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A STUDY OF THE ACIDIC LEACHING OF ZINC – LEAD SULPHIDES

BADANIA PROCESU KWAŚNEGO ŁUGOWANIA SIARCZKÓW CYNKU I OŁOWIU

Abstract

Zinc sulphide concentrates contain small amounts of magnesium, typically 0.2–0.4%. Magnesium dissolved in process liquors is undesirable in further technological processes because of obstacles in the zinc electrolysis process. In laboratory experiments on the phosphoric acid leaching the following parameters were included: pulp density, the temperature and time of leaching, phosphoric acid concentration. From the experimental results it has been concluded that magnesium recovery from sulphide concentrates reaches 89% under laboratory conditions.

Keywords: zinc concentrates, leaching, phosphoric acid

Streszczenie

Koncentraty siarczku cynku zawierają małe ilości magnezu, zwykle od 0.2 do 0.4%. Obecność magnezu w formie rozpuszczonej w roztworach stosowanych w dalszych etapach technologii jest niepożądana ze względu na utrudnienia w procesie elektrolizy cynku. W badaniach laboratoryjnych ługowania koncentratów cynku zastosowano roztwory kwasu fosforowego o różnych stężeniach, zmienne temperatury ługowania oraz różne stosunki fazy stałej do ciekłej. Obliczony na podstawie wyników badań stopień wylugowania magnezu wyniósł 89%.

Słowa kluczowe: koncentraty cynku, ługowanie, kwas fosforowy

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1. Introduction

Zinc concentrates produced in Poland usually contain a dolomite addition. Dolomite appearance is undesirable during further hydrometallurgical processing because of the magnesium presence, which is an unwanted impurity during zinc electrodeposition. The magnesium admixture results in a lower quality of the metallic zinc product as well as technological and economic indexes. The hydrometallurgical method of zinc production demands magnesium level lowering below 0.3% MgO.

There are two industrial methods of magnesium removal [1–5]:

- systematic elimination of the solution from the zinc electrolysis circle,
- chemical treatment and cleaning flotation of zinc concentrates with sulphuric acid solutions.

The disadvantages of the first method are mainly the losses of the desired metals, as well as the environmental pollution.

The second method uses different reactivities of zinc and lead sulphides in contrary to dolomite components (magnesium and calcium). A sulphuric acid solution as the leaching agent causes quicker transfer of magnesium and calcium to the solution in comparison with zinc and lead.

The goal of this work was to determine the results of zinc concentrate leaching by means of phosphoric acid, taking into account magnesium concentration in the final product as well as the degree of its leaching from the initial sample.

2. Experimental

2.1. Materials characteristics

Zinc concentrate derived from “Trzebieńka” Mining Works was applied in the research. The chemical content of the initial material was analysed by the ICP AES method using Perkin –Elmer “Plasma 40” spectrometer. The analysis results are presented in Table 1. The sphalerite concentrate contains 55.14% of Zn, which corresponds to 82.18% of ZnS. The mineralogical composition of the initial sample was determined by the X-ray diffraction method using Phillips diffractometer with X’Pert system, and the result of the phase analysis is shown in Fig. 1. The concentrate contains mainly sphalerite ZnS, galena PbS, dolomite $\text{Ca}_3\text{Mg}(\text{CO}_3)_2$ and small amounts of SiO_2 . A photomicrograph of the initial sample is shown in Fig. 2.

Phosphoric acid in the form of 2, 3 and 10% solutions was used in the leaching process. They were prepared on the basis of domestic chemicals p.a. grade.

Table 1

Chemical content of the zinc concentrate

Component	Zn	Pb	Fe	Mg	Ca	S _{total}	S _{sulf}	SiO ₂
Content [%]	55.14	3.60	1.13	1.18	2.31	28.88	28.60	0.68

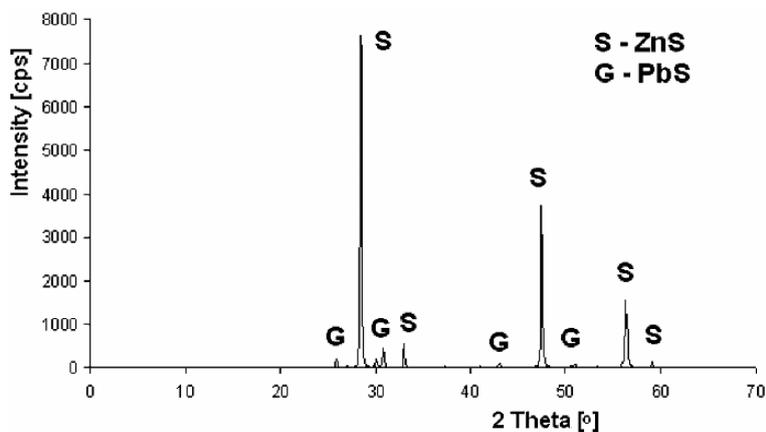


Fig. 1. X-ray diffraction pattern of the initial zinc concentrate

Rys. 1. Dyfraktogram koncentratu cynku użytego do ługowania

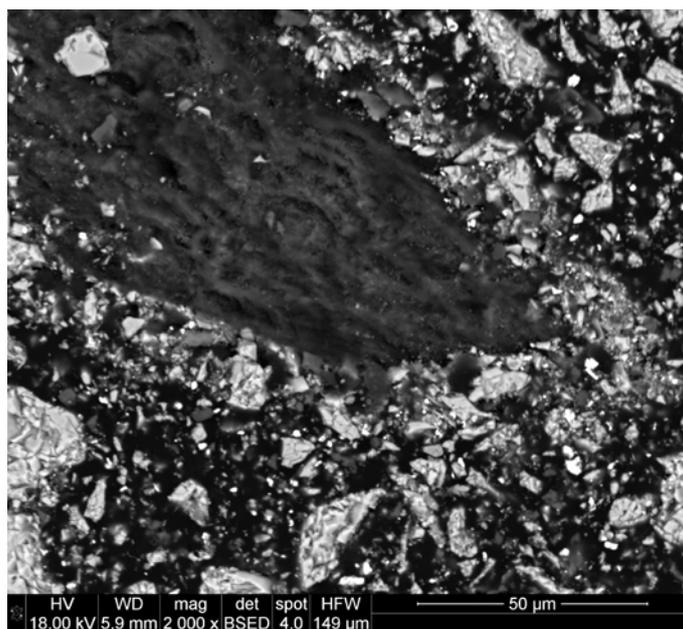


Fig. 2. SEM micrograph of zinc concentrate

Rys. 2. Fotomikrografia koncentratu cynku

2.2. Leaching experiments

The leaching process was realized at 50°C in typical laboratory equipment – a glass reactor with temperature control and standard stirring. The acid solution was initially heated

to a desired temperature and then 20 g of a concentrate sample was added. The mixture was stirred for 30, 60, and 120 minutes respectively. When the leaching process was finished, the mixture was filtered using Buchner funnel, and leachate as well as solid residue were analyzed to define Mg, Ca, Zn, Pb and Fe concentrations in both phases. The solid to liquid phase mass ratio equalled 1:2.

The results of the experimental series are shown in Figs 3, 4, 5 and 6.

The process of leaching was defined by means of a degree of each component transfer to the solution (leachate). It was calculated from the following dependence

$$\alpha_i = \frac{V_R \cdot C_i}{m_p \cdot \frac{x_i}{100}} \cdot 100 \quad [\%] \quad (1)$$

where:

- α_i – leaching degree of i -component [%],
- V_R – bulk volume of leachate [dm^3],
- $C_i - i$ – component concentration in leachate [g/dm^3],
- m_p – mass of leaching sample [g],
- x_i – content of i -component in leachate [%].

Figures 3–6 show changes of the degree of different components leaching. It comes out from Figs 3 and 4 that the leaching process with a phosphoric acid solution easily proceeds for calcium and magnesium. A high level of leaching is realized for the weak acid (2% H_3PO_4) after 30 minutes of leaching. The level of magnesium leaching reaches almost 90% after 240 minutes of the process. At the same time the corresponding value for calcium reaches 80%. The degree of magnesium leaching at the achieved level matches the magnesium content of 0.3% and is lower in the final concentrate (product).

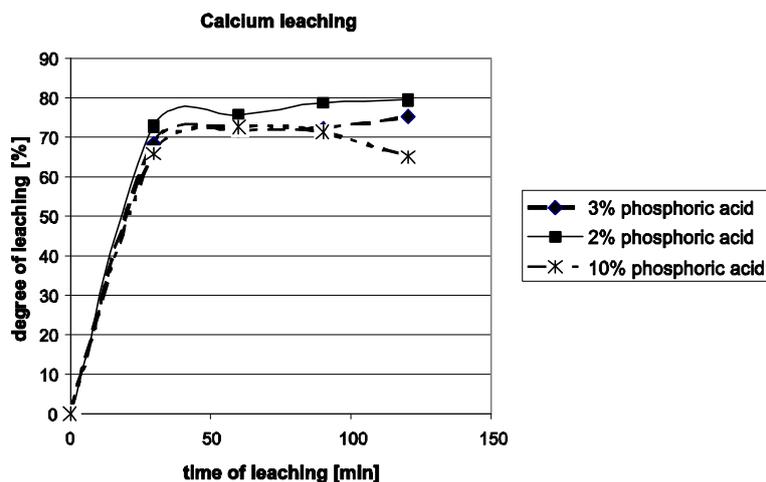


Fig. 3. The dependence of calcium degree of leaching on time of reaction

Rys. 3. Zależność stopnia wylugowania wapnia od czasu reakcji

Figures 5 and 6 show that zinc and lead components are resistant to phosphoric acid leaching under experiment conditions, which is a very desirable circumstance. The level of zinc degree of leaching reaches 1% and the lowest values are achieved for the stronger acid (10% H_3PO_4). The same dependence for lead shows a maximum value of 0.65%, and the lowest values are also achieved for 10% H_3PO_4 , similarly to the results for zinc leaching.

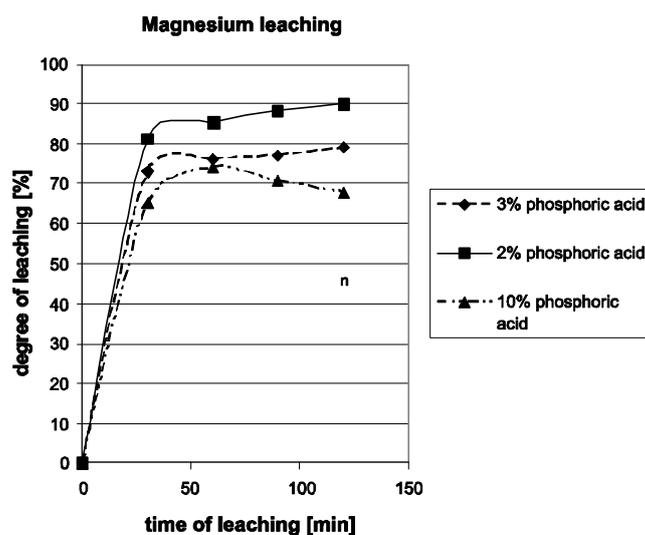


Fig. 4. The dependence of magnesium degree of leaching on time of reaction

Rys. 4. Zależność stopnia wylugowania magnezu od czasu reakcji

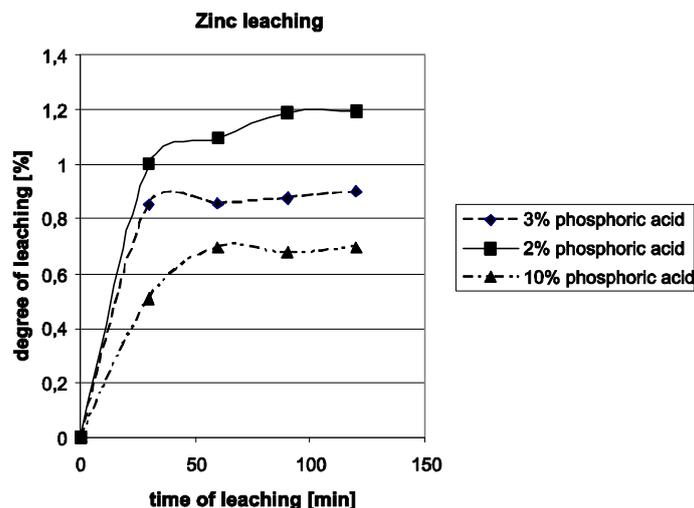


Fig. 5. The dependence of zinc degree of leaching on time of reaction

Rys. 5. Zależność stopnia wylugowania cynku od czasu reakcji

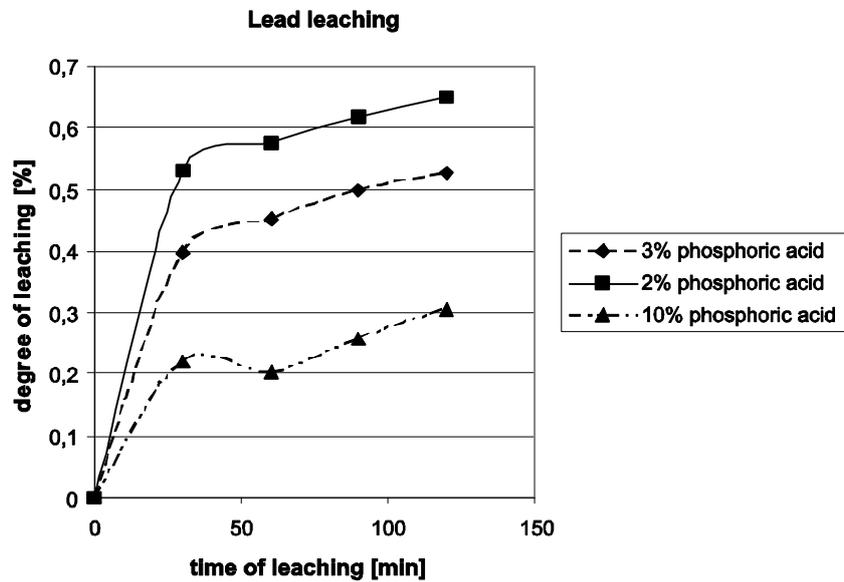


Fig. 6. The dependence of lead degree of leaching on time of reaction

Rys. 6. Zależność stopnia wyługowania ołowiu od czasu reakcji

The final concentrate was identified as zinc and lead sulphides – blende and galena, which is proved by the X-ray diffraction pattern shown in Fig. 7.

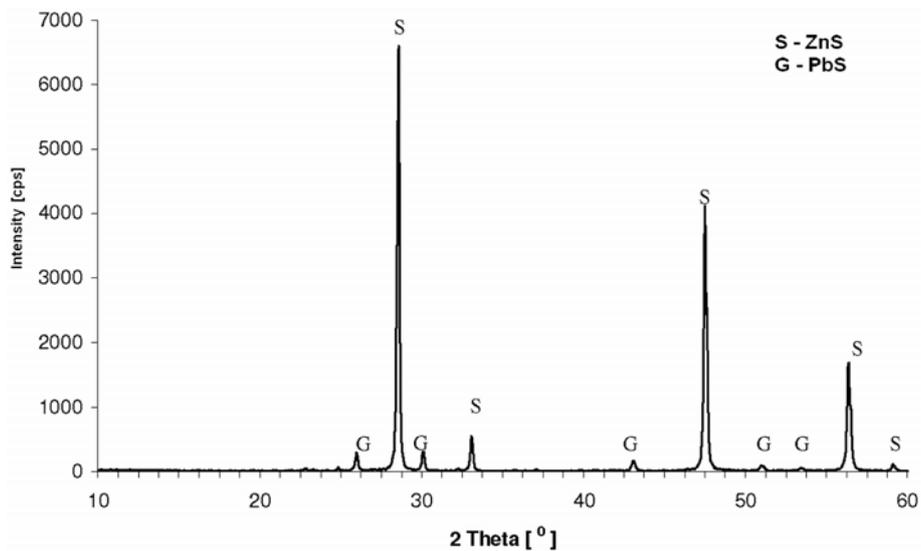


Fig. 7. X-ray diffraction pattern of the final concentrate

Rys. 7. Dyfraktogram produktu finalnego

3. Conclusions

As a result of the experiments it can be stated that the degree of magnesium leaching from the concentrate is satisfactory and its value is included within the range from 65% to 90%. Similar values were achieved for calcium, but the final value was equal to 80%.

The degree of leaching of zinc amounted to 1.2% and it proved that zinc losses during the process of magnesium removal were very low. The similar situation was observed for lead, which was leached at an even lower level than zinc.

The leachates – solutions obtained after acidic leaching – are the possible source of calcium and magnesium dihydrophosphates. These two salts crystallize from the solution not at the same time, but the first product is observed in the form of $\text{Ca}(\text{H}_2\text{PO}_4)_2 \cdot 2\text{H}_2\text{O}$. The other salt is crystallizing after evaporation and the product observed is $\text{Mg}(\text{H}_2\text{PO}_4)_2$. Both products contain small amounts of zinc phosphate admixture, which is a desirable microelement of fertilizers.

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References

- [1] Booster J.L., van Sandwijk A., Reuter M.A., *Magnesium removal in the electrolytic zinc industry*, Minerals Engineering, 13, 17, 2000.
- [2] Jarosiński A., Exemplary solutions of zinc raw material processing, *Recyklacja Odpadu XI, Košice 2007*, 177-183.
- [3] Borkowski J., Pasik J., Pudło W., Sanak-Rydlowska S., *Wydzielanie galeny z koncentratu blendy cynkowej metodą flotacji*, XXIII Konferencja Krakowska Przeróbki Kopalni, Bukowina Tatrzańska 1991, 225-234.
- [4] Cichy K., Szolomicki Z., Reguła C., *Nowe technologie w procesie wzbogacania rud Zn-Pb w ZGH „Bolesław” S.A.*, Rudy Metale, 52, 10, 595, 2007.
- [5] Shermak K.D., *An approach to reduce magnesium from zinc electrolyte with recovery of zinc from disposed residue of effluent treatment plant*, Hydrometallurgy, 407, 1990.