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DISSOLUTION KINETICS OF GOLD IN CYANIDE SOLUTIONS ON THE BASIS OF PLASMA-CHEMICALLY “ACTIVATED” WATER

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The paper considers an opportunity and evaluates the effectiveness of using the solutions treated with low-temperature non-equilibrium contact plasma in order to intensify dissolution of metal gold in cyanide leaching solutions. As a result of investigations, it was found that plasma-chemically treated solutions due to presence of peroxide compounds, radicals and particles formed in water during treatment, exhibit significant oxidizing properties compared with synthetic hydrogen peroxide and gaseous oxygen which are currently used in hydrometallurgical industry as oxidizing components. Using a rotating disk technique, the effect of the basic technological parameters (the effects of rotation speed, cyanide, potassium hydroxide and hydrogen peroxide concentration, temperature, pH) on the rate of process of metal gold dissolution in plasma-chemically treated solutions, and those using synthetic hydrogen peroxide and gaseous oxygen, was found. It is shown that the dissolution of gold in all cases occurs in transient conditions, as evidenced by the calculated values of activation energies. Comparison of the values of activation energies of the gold dissolution process points to the advantage of use of plasma-chemically treated solutions over use of synthetic hydrogen peroxide and oxygen as oxidizing agents.

Introduction

At present time, central banks of many countries in the world hold a considerable part of their reserves in precious metals [1,2]. Ukraine is not an exclusion in this regard and following the current legislation gold, silver, and platinum belong to the “banking” metals. Therefore, there is an urgent issue of searching for stable raw material supplies’ bases for systematic accumulation of the gold and foreign currency reserves of the State. Until recently, production of precious metals of secondary raw materials was the main source of replenishment of the gold reserves of the National bank of Ukraine, However, resources of such materials are now depleted, and today the basic resources are gold bearing ores and concentrates thereof. Over 16 gold ore fields and 690 points of gold ore mineralization are known in Ukraine, among which the gold targets of Nagolny ore district (Donbass) are the most promising ones for extracting precious metals. They are represented by gold-sulfide, poly-metallic ores with the average grade of gold and silver equal to 8–60 and 35–1380 g/t, accordingly [3,4]. The main problem restricting their extensive involvement in operation is the fact that in accordance with the mining classification [5] they are “resistant” to cyanide method of leaching being considered now as one of the dominant methods of precious metals’ extraction from ores and concentrates. Specialists of the world hydrometallurgical industry have developed the techniques of processing refractory ores and concentrates which are successively employed now. These techniques are chosen with due account for the main factors of refractoriness: form of gold, material composition, dispersion, types of impurities and so on [6,7]. However, their successful use, for the most part, is connected with multistage technologies requiring inclusion of the complex equipment into the general leaching technique, obligatory running of the process at higher temperatures etc., which results in increasing of the cost of products obtained. In view of the above, the problem of searching for methods to increase the efficiency of the traditional cyanide technology which would allow treatment of this kind of raw materials with high performance indices, and without considerable capital inputs, is the urgent one.

One of possible ways of intensifying the extraction of gold from ore concentrates can be the use of cyanide solutions prepared on the basis of water treated with low-temperature non-equilibrium contact plasma (NCP) [8,9]. The process of water activation consists in the plasma discharge contact action on water. In the course of complex chemical processes, reactive hydrated electrons, radicals and particles appear which lead to generation of peroxide/super-peroxide compounds of hydrogen [10]. As based on the results of previous investigations [11–13] the authors found that the above compounds owing to their high oxidation capacity were active oxidizing components of the cyanide process promoting 2–3 times increase of gold leaching intensity, compared with the traditional leaching

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process.

Therefore, for the further development of the technology of extracting precious metals from refractory ore concentrates the primary task is establishing the basic kinetics of the process of gold dissolving by cyanide solutions prepared on the basis of water treated with low-temperature non-equilibrium contact plasma.

Experimental

NCP treatment of water was performed with the use of laboratory-scale plant [7]. Plasma-chemically activated water depending on treatment conditions contains 100–600 mg/l ($0.3–2.0\cdot10^{-2}$ mol/l) of H_2O_2 and its pH is 4–11. Reactive capacity of plasma-chemically activated water is maintained during 4–5 weeks from the moment of its treatment with NCP.

In the course of investigation of kinetics of gold dissolving in the cyanide systems of leaching based on water treated with NCP, as the controls cyanide leaching systems were used with oxidizing agents as below: air at partial oxygen pressure PO_2 0.021 and PO_2 0.1 MPa (traditional leaching) [14]; synthetic hydrogen peroxide H_2O_2 $6.0\cdot10^{-2}$ mol/l at PO_2 0.1 MPa. Concentration of peroxide compounds was determined with the use of peroxide test method and permanganatometric method.

Kinetics of the process was investigated using the method of rotating disk following the procedure of [14,15]. Rotating disk, as a surface of the reaction, is characterized by an important feature: thickness of the boundary diffusion layer is prevailing on all the disk surface and, as a consequence, conditions of transporting the reagents to any point of the surface, regardless of its distance to the axis of disk rotation, are the same, that is, equally accessible surface mainly for diffusion penetration of reagents to leaching components is created (this statement is true for the laminar motion of the liquid). As an object of research, metal gold disks were used; their surface was polished, washed with water and degreased by ethyl alcohol. Leaching systems were prepared by introducing reagents in specified concentration, such as potassium cyanide (KCN) and potassium hydroxide KOH, into plasma-chemically treated water and synthetically produced aqueous solution of synthetic hydrogen peroxide.

Calculation of specific rate of dissolution was made according to formula [15]:

$$V=\frac{G}{S\cdot\tau}, \qquad (1)$$

where n is the specific rate of metal dissolution, $mol\cdot cm^{-2}\cdot s^{-1}$; V is the amount of dissolved metal, mol/l; S is the area of the disk surface, cm^2; t is the time of dissolution, s.

Concentration of metals in the solution was determined using atomic-absorption spectrophotometer Selmi S115 FCM. Experiments were carried out with the discrete choice of samples in the adequate conditions with three-time repetition.

Results and Discussion

It is known that investigation of the kinetics of gold dissolution provides for determining the dependence of the process speed from the basic technological parameters [14]. Taking into account that the process of gold dissolution in accordance with [15] runs following the reactions (2), (3), one of the determinative factors is the concentration of oxidizing agent and complexing agent in the system:

$$2Au+4CN^-+O_2+2H_2O= \\ =2[Au(CN)_2]^-+2OH^-+H_2O_2; \qquad (2)$$

$$2Au+H_2O_2+4CN^-=2[Au(CN)_2]^-+2OH^-. \qquad (3)$$

The work deals with the dependence of specific rate of dissolution of metallic gold on the abovementioned factors in the cyanide solutions prepared on the basis of plasma-chemically treated water, traditional leaching conditions (in the presence of air) and in the solutions of synthetic hydrogen peroxide. When kinetics of dissolution of metal gold is investigated, it is desirable to exclude the effect of external diffusion braking on the process, for which purpose the dependence of specific rate of gold dissolution on the disk rotation intensity is determined. Effect of hydrodynamic conditions on the rate of metal gold dissolution was investigated in the interval of disk rotation speed (n) 4.0–81.2 rad/s, which is in compliance with the Reynolds number of not more than $1.3\cdot10^4$ (laminar mode) at the concentration of potassium cyanide (KCN) of $5.0\cdot10^{-3}$ mol/l and potassium hydroxide (KOH) of $0.4\cdot10^{-2}$ mol/l, at the temperature of 298 K (Fig. 1).

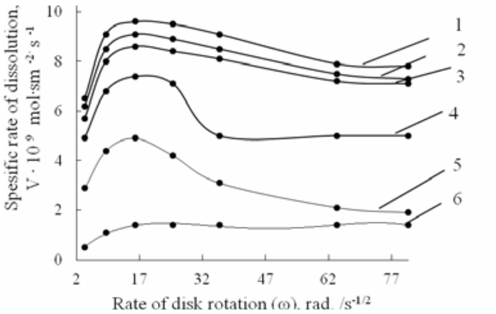

Fig. 1. Dependence of the specific rate of gold dissolution on the intensity of disk rotation using, as oxidizing agents, the following substances: 1,2,3 – plasma-chemically treated water 30, 20, 10 min; accordingly; 2 – synthetic hydrogen peroxide; 3 – at partial pressure of oxygen PO_2 0.1 MPa; 4 – at partial pressure of oxygen PO_2 0.021 MPa)

The Fig. 1 shows that in all cases, both in the case of using cyanide solutions made on the basis of plasma-chemically treated water and in the traditional system of leaching, as well as the solutions with the use of artificial synthetic hydrogen peroxide as an oxidizing agent, the type of dependence of specific rate of gold dissolution on the intensity of disk rotation corresponds to the process that runs in the domain of transition kinetics. For example, in all leaching systems under study when the angular rate of disk rotation increases from 4.0 to 15.7 rad/s, specific rate of metal gold dissolution is growing pro rata to the square root of the number of disk revolutions, and the limiting stage of the given process is the diffusive feeding of reagents to the disk surface, or removal of the reaction products formed. With the further increase in the rate of disk rotation over 16.0 rad/s, the process goes to kinetic zone, where the nature of dissolution in the solutions under study, in contrast to the diffusion area, is not the same. So, only in those solutions where the air with partial pressure of oxygen PO_2 0.021 MPa is used, specific rate of metal gold dissolution does not practically change, whereas in the cyanide solutions, using the air with partial pressure of oxygen PO_2 0.1 MPa, plasma-chemically treated water and synthetic hydrogen peroxide this index gradually decreases. Reduction of specific rate of metal gold dissolution is probably connected with the passivation of its surface which grows with the increase in oxygen concentration in the solution. This phenomenon is well known, but its nature has not ascertained so far [15,16]. So, it is considered that at excessive intensity of the solution mixing, molecules of dissolved oxygen are adsorbed on the surface of gold and decelerate the process of dissolution.

Taking into account the data obtained, investigation of the effect of other process parameters was carried out at fixed value of the rate of disk rotation 16 rad/s, excluding the effect of external diffusion factors on the rate of metal gold dissolution.

The dependence of specific rate of gold dissolution on concentration of the potassium cyanide was investigated in the range of concentrations of $(0.14-2.0)\cdot10^{-3}$ mol/l, at concentration of potassium hydroxide of $4.0\cdot10^{-3}$ mol/l, rate of disk rotation equal to 16 rad/s, at the temperature of 298 K. The results of investigations are given in Fig. 2.

It was found that in the event of using the cyanide solution prepared on the basis of plasma-chemically treated water (Fig. 2, curves 1—3), with the potassium cyanide concentrations varying in the range of $(0.14-0.4)\cdot10^{-3}$ mol/l, the linear relationship of specific rate of gold dissolution and complexing agent concentration is observed.

This steady relationship proves that the process of gold dissolution is the reaction of first order with regard to KCN. When the concentration of complexing agent KCN increases to $(0.5-1.5)\cdot10^{-3}$ mol/l, specific rate of metal gold dissolution grows and reaches its maximum value of $(11.0-11.1)\cdot10^{-9}$, $(11.45-11.5)\cdot10^{-9}$, $(12.0-12.1)\cdot10^{-9}$ mol/cm²·s. So, potassium cyanide concentration of $1.5\cdot10^{-3}$ is the limiting one, and further increase in potassium cyanide concentration in the solution to $2.0\cdot10^{-3}$ mol/l promotes gradual decrease in specific rate of gold dissolution which is probably explained by formation of passivating film on the surface, which inhibits the rate of metal gold dissolution.

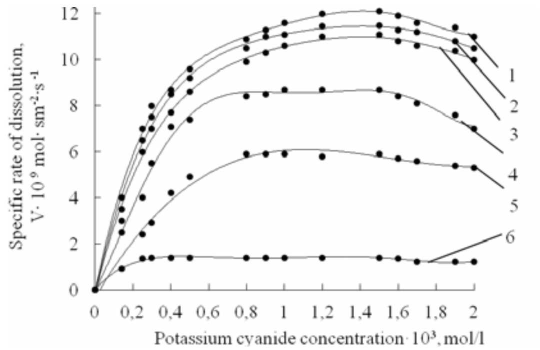

Fig. 2. Dependence of specific rate of gold dissolution on the concentration of potassium cyanide, using, as oxidizing agents, the following substances: 1,2,3 — plasma-chemically treated water 30, 20, 10 min; accordingly; 4 — synthetic hydrogen peroxide; 5 — at partial pressure of oxygen PO_2 0.1 MPa; 6 — at partial pressure of oxygen PO_2 0.021 MPa)

When synthetic hydrogen peroxide (Fig. 2, curve 4) is used as an oxidizing agent in the cyanide solutions, the nature of dependence of specific rate of gold dissolution is similar to that observed in the solutions prepared on the basis of plasma-chemically treated water, however, the process is slower: maximum specific rate of dissolution is $(8.6-8.7)\cdot10^{-9}$ mol/cm²·s.

Referring to the traditional conditions of dissolution, with the use of air at the partial oxygen pressure value of PO_2 0.021 and 0.1 MPa (Fig. 2, curve 5, 6), then, just as in the other systems under study, existence of the limit concentration of potassium cyanide is observed therein. However, unlike the systems presented above, firstly, the value of the limit concentration of potassium cyanide is maximal one, but specific rate of gold dissolution is less. Besides, at PO_2 0.021 and 0.1 MPa the limit value of complexing agent is equal to $5.0\cdot10^{-3}$ and $8.0\cdot10^{-3}$ mol/l, accordingly, and at these concentrations maximum rate of dissolution of metal gold $(1.39-1.4)\cdot10^{-9}$ and $(5.7-5.9)\cdot10^{-9}$ mol/cm² is achieved within the systems. Secondly, with the increase in the amount of potassium cyanide in the solution to $2.0\cdot10^{-3}$ mol/l in the domain of concentration after its limit value, specific rate of dissolution does not decrease as in all studies presented above, but instead it remains almost constant. This fact is explained by excessive concentration of potassium cyanide in the solution with regard to oxygen in the bulk solution and the area near to the disk surface. In these conditions of increased concentration of

CN^- ions, the rate of cyanide diffusion becomes higher than the rate of oxygen diffusion, and total dissolution rate shall rise at increase of the concentration of dissolved oxygen only, and it does not depend on potassium cyanide concentration.

In is known [16,17] that potassium cyanide (KCN) when dissolved in water is hydrolyzed according to reaction (4), which results in its significant losses. In the industrial conditions, alkali metal hydroxides are added to the leaching systems for stabilization of cyanide solutions.

$$KCN+H_2O=HCN+KOH. \qquad (4)$$

Authors of the work [17], with the help of rotating disk method, investigated the effect of pH of the cyanide solution in the presence of air (pH changing from 2.1 to 14) on the rate of dissolution of high carat gold. It is shown that in the range of pH 9.3–12.8 the rate of dissolution is constant, while at pH less than 9.3 and more than 12.8 it decreases rapidly. Given the above, it was feasible to establish the effect of pH in the cyanide solutions under study on specific rate of dissolution of metal gold.

Effect of pH value of solutions on the rate of gold dissolution was investigated at the potassium cyanide concentration of $5.0\cdot10^{-3}$ mol/l, rate of disk rotation equal to 15.7 rad/s, at temperature of 298 K. The results are presented in Fig. 3.

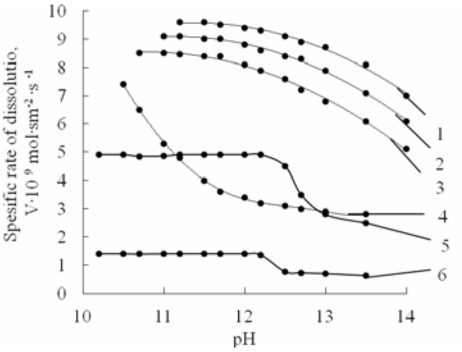

Fig. 3. Dependence of the specific rate of gold dissolution on pH value, using, as oxidizing agents, the following substances: 1,2,3 – plasma-chemically treated water 30, 20, 10 min; accordingly; 4 – synthetic hydrogen peroxide; 4 – air (at partial pressure of oxygen PO_2 0,1 MPa); 6 – air (at partial pressure of oxygen PO_2 0,021 MPa)

It was established that the data concerning the effect of pH of cyanide solutions with the use of air on the rate of gold dissolution agrees with the known data [16]. In the pH range of the solution being 10,0–12,5, specific rate of gold dissolution remains constant and makes $1.4\cdot10^{-9}$ and $4.9\cdot10^{-9}$ mol/cm²·s at PO_2 0.021 and 0.1 MPa (Fig. 3, curves 5, 6), accordingly, while in high-alkali solutions with pH>12.5 this index decreases. Higher pH in the range of 10.0–13.5 in the cyanide solutions with the use of synthetic hydrogen peroxide as an oxidizing agent (Fig. 3, curve 4) promotes sharp decrease in the rate of dissolution of metal gold. This latter phenomenon can be the result of formation of thin passivating film, and the cause of potassium cyanide oxidation by hydrogen peroxide.

Referring to cyanide solutions prepared on the basis of plasma-chemically treated water (Fig. 3, curves 1,2,3) when pH of the solutions varies from 10.0 to 11.5 the dissolution rate remain almost constant, but increase of pH over 11.5 promotes rapid decrease of specific rate of gold dissolution from $9.6\cdot10^{-9}$ to $6.1\cdot10^{-9}$ mol/cm²·s. However, it is necessary to note that obtained rates almost two times higher than the rate observed in the course of dissolution of metal gold with the use of air with partial pressure of oxygen PO_2 0.021 and 0.1 MPa, and the solution of synthetic hydrogen peroxide.

Given the assumption that hydrogen peroxide through its ability to oxidize potassium cyanide may cause a decrease in specific rate of gold dissolution, the effect of hydrogen peroxide concentration on concentration of potassium cyanide in the solution has been investigated. Results are presented in Fig. 4.

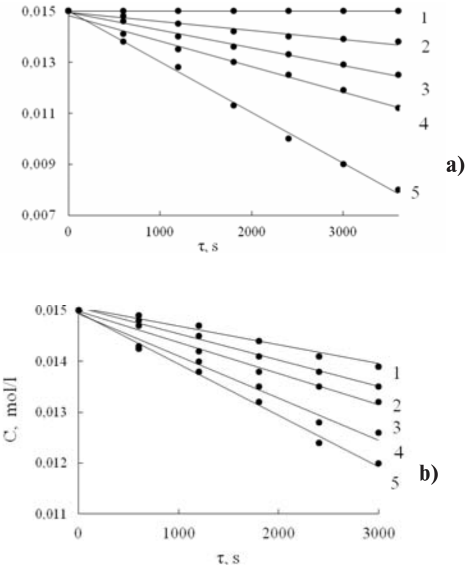

Fig. 4. Effect of hydrogen peroxide concentration on concentration of potassium cyanide in the solution: a) synthetic hydrogen peroxide: 1 – 0.01 mol/l; 2 – 0.02 mol/l; 3 – 0.04 mol/l; 4 – 0.06 mol/l; 1 – 0.1 mol/l; b) hydrogen peroxide formed as a result of water treatment with NCP: 1 – 0.003 mol/l; 2 – 0.006 mol/l; 3 – 0.009 mol/l; 4 – 0.014 mol/l; 1 – 0.02 mol/l

Resulting data (Fig. 4,a) proved that introduction into standardized test solution of potassium cyanide, with initial KCN content of $1.5\cdot10^{-2}$ mol/l, of synthetic hydrogen peroxide H_2O_2 in the amount of $(1.0-6.0)\cdot10^{-2}$ mol/l contributes to a slight decrease in KCN concentration. So, in 60 minutes after introduction into cyanide solution of $6.0 \cdot 10^{-2}$ mol/l of synthetic hydrogen peroxide (H_2O_2) amount of potassium cyanide decreases to $1.1 \cdot 10^{-2}$ mol/l, comprising 73% of its initial concentration. However, with increase in the amount of synthetic hydrogen peroxide to 0.1 mol/l for the same time interval, because of the oxidation reaction, cyanide concentration is 0.08 mol/l which is 50% of its initial concentration.

In water treated with NCP, the accumulation of peroxide compounds is limited by parameters of the unit, and depending on treatment conditions their concentration it falls within $(0.3-2.0) \cdot 10^{-2}$ mol/l. Experiments prove (Fig. 4,b) that while at such concentration of H_2O_2 in standardized test solution there occurs oxidation of CN^- cyan-ions, this reaction is slow, and the degree of oxidation is not sufficient to stop dissolution of gold. For example, in one hour after introducing into standardized test solution of potassium cyanide (KCN $1.5 \cdot 10^{-2}$ mol/l) plasma-chemically treated water containing $0.3 \cdot 10^{-2}$ mol/l of the formed hydrogen peroxide H_2O_2, the content of complexing agent KCN decreases to $1.385 \cdot 10^{-2}$ mol/l, at $0.6 \cdot 10^{-2}$ mol/l of the formed peroxide H_2O_2 residual content of KCN is $1.32 \cdot 10^{-2}$ mol/l, at $0.9 \cdot 10^{-2}$ mol/l this value is $1.28 \cdot 10^{-2}$ mol/l, at $1.4 \cdot 10^{-2}$—$1.19 \cdot 10^{-2}$ mol/l, and at $2.0 \cdot 10^{-2}$—$1.13 \cdot 10^{-2}$ mol/l, accordingly. Besides, in accordance with the data of [17], such concentration of hydrogen peroxide is the optimal one, since it was found that addition of small concentrations of hydrogen peroxide ($0.35 \cdot 10^{-3}$ mol/l) had no effect on the gold cyanidation, while at the concentration of hydrogen peroxide or more than $1.2 \cdot 10^{-2}$ mol/l the dissolution almost stopped, in connection with cyanide oxidation by peroxide.

Therefore, we may conclude that the determining factor in decrease of specific rate of gold dissolution is not the oxidation of cyanide by peroxide compounds, but formation of passive film on the gold surface, nature and composition of which are little studied at present time [14].

Since there is no literature data relating to concentrations of peroxide compounds which would promote intensification of cyanidation, we investigated the effect of H_2O_2 concentrations in cyanide solutions on specific rate of gold dissolution. The results are given in Fig. 5.

As a result of investigations, it was found that when the concentration of artificially introduced synthetic hydrogen peroxide in cyanide solution increased in the range of 0.01—0.06 mol/l (Fig. 5, curve 2) specific rate of gold dissolution has extremely grown and reached the maximum value of $(7.4-7.5) \cdot 10^{-9}$ mol/cm^2·s. However, with the further increase in H_2O_2 concentration to 0.1 mol/l a decrease in the rate of dissolution is observed, which is probably attributed to oxidation of cyanide. From the results of comparison of rate of gold dissolution in cyanide solutions with the use of artificially introduced hydrogen peroxide and oxygen of air, as oxidizers, it is evident that usage of low concentrations of hydrogen peroxide (less than 0.014—0.02 mol/l) is ineffective; this being the case, the rate of gold dissolution in the latter is correspondingly higher and it makes $1.4 \cdot 10^{-9}$ and $4.9 \cdot 10^{-9}$ mol/cm^2·s (at PO_2 0.021 and 0.1 MPa accordingly), but increase in the amount of artificially introduced synthetic hydrogen peroxide in the solution to $6.0 \cdot 10^{-2}$ mol/l intensifies the process considerably, and specific rate of gold dissolution exceeds the similar index in traditional systems 1.5—5.0 times.

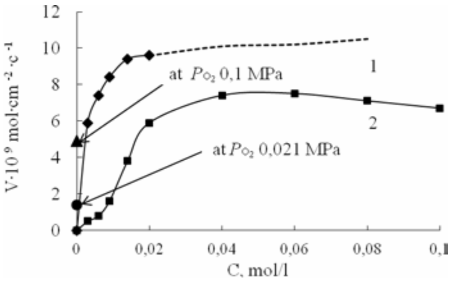

Fig. 5. Effect of hydrogen peroxide concentration on the specific rate of metal gold dissolution: 1— hydrogen peroxide formed in water during treatment with NCP; 2 — synthetic hydrogen peroxide

In cyanide solutions prepared on the basis of plasma-chemically treated water, as stated above, concentration of peroxide compounds is limited; depending on the treatment conditions it varies from $0.3 \cdot 10^{-2}$ to $2.0 \cdot 10^{-2}$ mol/l. Experiments prove that proportional relationship exists between the rate of dissolution of gold and amount of H_2O_2, accumulated as a result of water treatment with NCP (Fig. 5, curve 1), in the given range of concentrations.

High efficiency of low concentrations of the peroxide compounds of activated water compared with similar values of the amount of artificially introduced synthetic hydrogen peroxide is the evidence of presence in water treated with NCP of compounds enhancing its oxidizing properties.

One of the main values characterizing the process of gold dissolution is the activation energy [14—16]. In order to determine the activation energy by experiments, dependence of the rate of metal gold dissolution on temperature at the concentration of potassium cyanide equal to $5.0 \cdot 10^{-3}$ mol/l and KOH $4.0 \cdot 10^{-3}$ mol/l was investigated in the kinetic (ω=36 rad/s) conditions. According to this data, dependence of the rate constant at various temperatures was determined; on the basis of the Arrhenius equation the graphs of dependence of the logarithm of reaction rate constant on the reciprocal temperature were constructed, and the value of gold activation energy in the kinetic conditions was determined. Results are given in Fig. 6.

Activation energy calculated for the process of gold dissolution in solutions with the use, as oxidizing agents plasma-chemically treated water 41.5 kJ/mol. On the basis of obtained values of the activation energies, it is possible to consider that the limiting stage is the kinetic reaction.

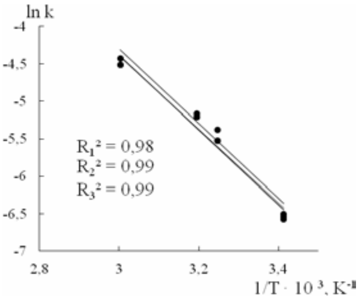

Fig. 6. Dependence of the logarithm of gold dissolution rate constant on the reciprocal temperature in solutions with the use, as oxidizing agents plasma-chemically treated water

Equations of dependence of the gold dissolution reaction rate constant on the temperature can be represented as follows:

$$k=3,87\cdot10^5\cdot\exp(-41550/RT). \qquad (5)$$

Conclusions

The paper deals with the investigation, with the use of rotating disk method, of the dependence of the rate of gold dissolution process on the basic technological parameters (temperature and concentration of reagents and intensity of mixing) in cyanide solutions prepared on the basis of plasma-chemically treated water, in traditional conditions of leaching (in the presence of air), and in the solutions of synthetic hydrogen peroxide. Using a rotating disk technique, the effects of rotation speed, cyanide, potassium hydroxide and hydrogen peroxide concentration, temperature, pH were measured. Oxygen and synthetic hydrogen peroxide were also examined as oxidants in the cyanide system. For the conditions studied, it appears that a surface reaction limits the rate of gold dissolution. It was found that dissolution of gold in all cases is characterized by the transient type of kinetics, which is confirmed by calculated values of the activation energy. However, it should be noted that the rate of dissolution process is considerably higher in the event of using water treated with non-equilibrium contact plasma. Nevertheless, the revealed kinetic behavior characterizes the reactions' mechanism in the ideal conditions of leaching, since in this case as an object of study the metal disks of gold are used. Instead, the component composition of ore flotation concentrate is characterized by presence of a considerable amount of various elements, which may to some extent affect the rate of reaction of gold and copper dissolution. Therefore, it is further planned to investigate the efficiency of direct action of plasma-chemically activated leaching systems on the ore concentrate.

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DISSOLUTION KINETICS OF GOLD IN CYANIDE SOLUTIONS ON THE BASIS OF PLASMA-CHEMICALLY «ACTIVATED» WATER

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The paper considers an opportunity and evaluates the effectiveness of using the solutions treated with low-temperature non-equilibrium contact plasma in order to intensify the dissolution of metal gold in cyanide leaching solutions. As a result of investigations, it was found that plasma-chemically treated solutions due to the presence of peroxide compounds, radicals and particles formed in water during treatment, exhibit significant oxidizing properties compared with synthetic hydrogen peroxide and gaseous oxygen which are currently used in hydrometallurgical industry as oxidizing components. Using a rotating disk technique, the effect of the basic technological parameters (the effects of rotation speed, cyanide, potassium hydroxide and hydrogen peroxide concentration, temperature, pH) on the rate of process of metal gold dissolution in plasma-chemically treated solutions, and those using synthetic hydrogen peroxide and gaseous oxygen, was found. It is shown that the dissolution of gold in all cases occurs in transient conditions, as evidenced by the calculated values of activation energies. Comparison of the values of activation energies of the gold dissolution process points to the advantage of use of plasma-chemically treated solutions over use of synthetic hydrogen peroxide and oxygen as oxidizing agents.

Keywords: kinetics; dissolution; gold; cyanidation solution; non-equilibrium low temperature plasma.

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