CHARACTERISTICS OF GOLD LEACHING AND GRAVITY SEPARATION OF FLOTATION TAILS IN MINE

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Abstract: *today, the demand for underground resources is increasing, and it requires us to use all of our precious resources without fail. Therefore, we have identified the leaching characteristics of the flotation tailing in A mine and it's causes, and proposed one way to effectively leach gold. This article describes the state of presence of the flotation tailing in A mine and the cause of difficult leaching. The acid decomposition method is recommended as an effective pretreatment method for the flotation tailing. In order to leach gold from the flotation tailing of this mine, it is first necessary to concentrate it on a jigging separator and then remove the influence of the flotation reagent by acid decomposition.*
Keywords: *gold leaching, gravity separation, flotation tail, jigging, acid decomposition method.*

ХАРАКТЕРИСТИКА ВЫЩЕЛАЧИВАНИЯ ЗОЛОТА И РАЗДЕЛЕНИЯ ГРАВИТАЦИИ ФЛОТАЦИОННЫХ ХВОСТОВ В РУДНИКЕ

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Аннотация: *сегодня спрос на подземные ресурсы растет и это требует от нас использовать все наши драгоценные ресурсы в обязательном порядке. Поэтому мы определили характеристики выщелачивания флотации хвостохранилища на руднике А и его причин, и предложили один способ эффективного выщелачивания золота. В этой статье описывается состояние присутствия флотации в хвостохранилище на руднике А и причина сложного выщелачивания. Метод кислотного разложения рекомендуется в качестве эффективного метода предварительной обработки для хвостохранилища флотации. Для выщелачивания золота из флотационного хвоста этого рудника сначала необходимо сконцентрировать его на отсадочном сепараторе, а затем удалить влияние флотационного реагента путем кислотного разложения.*
Ключевые слова: *выщелачивание золота, гравитационное разделение, хвост флотации, отсадка, метод кислотной декомпозиции.*

1. Leaching characteristics of gold from the flotation tailing in A mine

1) Cyanide gold leaching characteristics

Before gold leaching with cyanide method, first the flotation tailing was pretreated in NaOH solution (pH 14) for 24 h. At this time, NaOH solution is added so that the pH of the final pre-leach solution is 9 – 10. At time cyanide leaching, NaCN concentrations of the leachate were 0.03, 0.05, 0.07, 0.10 and 0.20 %. To setting with 0.03 % the minimum concentration of NaCN is because the activity of copper mineral (major minerals in A mining) is minimized at this concentration [1] and to doing with 0.20 % the maximum concentration of NaCN is to dissolve all of them copper mineral with gold.

The mass of sample is 10 g, the quantity of leachate 8 ml, in the leachates with NaCN concentrations of 0.03, 0.05 and 0.07 % the leaching time was 48h, in other leachates(NaCN concentrations of 0.10 and 0.20 %) 72h, and the leaching temperature was 8 – 10℃.

The gold leaching rate was calculated by the following equation.

$$\text{Gold leach rate} = \frac{\text{gold content of leachate}}{\text{gold content of leachate} + \text{gold of residue}} \times 100\ (\%) \qquad (1)$$

Table 1. Results of cyanide gold leaching from the flotation tailing

№	NaCN, %	Volume, ml	Gold content, g/ t	Gold content of residue, g/ t	Gold leach rate, %
1	0.03	6	trace	6.0	0
2	0.05	6	–	0.5	0

3	0.07	7	trace	trace	0
4	0.10	6	–	5.0	0
5	0.20	6	–	2.0	0

Table 1 shows the results of leaching by the method of crystal violet analysis. As shown in Table 1, the cyanide gold leaching characteristic of the flotation tailing in A mine is very bad. This is because it contains a lot of copper minerals in the tailings, or the surface of the gold and auriferous mineral is covered by the flotation reagent.

2) Selective leaching characteristics at CCA system

The selective leaching method was applied to evaluate the effect of copper minerals on cyanide gold leaching. At CCA (Copper- Cyanide- Ammonia) system the principle of selective leaching of gold is as follows.

$2 \sim 4NH_3\ H_2O + Cu^{2+} \rightarrow [Cu(NH_3)_{2\sim4}]^{2+} + 2 \sim 4H_2O$

$NH_3\ H_2O + Cu(CN)_2^- \rightarrow [Cu(CN)_2NH_3]^- + H_2O$

$Au + [Cu(CN)_2NH_3\ ]^- + Cu(NH_3)_{2\sim4}^{2+} \rightarrow Au(NH_3)CN\ CuCN_{adsorption} + Cu(NH_3)_2^+ + 0 \sim 2NH_3$

$Au(NH_3)CN\ CuCN_{adsorption} + NH_3 \rightarrow Au(CN)_2^-2 + Cu(NH_3)_2^+$

$NH_3\ H_2O + Cu(CN)_2^- \rightarrow [Cu(CN)_2NH_3]^- + H_2O$

$2Cu(NH_3)_2^+ + O_2 + 4NH_4^+ \rightarrow 2Cu(NH_3)_4^{2+} + 2H_2O$

$2Cu(NH_3)_4^{2+} + Cu(CN)_2^- \rightarrow CuCN + CN^- + Cu(NH_3)_2^+ + 2NH_3$

$2Cu(NH_3)_4^{2+} + CuCN + 2OH^- \rightarrow Cu(OH)_2 + CN^- + Cu(NH_3)_2^+ + 2NH_3$

As shown in the reaction equations, in the CCA system, because the copper ions are precipitated as copper hydroxide, it does not affect to gold leaching. According to the information, in the CCA system, the reagent consumption standard is 1 ~ 2kg / t of NH_3, 1 ~ 2kg / t of NaCN, and the pH of the leachate is 10.5 – 11.0. Under these conditions, the gold is dissolved by the oxidation of $Cu(NH_3)_4^{2+}$ or O_2, more precisely by the oxidation of $Cu(NH_3)_4^{2+}$, $[2Cu(CN)_2NH_3]^{2-}$ [2]. In the CCA system, in order to studying the gold leaching characteristics of the flotation tailing in A mine the experiment was carried out by the following method.

The sample preparation and the pretreatment were the same as in the cyanide leaching process. The NaCN concentration of the leachate was fixed at 0.05%, and the addition amounts of ammonium phosphate were set at 150, 120, 80, 50 and 20 mg, respectively. When ammonium is added to the leach solution, ammonia is so occur that the pH of the leachate gradually decreases as the leaching time becomes longer. Therefore, the pH value of the leachate was maintained at about 10 by measuring the pH of the leachate once every 2 h and replenishing the NaOH solution. Unlike cyanide leaching, agitation leaching method was applied.

Table 2 shows the results of selective leaching experiment on the flotation tailing in A mine.

Table 2. Results of selective leaching experiment on the flotation tailing

Added amount of ammonium sulfate, mg	150	120	80	50	20
Initial volume, ml	10.5	10.0	9.5	9.0	9.0
Last volume, ml	10.0	7.5	7.5	6.5	6.5
Content of gold, g/t	0	trace	0	0	0
Leaching time, h	48	48	48	72	72
Content of gold in leaching residues, g/t	trace	0.5	7.0	4.0	0.0
Gold leach rate, %	0	0	0	0	0

The reason for the difference in the initial volume of the leaching solution is because that NaOH solution was added to the constant maintain of the pH of the leachate.

As shown in Table 2, in the CCA system, the selective leaching characteristic of A mine flotation tailing is very bad, too. From this, it can be seen that the cause of bad leaching characteristic of A mine flotation tailing is not caused by the effect of copper mineral. The major cause of the intractable leaching characteristics of the mine flotation tailing is that the surface of the gold or auriferous mineral is covered by the flotation reagent, and so them is not able to participate in the reaction. Therefore, in order to leach gold by a chemical method in A mine flotation tailing, the pretreatment should be performed to remove the influence of the flotation reagent.

The basic flotation reagents using in A mine are xanthogenate and dithiophosphate, and the typical methods for eliminating their effects are methods by the acid decomposition and the activated carbon adsorption.

The acid decomposition method utilizes the properties of xanthogenate which are very unstable under strongly acidic conditions. The information show that xanthogenate dissolves very quickly at pH 1 - 3. For example, at pH 1, xanthogenate are completely decomposed in 5 min [3]. The activated carbon adsorption method utilizes the strong adsorption characteristics of activated carbon. However, this method has a drawback in that the amount of activated carbon consumed is high when the concentration of xanthogenate is high. To overcome this, a mixture of activated carbon and clay minerals is used [4].

Therefore, an effective pretreatment method for the gold leaching of A mine flotation tailing is acid decomposition. In order to reduce acid consumption when applying this method, the auriferous minerals must be concentrated and the carbonate minerals must be removed.

2. Gravity separation of A mine flotation tailing

In order to know the distribution of the auriferous minerals according to the grain size and density carried out the heavy mineral experiment with 50 g of the flotation tailing. It was named to the first of order the heavy concentrate obtained firstly (about one - sixth of the initial amount of the sample) by working with the panning plate. And the secondary heavy concentrate was named to the heavy concentrate obtained when worked again with the panning plate from the remaining samples excluding to first. As the same method, all samples classified to 7 of groups. After drying the heavy concentrate samples they weigh and analyzed (Table 3).

Table 3. Results of the heavy concentrate experiment of the flotation tailing

№	Order of heavy concentrate	Mass of heavy concentrate, g	Content of gold, t/g
1	1	7.30	6
2	2	5.80	2
3	3	4.60	0
4	4	5.55	1
5	5	5.60	8
6	6	6.10	1
7	overflow	14.05	0
total	–	50.00	–

As shown in Table 3, most of the gold minerals are included in the first and fifth heavy concentrate. From this, it can know that the grain size of gold or auriferous minerals is classified 2 of group of the coarse grain and fine. Therefore, it is difficult to treat A mine flotation tailing by the method of sizing, conveyer, table separation and heavy media separation.

In the working to gravity separation from the mine flotation tailing, the most effective method is the jigging. It is because the jigging can collect the fine grained heavy minerals too using to the dropping effect of the grains and the classification by density or grain size.

Conclusion

The major cause of the intractable leaching characteristics of the mine flotation tailing is that the gold and auriferous minerals are covered by the flotation reagent and so they can not participate in the leaching reaction.

In order to effectively leach gold from the mine flotation tailing, first we must concentrate the leachate to maximize the gold using to the jigging, and remove the influence of the flotation reagent by the acid decomposition method.

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