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LABORATORY INVESTIGATIONS OF TECHNOLOGICAL PROCESS FOR TREATMENT THE POLYMETALLIC GOLDBEARING CONCENTRATE

Joksim Marinković, Mile Bugarin, Vlastimir Trujić,
Milorad Ćirković
Copper Institute, Bor
Serbia

ABSTRACT
This work presents the results of laboratory investigations the pyrometallurgical process of gold and silver extraction from polymetallic goldbearing concentrate with content in (%): Cu – 2.3; Fe – 19.8; S – 27.19; Zn – 9.13; As – 0.167; Pb – 15.63; SiO_2 – 17.93; CaO – 0.97; Al_2O_3 – 11.43; Ag – 480 g/t; Au – 659 g/t. This concentrate was undergone to the pyrometallurgical treatment (oxidation roasting – reduction smelting). Products of reduction smelting are: raw lead with transfer from 90.5 to 97.95% gold and 77.28% to 93.37% silver, polymetallic matte with transfer from 1.1 to 3.92% gold and 4.35 to 8.42% silver and slag with transfer from 0.58 to 1.6% gold and 2.45 to 6.82% silver.
Key words: polymetallic goldbearing concentrate, pyrometallurgical treatment, gold,

1. INTRODUCTION
In the world, today, for gold extraction from sulphide ores and concentrates, the pyrometallurgical methods are used more and more, and the technologies as cianization and amalgamation [1,3] are left.

The basic reason for this is in higher recovery of gold and easier manipulation and environment protection.

In the process of pyrometallurgical extraction of precious metals there is always the basic phase - collector, where precious metals are collected. Selection of collector phase depends on content the starting raw material, further metallurgical treatment and other factors. In metallurgical treatment of suphide gold bearing concentrates as collector, the most usable are lead, copper or matte.

Lead is traditionally used as collector for precious metals due to high dissolubility of precious metals in lead at low temperatures, rapid separation of lead by pyrometallurgical method (cupellation process) and low working temperature (up to 1000^oC). This is especially if goldbearing concentrate or secondary raw materials contain significant quantity of lead. The main shortage of lead as collector is the required rigorous control of environment pollution and unsatisfactory recovery of I, Ru and Os in cupellation phase [2].

Copper as collector has wide use, especially if raw materials for treatment (ores, concentrates, secondary raw materials) beside precious metals, contain also copper. Silver and gold are completely mixed with copper at temperature over 1100^oC. Platinum group metals (Pt, Pd and Rh) have good solubility in copper at 1200^oC. Copper is much more expensive than lead what could have influence on copper selection as collector. This problem does not appear if starting raw material contains suitable copper concentration. An advantage of copper regarding to lead is in easier control of environment pollution.

Matte are melts of copper, lead, iron, zinc and other metals sulphides. In copper metallurgy, matte is a product where copper and precious metals are concentrated, and in lead metallurgy, matte presents an itermediate product and it is formed in smelting of copper reached ores and concentrates. Those mattes contain lead, copper, zinc, iron and precious metalsa (silver and gold). Lead - copper matte most often contain 8 - 20% Pb and 5 - 35 % Cu.

In decision making on selection the collecting phase in certain situation, beside the above mentioned, the other facts have to be taken into consideration as well as : chemical content of concentrate, what in some cases could have a decisive influence, consumption of normative material, training of labour force and others.

Goldbearing quartz from the locality Blagojev Kamen –East Serbia with content in (%) of : Cu - 0.047; S - 0.99; Pb - 0.11; Zn - 0.049; SiO_2 - 87.14, Al_2O_3 - 1.98; Au - 10-15g/t; Ag - 15-25 g/t; was undergone to the flotation process in semi-industrial Copper plant Institute Bor . Flotation process product , goldbearing concentrate with content in (%) of : Cu - 2.3; Fe - 19.8; S - 27.90; Zn - 9.13; As - 0.167; Pb - 15.63; SiO_2 - 17.93; CaO- 0.97; was used for laboratory investigations of pyrometallurgical process the extraction of precious metals.

2. LABORATORY INVESTIGATIONS

Laboratory investigations were carried out in Copper Institute Bor laboratories on a concentrate sample from Blagojev Kamen with the following content (%): Cu - 2.30; Fe - 19.80; S - 27.90; Zn - 9.13; As - 0.167; Pb- 15.63; SiO_2 - 17.93; CaO - 0.97; Al_2O_3 - 1.43; Ag - 480 g/t; Au - 659 g/t.

Investigations were carried out by smelting of concentrate of 1 kg concentrate in graphite tigel in the laboratory electrical resistance furnace. First investigation was carried out by smelting of unroasted concentrate sample. Two phases were obtained: matte and slag. Matte had the following content (%): Cu - 6.81; Pb - 9.00; Zn - 9.31; S - 30.80; Fe - 40.49; Au - 0.129 and Ag - 0.094. Content of matte was a little bit different from concentrate. Slag was very acidic with the following content: SiO_2 - 58.0%; CaO - 12.07%.

This method of concentrate smelting does not give the satisfied results because the polymetallic Cu - Pb - Zn matte is obtained with about 60% of transfered gold and silver.

The following serie sample was treated according to the technological layout: oxidation roasting, leaching, smelting. Content of roasting material-calcine (%): Cu-2.4; Fe-22.89; S-5.14; Zn-9.87; Pb-16.5.

Roasting material-calcine was leached with sulphuric acid, and the leaching residue - sediment was melted with addition of suitable flux quantity in tigel at 1250 ^oC. The smelting product is metallic phase 134.1 g with transfered 85.23% Au and 530 g slag.

The last serie samples was carried out according to the following layout: oxidation roasting - smelting with addition of reducer and without reducer in presence of suitable fluxes. Investigations were carried out with calcine with content of 7% S, and investigation with roasting material with 3.55% S. Smelting of calcine was carried out with variable quantity of reducer (powdered coal). Smelting of samples of 1 kg calcine was carried out in graphite tigel at 1250 ^oC. Graphite tigel was cooled by various intensity. Hardened melt includes three phases - raw lead on the bottom of tigel, Cu-Pb-Zn matte in medium part and slag on suface.

3. DISCUSSION OF THE LABORATORY INVESTIGATIONS RESULTS

Technological sheme for concentrate treatment in laboratory conditions included the roasting process of concentrate, charge preparation (addition of flux and coarsening) and smelting. The smelting products are: metal part, (raw lead, matte, slag) and gases. The results of laboratory investigations are present in Table 1.

Table 1. Results of laboratory investigations on smelting of gold bearing concentrate from Blagojev Kamen

Nº	Smelting products*	Weight g	Pb		Cu		Au		Ag	
			content wt.%	distribution %	content wt.%	distribution %	content wt.%	distribution %	content wt.%	distribution %
1	RL	91.1	91.98	50.93	3.30	11.64	0.78	95.38	0.576	91.50
	M	32.2	22.90	4.48	41.99	52.35	0.025	1.1	0.128	7.20
	S	85.9	1.55	8.09	1.39	46.23	0.0013	1.6	0.0016	2.45
2	RL	90.5	91.32	50.23	0.29	1.0	0.79	96.61	0.49	77.28
	M	69.5	24.76	10.47	25.55	68.75	0.02	1.88	0.036	4.35
	S	712	1.6	6.92	-	-	0.0006	0.58	0.0055	6.82
3	RL	90.4	96.38	55.88	2.09	7.31	0.74	90.5	0.53	82.95
	M	139.5	15.25	12.93	13.77	74.37	0.021	3.92	0.034	8.42
	S	609	1.05	3.88	0.16	3.77	0.001	0.82	0.0025	2.65
4	RL	89.6	95.49	52.00	2.34	8.12	0.809	97.95	0.598	93.37
	M	66	16.93	6.79	25.96	66.33	0.021	1.8	0.052	5.90
	S	797	1.51	7.40	-	-	0.001	1.08	0.0025	3.48

*RL – Raw lead
M - Matte
S - Slag

Metal part is raw lead with content 91.32 to 96.38% Pb and 0.66 to 1.38%, Ag from 0.598 to 1.11%. Second phase of smelting process is presented by Cu - Pb - Zn matte with contains: 15 - 24% Pb; 13.77 - 42% Cu; and 2 - 4% Zn., 0.02 to 0.14% Au and 0.22 to 0.8% Ag.

Third phase-slag has the following content: SiO2 - 36.45%; FeO - 26 - 31%; and CaO - 10 - 20%; and minimum quantity of useful metals: 1 to 1.55% Pb; 0.16 to 1.39% Cu; about 5% Zn; 0.0006 to 0.001% Au; and 0.0055 to 0.25% Ag.

Transfer degree of useful metals, especially precious metals into raw lead is very high: Pb from 50.23 to 55.88%; Au from 90.5 to 97.95% and Ag from 77.28 to 93.37%. Produced raw lead is very good collector for precious metals and in a case of good smelting process control, nearly total quantity of precious metals is transfered into raw lead.

In Cu - Pb - Zn matte transfers 4.48 to 10.47% Pb; 52.35 to 74.37% Cu; 1.1 to 3.92% Au and 4.35 to 8.42% Ag. Matte presents a reverse material where additional metal recovery could be carried out by supplemental treatment. Unsignificant quantity of metals is transfered into slag: 3.88 to 8 % Pb; about 0.58 to 1.6% Au and 2.45to 6.28% Ag. Very low is transfer degree of gold into slag.

4. TECHNOLOGICAL LAYOUT OF CONCENTRATE TREATMENT

Based on the laboratory investigation results and literature data, the following technological layout (Figure 1) was defined for treatment of sulphide polymetallic concentrate from Blagojev Kamen: oxidation roasting, charge preparation, smelting, cupellation of raw lead to dore metal and refining of dore metal. The first three phases of process were checked in laboratory conditions (oxidation roasting of concentrate, charge preparation and smelting).

During laboratory investigations, it was found out that the basic product of smelting process, where nearly total quantity of precious metals (from 90.5 to 97.9% Au and 77.28 to 93.37% Ag) is concentrated, is raw lead.

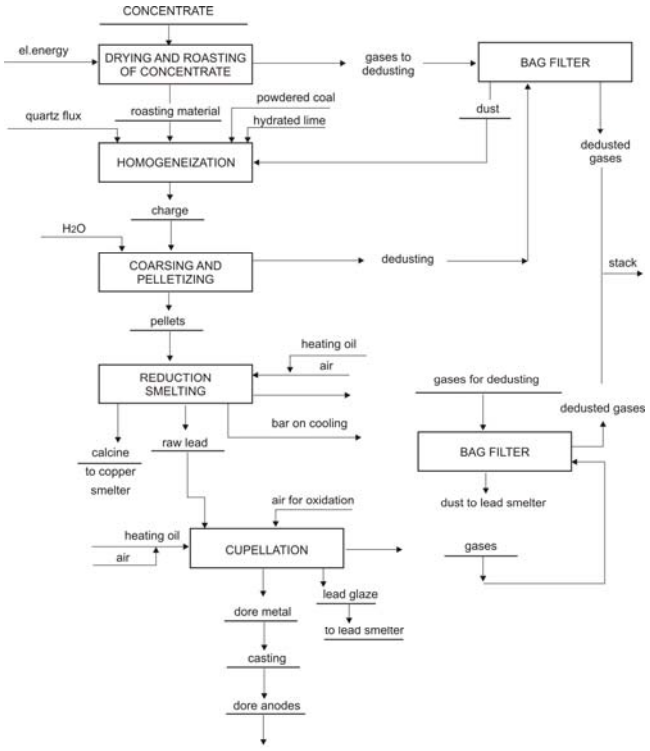

Figure 1. Block sheme of treatment the goldbearing concentrate from Blagojev Kamen

5. CONCLUSION

The investigations of technology for goldbearing quartz from the locality of East Serbia were carried out in the laboratories of Copper Institute Bor.

Goldbearing quartz was subjected to the flotation process. Product of flotation – concentrate with content of 659 g/t Au and 480 g/t Ag was subjected to pyrometallurgical treatment: oxidation roasting, reduction smelting.

Three stages were obtained in the smelting process:

- raw lead with content of 91.21 to 96.38 % Pb; 0.74 to 0.809 % Au and 0.49 to 0.598 % Ag.
- Cu – Pb – Zn matte with content of 15.25 to 24.76 % Pb; 13.77 to 41.99 % Cu; 2 – 4 % Zn; 0.02 to 0.075 % Au and 0.036 to 0.128 % Ag.
- Slag with content of 0.0006 to 0.0013 % Au.

The majority of precious metals from concentrate are transformed into raw lead as well as:
90.5 to 97.95 % Au and 77.28 to 93.37 % Ag.

The proposed technology for goldbearing quartz treatment consists of the following stages:

- flotation of previous crushed quartz ore
- oxidation roasting of flotation concentrate,
- reduction smelting,
- cupellation of raw lead even to dore metal,
- refining of dore metal.

6. REFERENCES

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