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Development of leaching technology for poor gold-bearing ores taking into account the interaction of solution with dispersed particles

6D070700- Mining

Thesis for the PhD degree

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Assessment of the status of the scientific and technical problem to be solved.

In recent years, work has been carried out in the field of gold mining to process ores with a low initial content of useful components. This process makes it possible to use poor and off-balance ores, overburden from open pits and stockpiled waste from concentrators.

The object of the study is the site "Belaya Gorka" of Rodnikovoye deposit, administratively located in the northern part of Kokpekty district (on the border with Zharma district) of East Kazakhstan region. The average grade of gold in ore is 1.44 g/t. The deposit mined by open-pit method, heap leaching is used to process rejected ore.

Relevance. Projected recovery factor on the object of study is 64%, actual - 50-55%, projected period of mining is 60 days, actual - 70-80 days. Nowadays, for intensification of leaching process different kinds of impact on ore are applied (physical, mechanical, chemical and biological), most of which are directed to accelerating of valuable components transfer from ore to productive solution, herewith the size of ore plays an important role.

The novelty of the topic consists in a set of measures aimed at increasing the efficiency of heap leaching by means of mechanical cavitation of working solution, by creating in it the adjacent flows with different velocities of movement.

The aim of the work is to increase the efficiency of heap leaching with the use of cavitated solution in conditions of increased content of dispersed particles.

As part of the scientific work has been carried out:

1. analysis of mining and geological conditions of Rodnikovoye deposit and heap leaching technology;
2. development of laboratory research methodology.
3. research of dispersed particles influence on heap leaching characteristics;
4. carrying out laboratory works on determining the influence of cavitated solution on the gold content in the productive solution;
5. processing of laboratory results and preparation of recommendations.

Scientific novelty of the work:

- the formula for determining the specific consumption of solution with regard to weight percentage of dispersed particles in ore mass and its natural humidity, i.e. the total volume of 0-1 mm particles with a firmly bound liquid, which will reduce the cost of chemical reagents, has been obtained;
- the dependence of the gold content in the productive solution on the degree of leaching solution cavitation and leaching time of ore with high content of disperse particles of non-linear form was obtained. The optimal time of treatment of solution will set with cavitator and achieve the maximum gold content in the solution;
- obtained dependence of the gold content in productive solution on the concentration of the reagent in cavitation solution, which will set the optimum concentration of the reagent in cavitated leaching solution. For conditions of investigated object, the optimal concentration of cyanide during solution activation

makes 600 ppm, which provides maximum gold content in pregnant solution and cuts leaching period.

Provisions placed on protection:

-the reagent consumption at heap leaching should be determined taking into account the fraction of dispersed particles and natural humidity of ore, which will reduce the cost of chemical reagents and increase the accuracy of consumption.

- Gold content in pregnant solution and leaching period are influenced by time of processing of leaching solution by cavitator. Optimal time of processing of leaching solution by cavitator for each deposit is determined by taking into account properties of ore;

- with quantitated leaching for the conditions of the object under study, the maximum gold grade in the solution is reached at a concentration of 600 ppm. The achieved gold content in the productive solution under the basic technology is 1.83 mg/l, while under the cavitated solution it is 2.10 mg/l, i.e. an increase in gold content by 14.7% is observed.

Relationship of this work to other research work.

The thesis work was carried out as part of the theme: "Development of technology for excavation and extraction of gold from poor ore veins", (No. 2018/BR05235618).

Practical significance of the thesis. The proposed mechanical cavitation of the solution before feeding it into the ore stack significantly increases the gold content in the pregnant solution during the heap leaching without additional reagent consumption.

Publications and approbation of the work. The results of the work have been reported at international scientific and technical and scientific and practical conferences: International scientific and practical conference "Rational use of mineral and technogenic raw materials under Industry 4.0" 14-15 March 2019, Almaty; International conference "Outlines of scientific practice" 2019, Ukraine; IV International scientific and practical conference "PRIKLADY SCIENCE AND TECHNOLOGICAL RESEARCH", 1-3 April 2020, Ivano-Frankivsk (Ukraine); International Scientific Conference "Fundamental and applied sciences", Sheffield, 30 October - 07 November 2020; International Scientific Conference "EDUCATION AND SCIENCE FOR THE XXI CENTURY", Sofia, 15-22 October 2020, at the scientific seminars of the Department "Mining Engineering" in KazNRTU named after K.I.Satpaev.

Publications include articles in Mining of Mineral Deposits 2019-09-30. 13(3): 40-48; Mining Information and Analytical Bulletin (scientific and technical journal) 2019;(12): 169-177; Bulletin of KazNRTU, 2020, no. 6; Scientific Bulletin of National Mining University, Ukraine no. 3, 2021; Mining Journal of Kazakhstan no. 4, 2021; Bulletin of National Engineering Academy of Kazakhstan. 2021. No. 2 (80) pp. 130-135.

Determination of the solution specific flow rate according to the obtained formulae will reduce the cost of chemical reagents, which can be very significant when treating large volumes of ore masses.

Determining the specific liquor consumption using the formulas discussed above will reduce the cost of chemicals, which can be very significant when treating large volumes of ore masses.

Pilot testing of the proposed technology

For the semi-industrial tests, an iron plate heap leaching plant was fabricated, which consists of a liquor trough, plant base, feed liquor tank, main piping and irrigation piping. The plant was installed in the laboratory.

CONCLUSION

1. The formula for determination of specific liquor consumption taking into account weight percentage of disperse particles and useful component in ore mass, and also natural humidity is offered that will allow reducing expenses for chemical reagents and increasing accuracy of liquor consumption.
2. To increase extraction of metal at high content of disperse particles without additional costs for leaching, mechanical cavitation of the solution before feeding it into the ore stack is proposed to change rheological properties of the working solution by creating in it adjacent streams with different velocities of movement.
3. Both for basic technology and for different degree of solution cavitation, for conditions of this deposit effective concentration of cyanide for leaching is 600-700 ppm.

4. Based on the results of pilot works with a limited amount of ore of 600 kg for each technology, it was found that the proposed solution cavitation technology increases the gold content in the productive solution by 14.7%