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Technogenic Zinc Usage Possibilities Investigation for Gold Cementation

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Abstract

Industrial dusts with high zinc content are formed in nonferrous and ferrous metals metallurgy. Hydrometallurgical processing of such dusts can be used. In this case, alkaline solutions with high impurities content are formed. It is possible to produce zinc powder with different technological properties by electroextraction from mentioned alkaline solutions. This work describes investigation of zinc powders usage possibilities to gold cementation from cyanide solutions.

Keywords: Gold, electroextraction, three-dimensional cathodes, cementation, cyanide, zinc powder

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1. Introduction

In non-ferrous and ferrous metals metallurgy large quantities of furnaces dusts with a very high zinc content are formed. Various technologies are used to extract zinc from the technogenic raw materials into salable products.

A promising method for mentioned technogenic dusts recycling is a technology based on alkaline leaching [1]. The main advantage of this approach is selectivity that provides a sufficiently high quality of leaching solutions. Electroextraction can be used for zinc extraction from such technogenic solutions [2]. The electroextraction product is zinc powder with relatively large particle size. It is interesting to investigate the opportunities of such technogenic zinc powder use in traditional spheres and in particular for the gold cementation from cyanide solutions. The feasibility of zinc powder usage for gold cementation is enhanced by the lack of strict requirements on the powder purity.

2. Gold Cementation

In this paper is described the study of technogenic zinc powders application for gold cementation from cyanide solutions obtained in the leaching of gravity concentrates. Traditionally, for such purposes fine zinc powders are used [3]. Cementation with fine

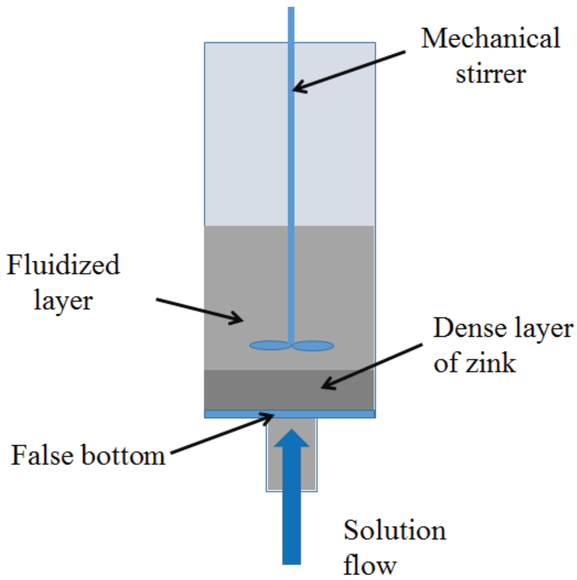

Figure 1: Scheme of the apparatus with fluidized layer.

zinc powders is performed in the percolation regime (Merrill-Crow technology) [4]. Small-scale apparatus shown on Figure 1 was used in the study of technogenic zinc powders. Specified apparatus is 1.8 cm diameter and 5 cm height with false bottom on top of which zinc powder is loaded. To prevent the cementing powder loses the perforated partition was placed on top of zinc.

Based on experiments results the apparatus concept was proposed featuring cementation in fluidized layer. In this case, the solution feeding is organized bottom-up in the reaction zone. In accordance with the hydrodynamic fundamentals in similar heterogeneous liquid: solid systems the local washouts arise. Experiments with different combinations of cementing apparatus design features and initial solution flow conditions confirmed the inevitability of this effect. Therefore large part of the cementing layer is not involved in the target process. To neutralize the specified negative features, it is proposed to force mixing of powder by mechanical stirrer. This technique helps to intensify mass transfer and allows increasing the gold extraction from solution during its passing through zinc layer.

In conventional methods of gold cementation by zinc or aluminum powder, the parent solution is pumped through a layer of metal on the filter surface. Process if performed under excess pressure or vacuum. The process is implemented in a cyclic mode and lasts until the pressure drop across the filter surface exceeds a critical level. Filter clogging restricts the layer thickness and limits the cycle time to a few days. To reduce the hydrodynamic resistance of cementing layer in Merrill-Crow technology zinc powder is mixed with inert perlite. Because of perlite added and short cycle time the gold containing precipitate obtained is very pauperate. It is possible to obtain products with gold content only about 5-10%.

Powder name	Bulk density [g/cm^3]	Mean particle size [μm]	Chemical composition [%]
Industrial powder	2,812	5	98 Zn; 2 ZnO
Experimental powder № 1	3,167	80	94 Zn; 6 ZnO
Experimental powder № 2	3,250	50	90 Zn; 10 ZnO

Table 1: Characteristics of the zinc powders.

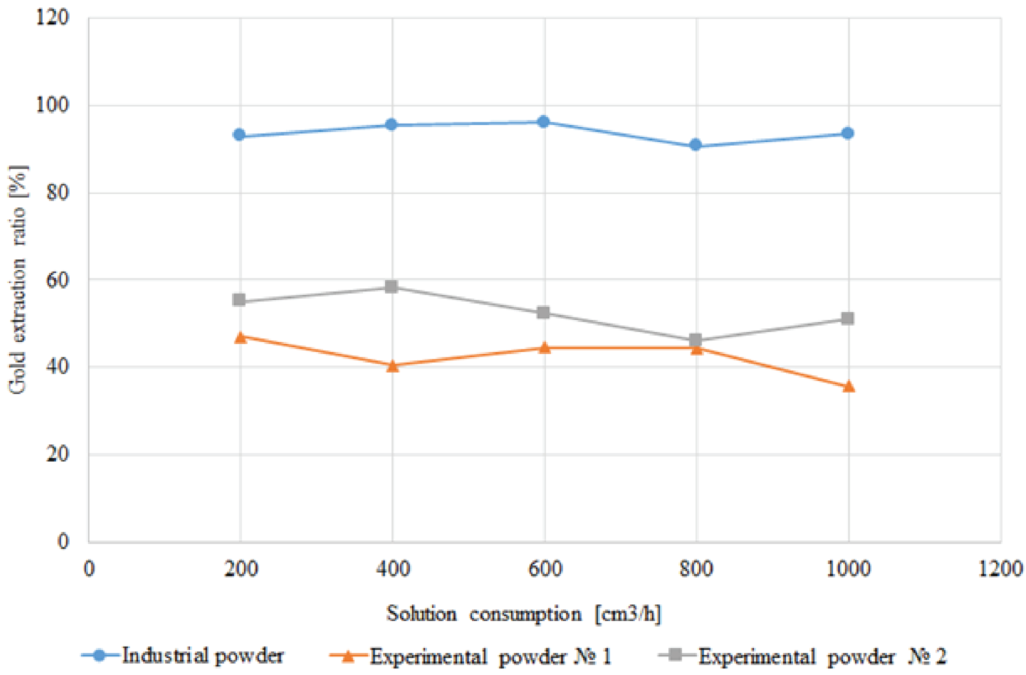

Figure 2: The dependence of the gold extraction ratio from the solution consumption.

Cementation in fluidized layer involves a combination of gold deposition and the separation of residue and solution without gold. The pressure in the system remains unchanged for a substantially longer time. Inert additives are not required. Contact duration of solution with the powder can be increased ten times by raising the thickness of the cementing layer. This feature dramatically reduces the requirements for specific surface and allows the use of cheap and low quality powders obtained from technogenic products, which favorably affects the cost of redistribution.

Taking into account the apparatus features the optimizing studies were conducted using gold-bearing cyanide solutions.

Zinc powders obtained by traditional methods used in the Merrill-Crow technology in Berezovsky mine and experimental powders derived from technogenic products were compared.

Parent solution contained 10 mg/dm^3 gold, 0.75 g/dm^3 cyanide. The characteristics of the zinc powders are given in table 1.

Zinc mass [g]	Zinc volume [cm^3]	Remaining content [mg/dm^3]	Gold extraction ratio [%]
10	3,08	2,04	80,02
15	4,62	0,46	95,50
20	6,15	0,00	99,99
25	7,70	0,00	99,99
30	9,23	0,00	99,99

Table 2: The dependence of the gold extraction ratio from the mass of zinc powder.

Cementation was carried out with change of solution consumption in the range of 200 – 1000 cm^3/h, with a step of 200 cm^3/h. In each experiment 100 cm^3 of solution was passed obtained after gold concentrate agitation leaching stage. Mass of zinc powder was 5 g. The gold content in the parent solution and the mother liquor was estimated on atomic absorption spectrophotometer novAA 300 Analytik Jena. A comparison of gold extraction ratio from cyanide solutions using various zinc powders is presented on Figure 2.

Results of cementation with №1 and №2 experimental zinc powders showed worst result in comparison with results provided by high quality zinc powder. Results were obtained at small contact duration of the solution with zinc layer and a smaller specific surface of technogenic zinc powders, due to their larger particle size.

Experiments with different mass of the zinc powder and therefore different height of fluidized layer were conducted to identify satisfactory regimes, which will provide desired gold extraction. The mass of the powder has changed in the interval between 10 and 30 grams. The average solution consumption is 600 cm^3/h. The results are shown in table 2.

As can be seen from the experimental results the sample of 20 grams in the described conditions is sufficient for the complete gold extraction from solution.

To allow dimensional scaling of these results for installation size increase, it is possible to use solution contact duration with metal zinc as basis.

To estimate contact duration of zinc powder with a gold bearing solution it is necessary to know value of layer height and average solution flow speed through the layer:

$$\tau = \frac{h}{\upsilon}, \tag{1}$$

where, h – height of the loosened layer powder, cm;

υ – average flow rate, cm/s; which is determined by the ratio of solution consumption Q (cm^3/h) to clear area cross-section ω (cm^2):

$$\upsilon = \frac{Q}{\omega}, \quad (2)$$

The clear area cross-section can be estimated from the difference of the total cross-sectional area and the area occupied by the zinc particles:

$$\omega = S_t - S_p, \quad (3)$$

where, S_t – total cross-sectional area, cm^2

S_p– area occupied by the zinc particles, cm^2.

It is found that we can assume equality of following relations in mentioned conditions

$$\frac{S_t}{S_p} = \frac{V_w}{V_{met}}, \quad (4)$$

where, V_w – volume of powder in working condition, cm^3

V_{met} – volume of the powder without voids between the particles, cm^3

The volume of the powder without voids between the particles was determined by pressuring of the sample in 20 g on the pneumatic press:

$$V_{met} = 3,74\ cm^3, \quad (5)$$

The volume of powder in working condition:

$$V_w = 6,15\ cm^3, \quad (6)$$

$$S_p = \frac{3,74}{6.15} * \pi \frac{d^2}{4} = 1,55\ cm^2, \quad (7)$$

$$\upsilon = \frac{600}{2,54 - 1,55} = 606,06\ cm/h, \quad (8)$$

Hence, when the layer working height is 2.2 cm, the contact duration of the solution with zinc powder is equal to:

$$\tau = \frac{2,2}{710,06} = 0,00363\ h\ or\ 13,1\ s. \quad (9)$$

3. Conclusions

Zinc powder obtained from technogenic alkaline solutions by electrolysis is inferior to high-quality zinc powder in gold cementation processes.

Increasing contact duration of solution with zinc powder by raising the layer thickness in the proposed design allows to lessen influence of the poor quality of experimental powders.

Sufficient solution contact duration with fluidized layer is about 13 second for gold concentration reduction in solution from 10 mg/dm^3 to 0.01 mg/dm^3.

References

[1] E. Abkhoshk, E. Jorjani, M. S. Al-Harahsheh, F. Rashchi, and M. Naazeri, "Review of the hydrometallurgical processing of non-sulfide zinc ores," Hydrometallurgy, vol. 149, pp. 153–167, 2014.

[2] J. Jiang, C. Guo, and Y. Zhao, "Production of zinc powder by alkaline hydrometallurgy," Applied Mechanics and Materials, vol. 26-28, pp. 1142–1146, 2010.

[3] V. I. Lakshmanan, R. Roy, and V. Ramachandran, Innovative Process Development in Metallurgical Industry, Springer International Publishing, Cham, 2016.

[4] C. N. Mpinga, S. M. Bradshaw, G. Akdogan, C. A. Snyders, and J. J. Eksteen, "Evaluation of the Merrill-Crowe process for the simultaneous removal of platinum, palladium and gold from cyanide leach solutions," Hydrometallurgy, vol. 142, pp. 36–46, 2014.