical composition of zinc concentrate

Mineral	Content %
Sphalerite	71.6
Galena	6.4
Pyrite	8.3
Chalcopyrite	2.2
Hematite	2.4
Others (carbonates, silicates,)	9.1

Table II.

Chemical composition of zinc concentrate

Chemical component	Percentage, %
Zn	47.64
Pb	5.80
Fe	8.52
Cu	0.81
S	30.45
Al_2O_3	1.12
CaO	1.40
SiO_2	2.83

From table I. the sphalerite content in the concentrate is 71.6%, while the other subordinate minerals are galena, pyrite, chalcopyrite, quartz and some carbonates and other minerals. These mineral impurities are genetically connected with the formation of sphalerite.

Techniques of work:

The initial sphalerite concentrate used is of grain size 98% − 200 mesh. The weight of the concentrate ranges from 5 − 10 gm. The sphalerite was mixed with sulphuric acid of particular amount and concentration and heated in electric furnace to a fixed temperature in dried air current.

The temperature was regulated automatically with accuracy ±3 °C. Leaching experiments were carried out at different temperatures and times. Dissolution of the sulphate mass with water was carried out in a beaker with magnetic stirrer at room temperature. The solution was filtered under vacuum and the obtained cake was washed with water. Filterate and washed water were combined together and analysed for the total zinc content & then the leaching efficiency of zinc was calculated.

Results and Discussion

A series of experiments were carried out to study the essential factors acting upon leaching of sphalerite (amount and concentration of sulphuric acid, tepperature and time) and to determine its optimum conditions of acid leaching.

1 – *Effect of acid concentration:*

Experiments were carried out at amount of sulphuric acid 120% of theoretical amount for dissolution of concentrate and oxidation of hydrogen sulphide, at temperatures 125° − 200 °C, duration of one hour and at different concentrations of acid.

As shown in Fig. 1, at 125° and 150 °C, leaching of sphalerite is rapidly increased, as the acid concentration increases. Maximum leaching of sphalerite (91.5%) at 150 °C reaches only using concentrated acid, while at 125 °C complete leaching of sphalerite does not take place.

At 200 °C, sharp increase of leaching is observed at low acid concentrations, then there is a gradual increase. In general, as the acid concentration and temperature increase, dissolution of sphalerite increases.

The suitable acid concentration was selected, taking into consideration the possibility of using the return zinc electrolyte solution is the leaching process. This may be considered as 20%, the nearest one to free acid content in the return zinc electrolyte and at which nearly complete leaching of sphalerite (~93.6%) is reached at 200 °C.

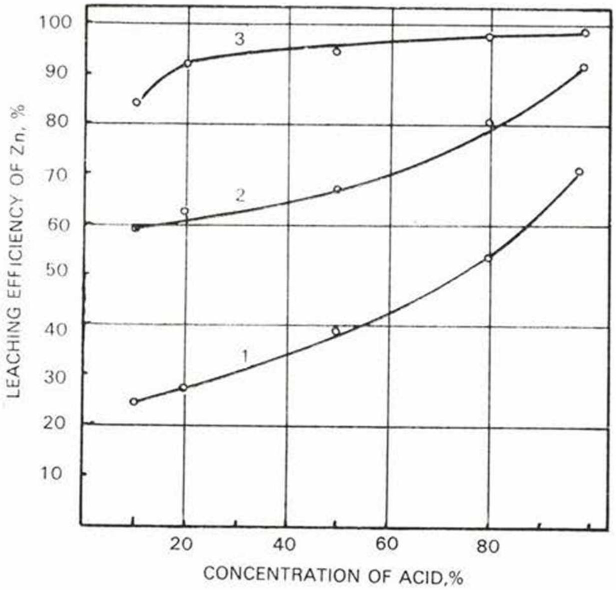

Fig. 1. Relation between the leaching efficiency of sphalerite and concentration of sulphuric acid at different temperatures. 1, 2, & 3 — at 125, 150 & 200 °C respectively.

2 — *Effect of acid amount:*

It is necessary to carry out leaching of sphalerite with some excess of sulphuric acid, as lead sulphide reacts more rapidly than zinc sulphide (Forward — Veltman 1959). Experiments were carried out using different amounts of sulphuric acid, ranging from 100 to 150% of theoretical value and at different acid concentrations and temperatures.

From the obtained results (Fig. 2) it is observed that the conversion of zinc sulphide to zinc sulphate is sharply increased, as the amount of acid increased from 100 to 120%, then it is slightly increased especially at higher temperature. The leaching efficiency of sphalerite is low at temperatures 125—150 °C, even at acid expense 150% of theoretical amount. This may be due to the low velocity of sulphatization at low temperature. On the other hand, at 200 °C, high leaching efficiency of sphalerite was obtained at acid amount 120% which can be considered as suitable amount for leaching. Thus, the extent of dissolution of sphalerite is directly proportional to the amount of sulphuric acid added.

3 — *Effect of temperature and time:*

To study the action of both temperature and time on leaching of sphalerite, experiments were carried out a fixed amount of acid 120% of theoretical amount and its concentration 20,50% of concentrated acid and at different temperatures 125—300 °C, and time from 5 to 75 min.

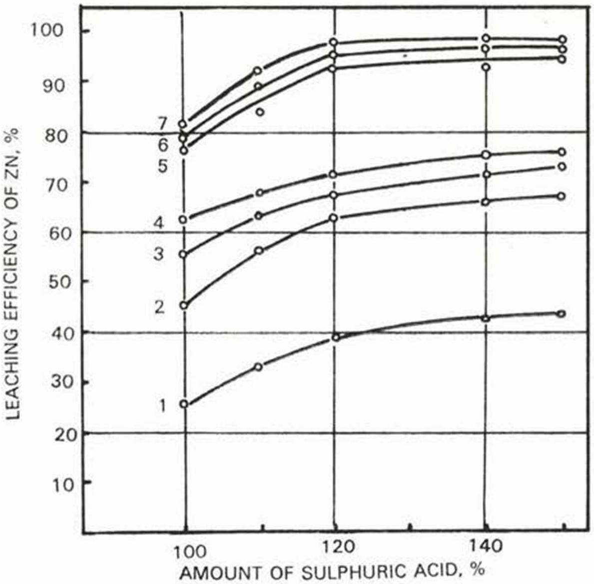

Fig. 2. Relation between leaching efficiency of sphalerite & amount of sulphuric acid at different concentrations & temperatures.
1,3,6 – 50% sulphuric acid at 125,150 & 200 °C
2,5 – 20% sulphuric,acid at 150 & 200 °C
4,7 – concentrated acid at 125 & 200 °C

From the obtained results (Fig. 3), the following conclusions have been drawn:

a) In general, as the temperature increases, the dissolution of sphalerite increases with time, except at 250 – 300 °C, where it decreases after a particular time of leaching.

b) At 125 °C it was found that the conversion of sphalerite to zinc sulphate though rapid initially in the first half hour, after that is slowly increased. At this temperature, complete leaching of sphalerite does not take place even at long time.

c) At 150 °C, sharp increase in dissolution of sphalerite with time was observed, and the higher the acid concentration, the greager would be the leaching efficiency. At this temperature, nearly complete leaching of sphalerite was reached using concentrated sulphuric acid.

d) At 200 °C, leaching efficiency of sphalerite is though very sharp during the first half hour for all acid concentrations, but after that it is gradual. At this temperature, complete leaching of sphalerite (98.7%) was reached during one hour using concentrated acid.

e) At 250 – 300 °C, high conversion of sphalerite to zinc sulphate was observed during the first twenty min. and complete leaching was reached after 30 – 20 min. respectively. At these temperatures, after reaching maximum and after particular time, the leaching efficiency of-

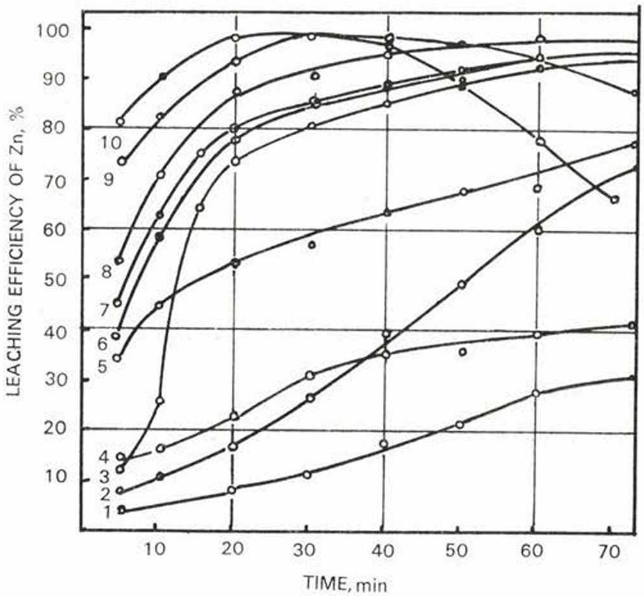

Fig. 3. Relation between leaching efficiency of sphalerite & time at different temperatures.
1,2 & 3 – 20% sulphuric acid, at 125,150 & 200 °C
4,5 & 6 – 50% sulphuric acid, at 125,150 & 200 °C
7,8,9 & 10 – concentrated acid at 150, 200, 250 and 300 °C respectively.

sphalerite decreases with time at different rates, depending upon the temperature of leaching. The higher the temperature, the more decrease of leaching efficiency of zinc will be observed. This decrease may be due to to not only the evaporation of water from reaction pulp, but also due to the increase of volatilization ot sulphuric acid.

Conclusions

1 – The possibility of acid leaching of sphalerite with sulphuric acid has been studied, from which it was found that as the acid concentration and temperature increase, the leaching efficiency of sphalerite increases with time. At high temperatures, after reaching complete dissolution and after a particular time of leaching, it decreases at different rates, depending upon the temperature.

2 – Sphalerite can be leached by dilute sulphuric acid solutions of amount 120% of theoretical value, at 200 °C and time 1 hour. At these conditions, nearly complete leaching of sphalerite (93.6%) was reached.

3 – The main advantages of the direct acid leaching of sphalerite are the following:

a – Avoiding of zinc loss due to zinc ferrite formation during roasting of sphalerite concentrate. Also, avoiding of the formation of some silicates and consequent difficulty of settling and filteration of the obtained solutions.

b – Accomplishment of the process in a single stage.

c – High extraction of zinc regardless of the iron content of the concentrate.

d – The process is simple and economic.

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