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VERIFICATION OF DESIGNED PARAMETERS OF PLANT FOR ELECTROCHEMICAL INVESTIGATIONS

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ABSTRACT
This work presents the general principes of design and operation the plant for electrochemical investigations in Mining and Metallurgy Institute. The plant was designed for market requiment for treatment of approx. 400 kg anode copper per anode operation. Testing and verification was performed on 360 kg anode copper per month. In the process of electrolytical refinig of copper metal degree of efficency of 99% was achieved. Testing confirmed the designed parameters.
Key words: designing, plant, electrochemical refinig of copper

1. INTRODUCTON

Six metals, platinum, palladium, rhodium, iridium, ruthenium and osmium, forms the platinum-group metals (PGMs). The world-wide production of the PGMs has increased dramatically over the last century and reflected to the increased fields of use these technologically important metals. Their unique combination of features: the chemical inertness, refractoriness as well as the catalytic activity enables their use as catalysts in the automotive, chemical, and petroleum-refining industries. They are also used in electrical and electronic industry, dentistry and medicine and jewelry. Commercially, platinum and palladium [1, 2] are the most important from this group of six metals. Regarding to their increasing importance, the high quality products of PGMs is required to meet demands in the certain field of use [3]. Although the metals of this group are generally found together, the mineral deposits of PGMs are very rare. PGMs generally occur in the nature associated usually with nickel or copper and a wide range of minor elements such as lead, tellurium, selenium and arsenic. Technical and commercial requirements are directed to the separation of PGMs from other metals and separation of each other inside the group aimed to obtaining the individual high purity metals, achieving high yield and high percentage of recovery [4]. Development of industry in the world has led to increase in the amounts of secondary raw materials that are recently increasingly used as the starting raw material for production of many metals. Secondary materials mainly contain high percentage of metals and, due to this reason, a great attention is paid to development of technologies for their treatment in order to recovery metals of high purity. The use of modern technologies significantly reduces the amount of waste material, reducing the costs of waste water and gas treatment and reducing the energy consumption. The results of various investigations, as well as developed technology on the basis of realized results, have found practical use in the recycling process.

This paper is the verification thr plant for electrolytical refining of anodes with non standard content. Obtaining the pure metals (Pt, Pd and Rh) on this type plant would become environmentally justified economically cost effective [5].

2. EXPERIMENTAL PART

Copper anodes, used for electrolytic refining process in order to verification designet parameters of plant were prepared from cathode copper and automotive catalysts with platinum group metals (Pt, Pd, Rh). Content of precious metals is up to maximum of 2 wt.%. Prepared cast was casted into suitable steel molds, and anodes, after cooling, were prepared for the process of electrolysis.

For determination Pt, Pd, Rh, Cr and Si content in anodes and anode slime, the atomic absorption spectrophotometer Perkin Elmer FAAS 403 was used.

During electrolysis process, the values of current intensity (A), cell voltage (V) and electrolyte temperature (^oC) were measured. Deposition current density was maintained within the limits of 130-140 A/dm^2. Direct current was supplied from an external source of DC with characteristics of I max. 150 A, U max. 10 V. Starting cathode was of cathode copper purity 99.95% Cu. Time of anode period during each experiment was 648 h and it was conditioned upon a request to transfer maximum possible quantity of precious metals into anode slime.

Experiments were carried out on a new semi-industrial plant which was specially designed for the needs of checking the results of laboratory tests (Figure 1 and Figure 2). Basic parts semi-industrial plant plants are: 1 power supplier, 2 electrolytic cell, 3 commercial tank, 4 supply tank, 5 storage tank for electrolyte, 6 receiving tank for electrolyte, 7 dishes for acceptance the anode slime, 8 pump for transport of electrolyte, 9 electrolyte distribution, 10 system for measuring and regulation of electrolyte temperature, 11 slime distribution, 12 device for floor transport, 13 crane, 14 fan. The equipment is made of chemically resistant materials.

Figure 1. New pilot plant for electrolytic refinig copper-Line 1

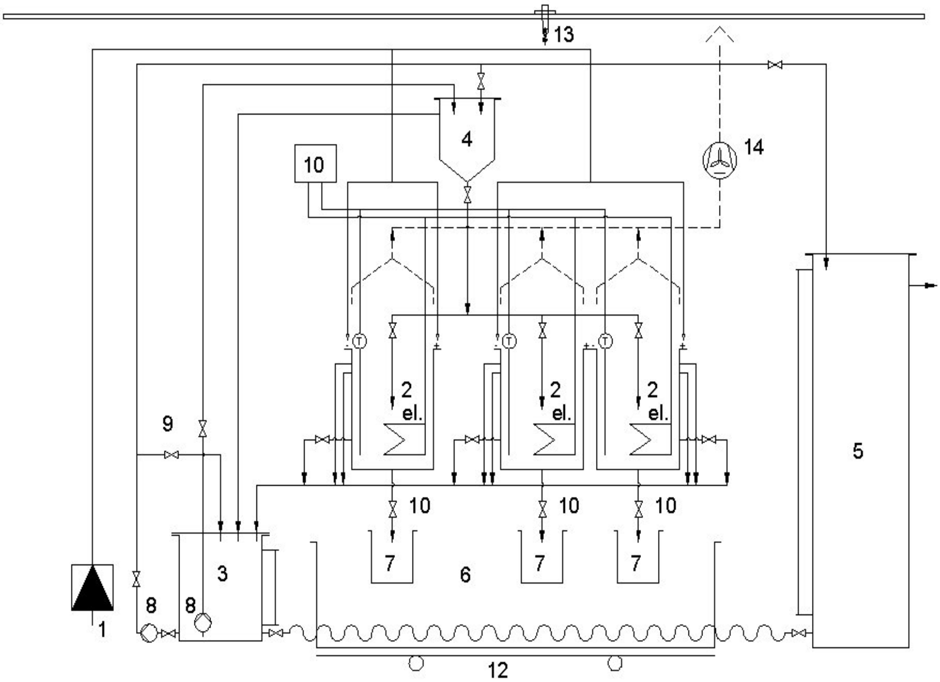

Figure 2. Technological scheme of semi-industrial plant for electrolytic refining of anodes with increased content of precious metals – Line 1

3. RESULTS AND DISCUSSION

3.1 Chemical content of anodes

Chemical analysis shown that Pt+Pd+Rh content for all samples was below 2 wt.% and minimum value was 1.11 wt.%, but maximum value was 1.24 wt.%. Cu content was a difference to 100 wt.%.

3.2 Electrolytic refining of copper anodes with increased content of PGMs

I EXPERIMENT

Six copper anodes, total weight of 156 kg (2 cells) were used for electrolytic refining. Process lasted 27 days as well as the I cathode period: 13 days, and the II cathode period: 14 days. Organization of electrodes in the cells is: cathode - anode - cathode, so that 3 anodes were inserted into in each cell. Inter-electrode axial distance amounted to 80 mm; electrolyte circulation: one change in cell volume at 2÷2.5 h.

Current intensity was maintained in the range of 150 to 160 A; temperature of electrolyte within the limits 53-57°C; Cu content in electrolyte: 35-45 g/dm^3; concentration of H_2SO_4 in the range of 160 to 180 g/dm^3 ; colloids: aqueous solution of thiourea and gelatin (4 g gelatin + 4 g of thiourea in 2 dm^3 of water) were added for 24 h in the system.

During the process, the voltage was measured on each cell individually. Voltage on the cell 1 varied within the limits: 320 to 360 mV and on the cell 2: 325-370 mV.

The obtained cathode copper was purity of 99.99%, and a degree of transfer the precious metals into anode slime was 99 wt.%.

II EXPERIMENT

The experiment was carried out on all three electrolytic cell and the rest of the supporting equipment that makes up the plant. Four anodes and five starting cathodes were inserted into the cells as provided by the project documentation. Mass of 12 anodes (3 cells) was 319.7 kg. As with the I experiment, the process lasted 27 days as well as the I cathode period: 13 days and the II cathode period: 14 days. The process time was conditioned to maximum possible dissolution of anodes in order to transfer as large as possible quantities of precious metals into anode slime.

Current intensity was maintained in the range of 150 to 160 A; temperature of electrolyte within the limits 53-57^{o}C; Cu content in electrolyte: 35-45 g/dm^3; concentration of H_2SO_4 in the range of 160 to 180 g/dm^3 ; colloids: aqueous solution of thiourea and gelatin (6 g gelatin + 6 g of thiourea in 2 l of water) were added for 24 h in the system.

Voltage on the cell 1 varied within the limits: 240 - 285 mV; on the cell 2: 245-290 mV, and on the cell 3: 250-290 mV. And in this experiment, the obtained cathode deposit has purity of 99.99% Cu, and distribution of precious metals in anode slime was 99 wt. %.

4. CONCLUSIONS

By electrolytic treatment of copper anodes containing PGMs to 2 wt.% in a two anode operations designed parameters was verificed. The obtained cathode copper was purity of 99.99%, and a degree of transfer the precious metals into anode slime was 99 wt.%.

5. ACKNOWLEDGMENT

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