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B.M. Nuranbaeva*, T.K. Ahmedzhanov

Kazakh National Technical University named after K. Satpayev Almaty, Kazakhstan
*E-mail: bulbulmold@mail.ru

Innovative method of heap leaching of gold with the use of uranium industry wastes and polymers for sorption of gold ions

Abstract. The proposes of paper is a process of leaching dumps (piles) commitments and refractory non-ferrous and precious metals, in which the front surface treatment leached amounts covered with a layer of finely porous material, such as waste production and processing of uranium ore, as well as a study of the sorption capacity of polymers in relation to ions of gold.

The aim of this work is to improve the efficiency of leaching while waste disposal and leaching of radioactive ores. The way to develop the tailings that is including, the minimum grain size of the ore, density of the surface tension of the leach solution and the contact angle [1], as well as a method for treatment of ores. [2].

In contrast to the above methods, the proposed method is mixing the leach ore radioactive waste (rock, sludge, etc.), which will increase the temperature and heat transfer between the solution and leach ore, which in turn leads to rapid oxidation of the ore, and thus increase the yield of ions in the solution of useful components. To increase the heat in the heap's surface is covered with the same radioactive nuclear waste. All this leads to more efficient leaching, in addition, to avoid the emergence of new waste is proposed to form a heap leaching in waste pits for subsequent disposal on-site leaching.

Leaching process was implemented on the models in the laboratory. Particle size analysis is carried out by the gravimetric method with a certain amount of ore. Particle size distribution of the leach ore is presented in Table 1.

Table 1 - Particle size distribution of ore leaching

№	V, m^3 volume	Size distribution of the ore, %, m				
		0-0,20 m	0,21-0,40 m	0,41-0,60 m	0,61-0,80 m	0,81 m
1	7,7	50,2	21,5	13,4	12,6	2,2
2	8,1	53,1	22,2	12,7	10,4	1,5
3	9,0	55,5	21,5	12,5	8,7	1,7
4	7,0	56,6	21,7	11,7	7,6	2,3
5	10,2	57,4	20,6	13,4	7,3	1,2
6	9,5	47,4	19,4	15,9	15,0	2,2
7	8,5	52,5	21,0	12,3	11,7	2,4

As can be seen from Table 1, the percentage of fraction 0-0,20 m this fraction should be subjected to a more detailed analysis of the particle size on the screens by the gravimetric method. The results of particle size analysis of fraction 0-0, 20 m are presented in Table 2. And we take this fraction as a hundred percent, and define the other factions.

Table 2 - Particle size fractions of ore 0-0, 20 m

Number of fraction	Interval of fraction, mm	1	2	3	4	5	6	7
		φ_1, %	φ_1, %	φ_1, %	φ_1, %	φ_1, %	φ_1, %	φ_1, %
1	0-1,0	4,5	4,3	5,2	5,0	3,7	3,5	4,1
2	1,0-2,5	6,0	5,8	6,5	6,1	7,0	6,9	6,0
3	2,5-5,0	7,3	7,5	6,9	8,0	7,2	7,5	7,2
4	5,0-7,5	6,4	6,6	7,9	8,5	7,5	8,5	6,9
5	7,5-10,0	7,7	7,3	9,2	8,7	9,3	9,4	7,3
6	10,0-12,5	9,4	9,0	9,6	9,3	9,6	10,4	9,0
7	12,5-15,0	8,9	9,2	10,7	9,5	10,2	9,1	9,2
8	15,0-17,5	9,9	10,0	7,2	8,5	11,0	7,7	9,4
9	17,5-20,0	7,3	6,7	6,5	4,8	4,1	4,5	9,8
10	20,0-30,0	6,5	7,5	7,0	8,5	6,8	6,9	6,7
11	30,0-40,0	5,9	5,5	5,1	4,5	5,3	6,6	7,5
12	40,0-50,0	6,0	5,8	4,9	4,4	5,9	6,8	5,5
13	50,0-100	5,4	5,6	5,1	4,0	4,5	4,0	5,8
14	100-150	4,8	5,0	4,5	5,3	4,7	5,2	3,6
15	150-200	4,0	4,2	3,8	4,5	3,2	3,0	2,0

To create a physical model of the leaching of ores, we represent it as a disconnected environment with heterogeneous porosity. Represent the real volume leach ore, consisting of fractions from these $N = N - N_1$; large fractions constituting the main skeleton of leachable ore, and fractions are filling, considering the volume ratio of the filler and the skeleton of a real object obtained relationship between porosity and aggregate real object [1]:

$$m_{N_1} = \frac{m_p}{\varphi_{N_1}} - \sum_{i=1}^{N_1} \varphi_i^{/} \qquad (1)$$

where m_{N_1} - porous aggregates;

m_p - Porosity of the real object;

$\sum_{i=1}^{N_1} \varphi_i^{/}$ - Amount of volume fraction ratio of the each share, the aggregate, which refers to the total volume of the real object, which should be defined as the ratio:

$$\sum_{i=1}^{N_1} \varphi_i^{/} = \frac{\sum_{i=1}^{N_1} \varphi_i}{\varphi_{N_1}} \qquad (2)$$

Here φ_i - Share of the aggregate amount of each fraction referred to the total volume filler;

φ_{N_1} - Share of the total aggregate, referred to the total volume of a real object;

To select a model porous aggregate is computed by (1) using the tables 1 and 2. If the porosity is less than the aggregate porosity of the real object, the separated fraction of the aggregate transfer one or part of one or more major factions of the skeleton of a real object and continue the calculation as long as the porosity of the aggregate will be equal to the porosity is not a real object $(m_{N_1} = m_p)$. Number of fractions, N_1 where $m_{N_1} = m_p$ should be selected as a model of a real object.

In some cases, the porosity of the aggregate may be higher porosity of the real object, in this case, adding the skeleton of a real object or a part of one, or a few more fines in the pre-selection, the computation of aggregate as long as the porosity of the aggregate will not equal porosity real object, i.e., $m_{N_1} = m_p$. Number of fractions N_1 where $m_{N_1} = m_p$ should be selected as a model for laboratory studies.

The same principle was selected porosity of radioactive waste, which is leached ore is stirred. The results of calculation of porosity model leach ore and radioactive waste were subjected to experimental verification. The calculated and experimental porosity of leached with radioactive waste coincided with a relative error of 15%. It can be concluded that in this way the chosen model is adequate to the real object, No. 10 (H) porosity model (aggregate) is the porosity of the real object. As the model is taken to the tenth inclusive fractions in the same percentage as shown in Table 2, i.e., the following fractions 0-1,0; 1,0-2,5; 2,5-5,0; 5,0-7,5; 7,5-10,0; 10,0-12,5; 12,5-15,0; 15,0-17,5; 17,5-20,0; 20,0-30,0 (intervals in mm). Thus, the model is formed on a concrete slab with a hole for drainage, leaching solution. The concrete slab is concave, so that the solution flowed out of the hole.

The model pile was formed in such a way that the ratio of the volume of ore V_p c volume of radioactive waste V_{po} consistent $\frac{V_p}{V_{po}} = 3$, and its surface is covered with radioactive waste.

The model pile was watered 2% sulfuric acid solution. Pregnant solution was analyzed to identify it mineralization.

Leaching gold ore with mixing radioactive waste in relation to the volume $\frac{V_p}{V_{po}} = 3$ and coated surface radioactive waste allowed increased output of gold pregnant solution by an average of 20. The results of the leaching of gold ore on the models in the laboratory are shown in Table 3.

Table 3 - Results of the leaching of gold ore on the models in the laboratory

№	Type of ore and radioactive waste	Extraction Au from a productive solution	
		prototype	The proposed method
1	Sulfide ore deposits containing gold Akbakai 1,6 g/t	75-78	80-85
2	Gold ore 2,0 g/t	87-96	93-97

Thus, the proposed method can improve the leaching of ore leaching efficiency and reduce the environmental impact on the environment due to leaching of waste disposal and the nuclear industry in the waste pits.

To extract gold from the pregnant solution leach ore commonly used sorption technology, in this case as sorbents used costly imposed from abroad sorbents (tar, coal and others.) To reduce the cost of obtaining gold from leach solutions proposed for use in sorption technologies domestic polymers [3,4].

In this regard a study of the sorption capacity of polymers in relation to ions of gold. Implementation of the project will address a number of environmental challenges of our waste disposal, reduce man-caused environmental burden to mining and oil and oil regions of Kazakhstan. Based on these studies suggest the following innovative technological scheme to extract gold (Figure 1).

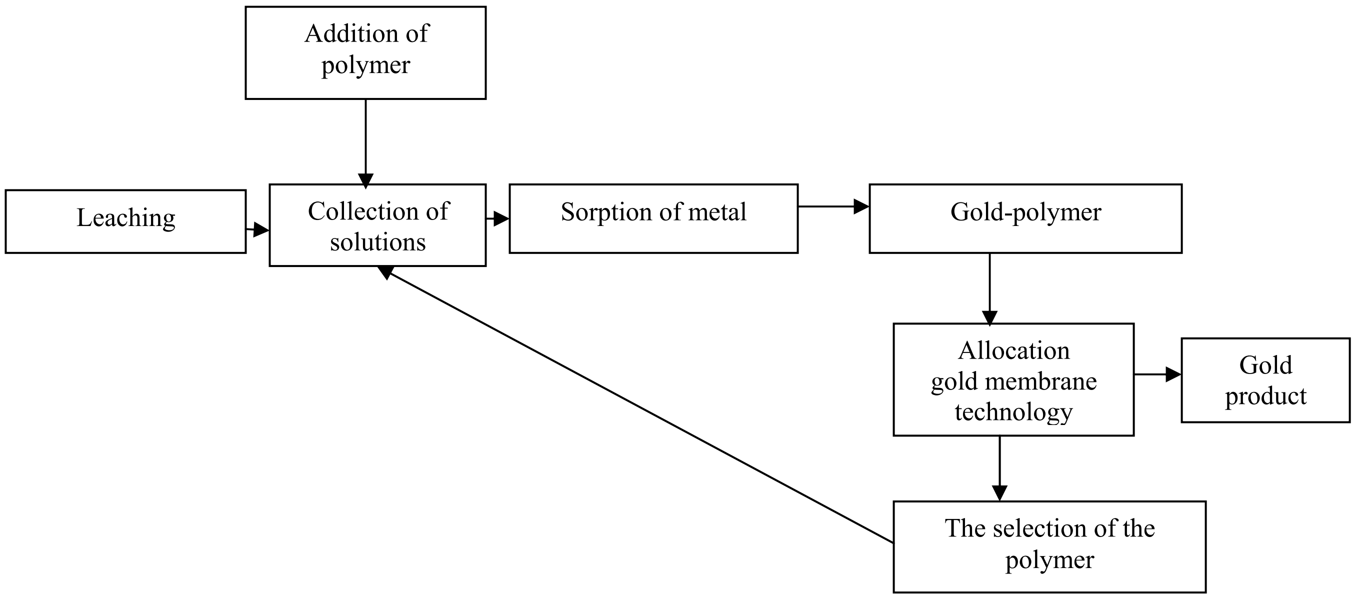

Figure 1 – Scheme showing the new technology for gold extraction operation

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