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THE MANAGEMENT OF COPPER FLOTATION REVENUE IN THE MINE OF VELIKI KRIVELJ

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ABSTRACT. The copper ore deposits represent a very important economic resource. Copper flotation has a key role in ensuring the conditions necessary for economically justifiable exploitation of copper. The main technological indicators of copper flotation which determine the level of revenue per mass unit of processed copper are exploitation and the copper content in concentrate. This thesis describes the economic-technological model of copper flotation which can help determine, for the given technological and market conditions, the optimal percentage of copper in concentrate, at which level the maximum revenue is achieved per ton of the processed ore in the process of flotation.
Key words: *copper flotation, economy, value of copper concentrate.*

УПРАВЛЕНИЕ НА ПРИХОДИТЕ ПРИ ФЛОТАЦИЯТА НА МЕДНИ РУДИ ОТ МИНА ВЕЛИКИ КРИВЕЛИ

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РЕЗЮМЕ. Медоносните рудни находища представляват важен икономически ресурс. Медната флотация играе ключова роля в осигуряване условията, необходими за икономически оправдан добив на мед. Главните технологични показатели при флотацията на медни руди, които определят нивото на приход за единица маса от преработена мед са експлоатация и съдържанието на мед в концентрата. Описан е икономически изгодния технологичен модел при флотация на медни руди, който спомага да се определи, при определени технологични и пазарни условия, оптималното съдържание на мед в концентрата, при което се постигат максимални приходи за тон преработена руда в процеса на флотиране.
Кючови думи: медна флотация, икономика, цена на медния концентрат

Introduction

The main parameters which influence the value of concentrate are the copper content in concentrate and the price of copper-metal in concentrate.

As a result of technology and process management, the higher the exploitation, the lower the copper content in concentrate[1], and vice versa.

Therefore, at the existing market price of copper, there is an optimal copper content in concentrate, whereat the value of concentrate which is processed per mass unit of ore achieves its maximum.

The model of managing copper flotation revenue

The value of copper (*Vm*) in concentrate which is obtained after processing one ton of ore is:

$$V_m = M_m \cdot C_{mk} \quad (1)$$

Whereby V_m stands for the value of copper in concentrate, ($/t)
M_m stands for the mass of copper in concentrate, (t)
C_{mk} stands for the price of copper in concentrate, ($/t).

The mass of copper in concentrate (M_m) is:

$$M_m = \frac{u \cdot I}{10^4}, \text{(t)} \quad (2)$$

Whereby *u* stands for the copper content in the ore, (%) and
I stands for the exploitation of copper, (%).

The price of copper in concentrate (C_{mk}) is defined by the smeltery of Bor and can be calculated by help of the following formula:

$$C_{mk} = C_m + 10^2 \cdot T \cdot \left(\frac{1}{k_r} - \frac{1}{k} \right) \quad (3)$$

Whereby: C_{mk} stands for the price of copper in concentrate, ($/t)
C_m stands for the basic price of copper in concentrate at standard copper content in concentrate (k_r), ($/t)
T stands for the smeltery coefficient, ($/t)
k_r stands for standard copper content in concentrate, (%); for Bor smeltery and Veliki Krivelj the concentrate is k_r=20,7%, and
k stands for copper content in concentrate, (%).

The correlation between the exploitation of copper (I) and the copper content in concentrate (k) in Veliki Krivelj flotation is given in the following form[1]:

$$I = I_0 - b \cdot k \quad (4)$$

that is,

$$I = 97{,}8 - 0{,}62 \cdot k \quad (5)$$

$$k \in [19...26\%]$$

where I_o are b are the parametres that depend on the ore and technology.

Taking into consideration the issues (2), (3), (4) and (5), the formula for calculating the value of copper in concentrate (1) gets its final form and is as follows:

$$V_m = \frac{u \cdot (I_0 - b \cdot k)}{10^4} \cdot \left[C_m + 10^2 \cdot T \cdot \left(\frac{1}{k_r} - \frac{1}{k} \right) \right] \quad (6)$$

$$k \in [19...26\%]$$

At the given market conditions the value of metal in concentrate, which is obtained after processing one ton of ore, depends only on the copper content in concentrate.

It goes without saying that the aim of every flotation is achieving the maximum value of copper in concentrate.

Therefore, the main task is to determine the value (k) at which equation (6) achieves its maximum. The solution consists in differentiating the equation (7) at (k) and equating the first derivative to zero.

$$\frac{\partial V_m}{\partial k} = \frac{u \cdot T \cdot I_o}{k^2} - u \cdot b \cdot \left(\frac{C_m}{10^2} + \frac{T}{k_r} \right) = 0 \quad (7)$$

Now we can derive the formula for the optimal copper content in concentrate (k_o):

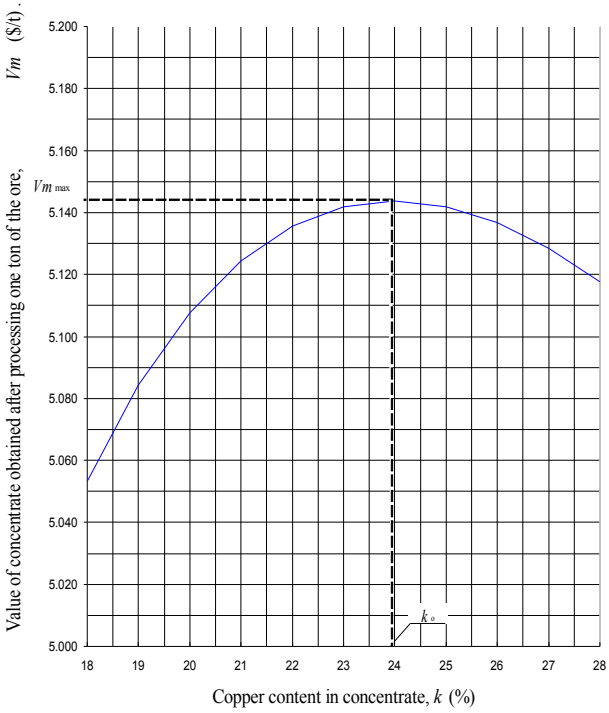
$$k_o = \sqrt{\frac{T \cdot I_o}{b \cdot \left(\frac{C_m}{10^2} + \frac{T}{k_r} \right)}}, (\%) \quad (8)$$

Taking into account the price of copper at the world market which is \$3200 per ton, the following is true for flotation in Veliki Krivelj:

C_m = 2008,64 \$/t
T = 88,97 \$/t
k_r = 20,7 %
I_o = 97,8 %
b = 0,62

and as a result of equation (8) we can see that the optimal copper content in concentrate (k_o) is 24%. With such copper content in concentrate, the value of copper in concentrate achieves its maximum value which according to equation (6) is V_m = 5,144 \$/t. The graphic representation of equation (6) related to flotation in Veliki Krivelj is shown in table 1.

Table 1. *The value of copper in concentrate which is obtained from one ton of ore in Veliki Krivelj depending on the copper content in concentrate (k).*



Equation (8) shows that the optimal copper content in concentrate does not depend on the copper content in the ore (u).

Equation (8) enables the management in charge of flotation to handle the process in the most efficient way possible. Taking into account the market price of copper as well as the price of processing concentrate in the smeltery, this equation helps determine the optimal copper content in concentrate (k_o) when flotation achieves its highest revenue.

Conclusion

The given model enables the optimal management of the copper flotation process. Taking into account the trends in prices at the copper market and the prices of industrial processing of concentrate, this model makes it possible to determine, at any time, the optimal copper content in concentrate when flotation records the highest revenue

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