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LEACHING REFUSE AFTER SPHALERITE MINERAL FOR EXTRACTION ZINC AND COBALT

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The paper deals with a possibility of zinc and cobalt extraction from refuse after sphalerite mineral leaching. It contains theoretic analysis of hydrometallurgical processes. Practical part describes samples and their leaching in 10 % and 20 % sulphuric acid. In the end of the paper it is evaluated under which conditions the highest yield of zinc and cobalt from refuse after sulphide ore leaching is reached.

Key words: hydrometallurgical processes, sphalerite minerals, leaching conditions, zinc, cobalt

INTRODUCTION

They are one of the sources of ore raw. These ones have to be processed through treatment processes in to form of concentrate serving as an input raw for production of the particular metal. Production of metals can proceed in several ways, for example in pyrometallurgical, hydrometallurgical or electrometallurgical way. After the production itself refining processes follow.

Hydrometallurgical processes are one of the essential processes of the production of metals. They are based on leaching of pre-treated concentrate, which is sulphate burnt most often to gain sulphates which are well soluble in suitable leaching agents. Two following phases are the product - leaching substance – the solid residue – and leach containing metal of our special interest. Then we gain a metal from the leach through the number of processes. When an input raw is a relatively rich an amount of metals appears also in a leaching substance which we can continue to leach by leaching agents and we gain a leach again and depleted waste leaching substance. We gain metals from a leach by already previously described processes.

The paper goal is to extract zinc and cobalt from refuse after sphalerite mineral leaching. The partial goal is theoretic analysis of hydrometallurgical processes. The goal of the practical part is sample treatment, subsequent leaching of sulphide concentrate in 10 % and 20 % sulphuric acid. In the end of the paper it is evaluated under which conditions the highest yield of zinc and cobalt from refuse after sulphide ore leaching is reached [1].

BASIC CHARACTERISTICS OF SPHALERITE MINERALS AND LEACHING PROCESS

Metal extraction from ores through hydrometallurgical processes takes place under relatively low temperatures of approx. up to 200 °C. When process takes place under temperatures up to 100 °C and total pressure 0,1 MPa we are talking about leaching under standard conditions. But if the process takes place under increased temperatures, it will automatically require also increasing of the total pressure. In this case the process takes place in the pressure reactor – autoclave – and we are talking about pressure leaching. Sulphides are compounds of S^{2-} anion with metals (one or more). Even such minerals rank among group of sulphides where sulphur is partially or completely substituted by As, Se, Te, rarely also by Sb and Bi. Chemical bonds in sulphides are mainly covalent or metal, often mixed. Majority of sulphides has metallic lustre. In comparison with metals they are not mostly ductile but they are fragile. Generally sulphides show a high density. They are of a considerable economic importance as a main raw material of a great number of metals [2-4].

Leaching is a selective extraction of one or more components from a solid concentrate (ore) to a liquid leach. From the physical and chemical point of view it is a heterogeneous process where two phases take part at least: solid (s) and liquid (l) [5,6]. Ratio of liquid and solid phases marked such as sludge K:P , i.e. ratio of leaching solution and ore, is an important factor influencing the course of leaching. To gain as high metal concentration in the leach as possible, K:P ratio should be as low as possible. Leaching is getting worse with increasing concentration and it means that in every individual case the leach concentration has to be the highest [7-9].

EXPERIMENTAL PROCEDURES

Zinc and cobalt extraction from refuse after sphalerite mineral leaching was the goal of the experimental section. Leaching was performed in sulphuric acid under various temperatures and time intervals.

The main part of the experimental work was to determine the most suitable conditions for reaching maximum zinc and cobalt yield.

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Samples were analysed on zinc and cobalt content in Nanotechnology Centre of VŠB – Technical University of Ostrava (CNT).

Table 1 **Shows chemical analysis from CNT/wt.%**

Input chemical analysis		
Cd	0,31	0,30
Co	1,21	1,12
Ni	0,32	0,33
Pb	0,72	0,72
Zn	10,8	10,8

Leaching took place in 10 % sulphuric acid without addition of oxidizer under temperatures of 20, 40, 60 and 80 °C during various time intervals from 0,5 hour, 1 hour, 2 hours up to 4 hours – see Table 1.

Leaching Procedure

Beakers with prepared solutions (200 ml of 10 % sulphuric acid) were put into electromagnetic stirrer. In every electromagnetic stirrer required temperatures (20 °C, 40 °C, 60 °C, 80 °C) were separately adjusted. When required temperatures were reached pre-dried and pre-ground sample amounting to 25 g (1:4) was poured into beakers. When determined time (0,5 hour, 1 hour, 2 hours, 4 hours) elapsed the leaching process was finished and leaching substance and leach were separated by filtration.

Gained samples after leaching (leach, leaching substance) were chemically analysed on zinc content, cobalt content and other element of our special interest – see Tables 2, 3.

Table 2 **Resulting content of zinc, cobalt and other metals in solution after the leaching (CNT)**

No	Temp	Time	Cd	Co	Ni	Pb	Zn
	/ °C	/ h	/mg/l	/mg/l	/mg/l	/mg/l	/g/l
1	20	0,5	365	3,25	118	3,63	17,8
2	20	1	357	2,84	121	3,74	17,3
3	20	2	364	2,43	120	3,66	17,5
4	20	4	353	2,01	126	3,49	17,4
5	40	0,5	388	1,82	133	3,03	17,5
6	40	1	386	1,37	130	3,77	17,5
7	40	2	393	1,86	133	3,45	17,9
8	40	4	404	3,34	146	3,33	19,1
9	60	0,5	424	2,47	139	3,65	18,2
10	60	1	386	2,91	127	3,34	18,1
11	60	2	499	52	159	3,31	21,1
12	60	4	521	76	167	3,90	22,7
13	80	0,5	471	56	147	3,86	20,7
14	80	1	516	143	158	3,54	22,2
15	80	2	839	922	257	2,68	28,8
16	80	4	908	1400	264	1,68	29,5
17	20	4	197	0,58	63	0,27	10,2

Measurement uncertainty: Cd 5 %, Co 10 %, Ni 5 %, Pb 4 % and Zn 7 %.

Table 3 **Resulting content of zinc, cobalt and other metals in the leach (CNT)**

No	temp	time	Cd	Co	Ni	Pb	Zn
	/ °C	/ h	/ %	/ %	/mg/kg	/ %	/ %
1	20	0,5	0,35	2,13	0,075	0,64	3,85
2	20	1	0,36	2,17	0,074	0,65	3,71
3	20	2	0,34	2,05	0,067	0,64	3,77
4	20	4	0,31	1,90	0,059	0,58	3,57
5	40	0,5	0,30	2,03	0,061	0,62	3,75
6	40	1	0,31	2,01	0,060	0,60	3,94
7	40	2	0,29	1,95	0,054	0,60	3,76
8	40	4	0,28	1,88	0,052	0,61	3,55
9	60	0,5	0,28	1,98	0,056	0,59	3,87
10	60	1	0,25	1,86	0,050	0,58	3,35
11	60	2	0,23	1,79	0,047	0,55	3,61
12	60	4	0,22	1,68	0,046	0,57	3,55
13	80	0,5	0,24	1,94	0,052	0,61	4,17
14	80	1	0,20	1,73	0,045	0,61	3,65
15	80	2	0,17	1,07	0,039	0,47	3,52
16	80	4	0,15	0,96	0,037	0,46	3,66
17	20	4	0,49	2,18	0,11	0,68	10,0

Measurement uncertainty: Cd 5 %, Co 10 %, Ni 5 %, Pb 4 % and Zn 7 %.

CONCLUSIONS

The goal of this work was to extract zinc and cobalt from refuse after sphalerite mineral leaching. The sample of waste leaching substance was treated and leached in the solution of sulphuric acid in several stages. During four stages zinc amount has increased equally with the temperature, this amount was recorded in g/l in contrast to cobalt amount which was recorded in mg/l. Cobalt has also increased equally with the temperature during these stages but at 80 °C sudden specific variations have occurred during 0,5 - 2 as well as 4 hours leaching. Only during water leaching for the period of 4 hours and under the temperature of 20 °C nearly any increase of zinc amount, neither cobalt amount has occurred.

From the comparison of the input analysis of the waste leaching substance we can see that values of zinc, cobalt and other metals of our interest have decreased.

From the total summary it is clear that the lower K:P ratio is the higher is the yield of metals. In this case it was 1:4, it means 25 g of the sample and 200 ml of 10 % of sulphuric acid. The most suitable for leaching could be using autoclave because of the shorter time of leaching and possibly the highest yield of metals.

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Note: The responsible translator for English language is Jana Drápalová from University of Ostrava, Czech Republic