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Short Communication

Optimization Of The Process Roasting For Roughing Sulfide Concentrate Sulfuric Acid Leaching

Lyutsiya Karimova

Limited Liability Company "KazGidroMed", Karaganda, Kazakhstan

E-mail: lutsia.08@mail.ru.

Abstract

The influence of various factors on roasting process roughing copper flotation concentrate in the laboratory the shaft furnace. Revealed extreme move depending on the temperature of copper extraction. Depending on the operating factors obtained partial and generalized functions of copper extraction into solution, which were developed on the basis of independent multifactor equations, united by the central values.

Key word: Calcined concentrate, leaching, copper extraction, factors.

Introduction

With the purpose ensure the most favorable conditions for effective leaching of copper sulfide concentrate used sulphatization roasting, which occurs at relatively low temperatures [1-3]. Furthermore, when low temperature roasting is possible to prevent the formation of sparingly soluble of ferrites and silicates, as well as sintering of the grains. Thus as an additional oxidant may be used trivalent iron sulfate produced in the roasting process by the oxidation of pyrite.

Earlier [4-6], the optimization process of roasting roughing copper sulphide concentrate under autogenous oxidation regime. The dependence of the maximum temperature of the autogenous roasting on the content of sulfur in the concentrate at different speeds of the air supply. In order to avoid melting the granules in the material used as the test roughing flotation concentrate having a sulfur content of not more than 6%.

Materials and Method

In this paper, as an object of research was a roughing flotation concentrate, chemical composition is given in Tables 1 and 2.

In determining the optimal conditions sulphatization roasting selected Gauss-Seidel method. The resulting equations for the recovery of copper in solution, taking into account important functions to describe the totality of relevant factors are summarized according to [7] in the form of their work with the normalization of the central experimental value in degree (*n*-1), where *n* - the number of private functions. Adequacy of the dependency coefficient was determined by nonlinear multiple correlation R [8] and its significance t_R [9].

The concentrate was subjected to balling in a laboratory pelletizer bowl with a diameter of 0.6 m, depth of 15 cm at a rotation speed of 20 r/min and feed a binder (water) by spraying.

Maximum relative mass loss pellets (W_{105}), in the process of drying at 105 °C, which was performed before the termination of the change in mass of pellets is 10.03%. Granule fraction required size sieve to sift (class +2-4 mm (d_{av} = 3 mm)). Bulk weight was 1.338 g/cm^3 pellets.

Roasting conducted in a vertically positioned tubular electric furnace having a quartz tube reactor with a diameter of 40 mm, a height of 400 mm. Initially, the furnace is heated to a certain temperature, which was supported by a relay connected to the secondary device and thermocouple voltage regulator circuit in the heating elements of the furnace. Then a sample of pellets in a basket made of a nichrome wire placed inside the oven, preheated to a predetermined temperature. Bottom blown into the furnace air flow is controlled with a rotameter.

Investigated the influence calcining temperature (t, from 400 to 650 °C), duration (τ, from 20 to 120 min), air flow blown into the reaction zone (V, from 0 to 100 cm^3/s) (table 3). Scatter graphs and approximation private dependency recovery of copper in the solution of the calcine and sulfur in the gas transition are presented in Figure 1.

Leaching was performed at of calcine L:S = 4:1, a temperature of 80 °C and duration of the experiment with 120 minutes of magnetic stirring with a solution of sulfuric acid with a concentration of 120 g/l.

Results and Discussion

As seen in Figure 1 and, depending on the course of extreme copper recovery temperature explained deceleration sulifats-forming after 450 °C due to the emergence of low-melting eutectics impeding the supply of oxygen to the sulphides of copper and iron formation. Moreover, these processes are shifted to lower temperatures due to the more developed general response surface, through which all the physical and chemical transformations are accelerated with a high degree of sulphatization of the order 90-92% copper.

On the high speed of the process shows the dependence of the recovery of copper from the duration of firing with the achievement of saturation of this dependence is already up to 20 minutes in contrast to the large granules (where the same figure is reached in 60 minutes). Decreasing dependence on copper extraction air flow in this case due to the large excess of its stoichiometric requirement against (10 cm^3/s), whereby the granules do not oxidize as much as cooled feed air. At the same time, without forced air sulphatisation passed by convection of air through the upper open portion in the furnace, which was sufficient for practical completion.

Table 1: Contents of the main component in the rougher concentrate,%

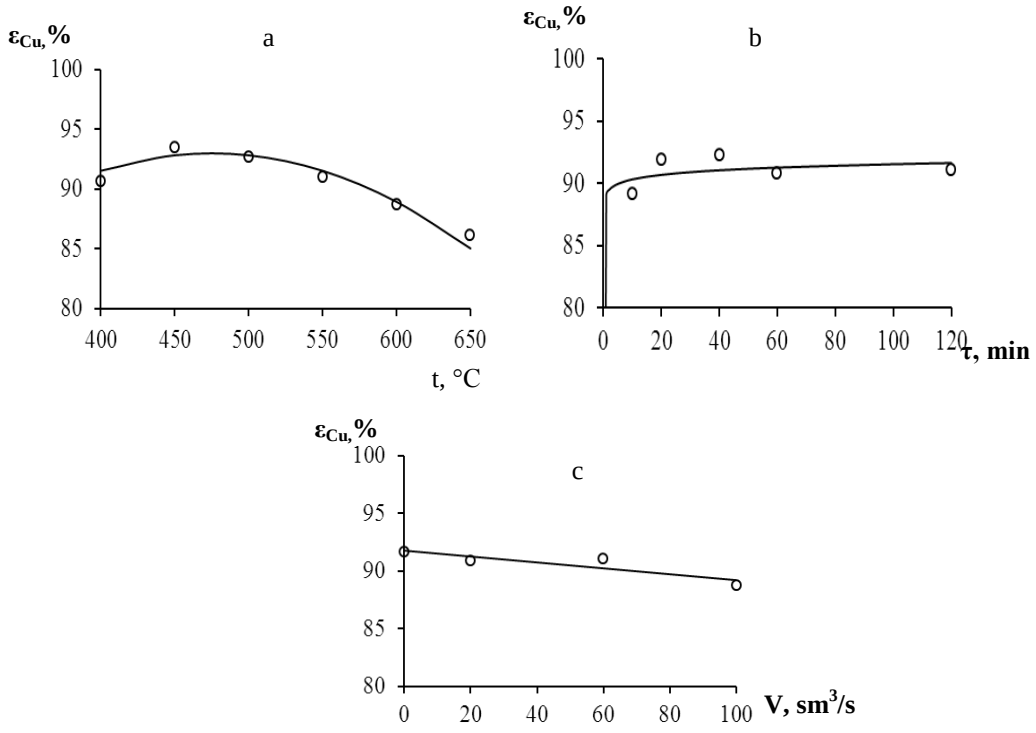
Cu	S	Fe	Ca	SiO_2	Al_2O_3	Zn	Ag г/т	Ti	Mg	K
3,91	3,05	4,67	3,55	41,05	2,28	0,357	83,2	0,301	0,786	1,48

Table 2: Results of phase analysis rougher concentrate on the content of forms of copper

Found% copper	Absolute error	Relative error
sulfates	<0,2(<0,01)	
carbonates	<0,2(0,09)	2,3
Oxides, silicates	<0,2	
Secondary sulfides	3,16	81,0
chalcopyrite	0,65	16,7
Total	3,90	100,0

Table 3: Experimental dependence (ε_{Cu}, e,%) and calculated by the generalized equation (eq) values to the solution of copper extraction from calcining temperature, t, ° C, duration τ, min, flow of air blown, V, cm^3/s

Investigated factors		β_{Cu}, roasting product,%	β_{Cu}, in sludge,%	ε_{Cu}, e, %	ε_{Cu}, eq (1)
t, °C (τ – 60 мин., V – 60 $см^3/с$, d – 3 мм)	400	3,46	0,41	90,63	91,00
	450	3,70	0,30	93,51	92,29
	500	3,70	0,34	92,65	92,29
	550	3,46	0,39	91,02	91,00
	600	3,70	0,51	88,70	88,42
	650	3,67	0,62	86,15	84,54
τ, мин, (t –550 °C, V – 60 $см^3/с$, d – 3мм)	10	3,76	0,47	89,12	90,06
	20	3,74	0,38	91,66	90,42
	40	3,76	0,37	92,23	90,79
	60	3,46	0,39	91,02	91,00
	120	3,75	0,43	91,03	91,37
V, $см^3/с$ (t –550 °C, τ– 60 мин., d – 3 мм)	0	3,72	0,39	91,67	92,55
	20	3,76	0,43	90,90	92,03
	60	3,46	0,39	91,02	91,00
	100	3,72	0,52	88,76	89,97



Points - experimental data; line - according to equations (Table 4);
Fig. 1: The dependence of copper recovery in the solution of of calcine on the given factors

The result obtained mathematical expressions that can be used to derive a mathematical model of the roasting process (Table 4). The central (c) for all functions of the condition: t = 550 °C, τ = 60 min, *d* = 3 mm, V = 60 cm^3/s value ε_{Cu}, c = 91.0024%, the generalized equation for the copper recovery in the solution is expressed as

$$\varepsilon_{Cu,p} = 1{,}208 \cdot 10^{-4}\left(93 - 2{,}56 \cdot 10^{-4}(t-475)^2\right)(89{,}121\tau^{0{,}0058})(91{,}706 - 0{,}0261V) \cdot \quad (1)$$

Table 4: Private function copper recovery in the solution to the definition of the correlation coefficient R and its significance t_R

The function retrieve of copper in solution, %	R	Condition is t_R>2	The significance
$\varepsilon_{Cu} = 93 + \frac{89-93}{(600-475)^2}(t-475)^2$	0,9432	17,08>2	significance
$\varepsilon_{Cu} = 89.121\tau^{0.0058}$	0,1874	1,61<2	little importance
$\varepsilon_{Cu} = -0.0261V + 91.706$	0,7598	3,113>2	significance

When comparing the results of the experiment and the calculation of the coefficient of nonlinear found multiple correlation for the recovery of copper in solution R = 0.8453, t_R = 10.68 > 2, which confirms the adequacy of the description of the experimental data by this equation.

Conclusions

1. Study the effect of various factors on the process of firing low-sulfur rough copper flotation concentrate in the laboratory of the shaft furnace.
2. It was established that the recovery of copper sulphatization roasting conditions can be achieved in greater than 95 % under various conditions, in particular when t - 450-500 °C, τ - 40-60 min. Exit cake under these conditions is 75%.
3. Identified extreme stroke depending on the temperature copper recovery, whereby the firing at a temperature above 550 °C impractical due to diffusion difficulties.

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