

M.Z. Bitimbayev¹, Y.P. Morozov², I.H. Khamidullin²

¹"Kazakhmys Corporation" LLP, JSC "MMC "Kazakhaltyn";

² FGBOU VO «Ural State Mining University" (Yekaterinburg, Russia)

mbitimbayev@mail.ru

STUDY OF GOLD ACCUMULATION REGULARITIES IN CLOSED GRINDING CYCLES

Abstract. The peculiarity of gold ore processing is the accumulation of gold during grinding cycles of the circulating equipment. It has been shown that the use of roll grinders and advanced mode of hydrocyclone operation can effectively recycle high gold grades, resulting in extraction of rich gold concentrate.

Key words: water-shredding concentration, mechanism, grinding and classification units, indicators of gold concentration.

Currently, the mining industry has an acute problem of increasing the extraction of useful components from gold ores and industrial materials. For the extraction of precious metals the most applicable are gravitational methods of enrichment. Also attention is drawn to the problem of extracting gold fine particles and plate-shaped particles that are poorly retrieved by existing technologies. In its decision there are new tasks of the theory of enrichment processes, improvements in technology and hardware equipment of ore dressing processes and technogenic raw materials.

The peculiarity of gold ore processing is the accumulation of gold in the circulating products of closed grinding cycles. Depending on the size of gold particles in the ore the concentration degree of gold in the closed grinding cycle in industrial environment by grinding the ore in ball mills is in the range from 2 to 8 or more [1]. The larger the gold in the ore, the higher the degree of concentration in the circulating product.

The accumulation of gold in the circulating products of grinding cycles is explained by the reason that sufficiently large gold particles are poorly broken and do not go into the sink of classifying apparatus as long as their particle size is reduced to a size at which, in accordance with a separation characteristics of classifying unit there is a possibility of access to the drain.

Process of accumulation of gold in the circulating products depends on the efficiency of classification of classifying equipment. Thus, hydrocyclones classification efficiency is 55-60%. Therefore, 20-30% of the particles larger than the size of the division are lost with drain hydrocyclone.

To ensure maximum performance of gold accumulation in circulation-grinding concentration it is necessary to reduce the overgrinding of gold particles and to provide high efficiency of classification.

Grinding of gold particles is significantly reduced when using the grinding method of crushing in the roll mill or by impact in a centrifugal impact mills.

To improve the effectiveness of classification we proposed in the circulation-grinding concentration to set the mode of hydro-cyclone, in which gold particles with a given size can not go down the hydrocyclone drain [1, 2, 3]. For given conditions it is determined the hydrocyclone separation characteristics when working in open loop. An example of such a separation characteristics is shown in Fig. 1.

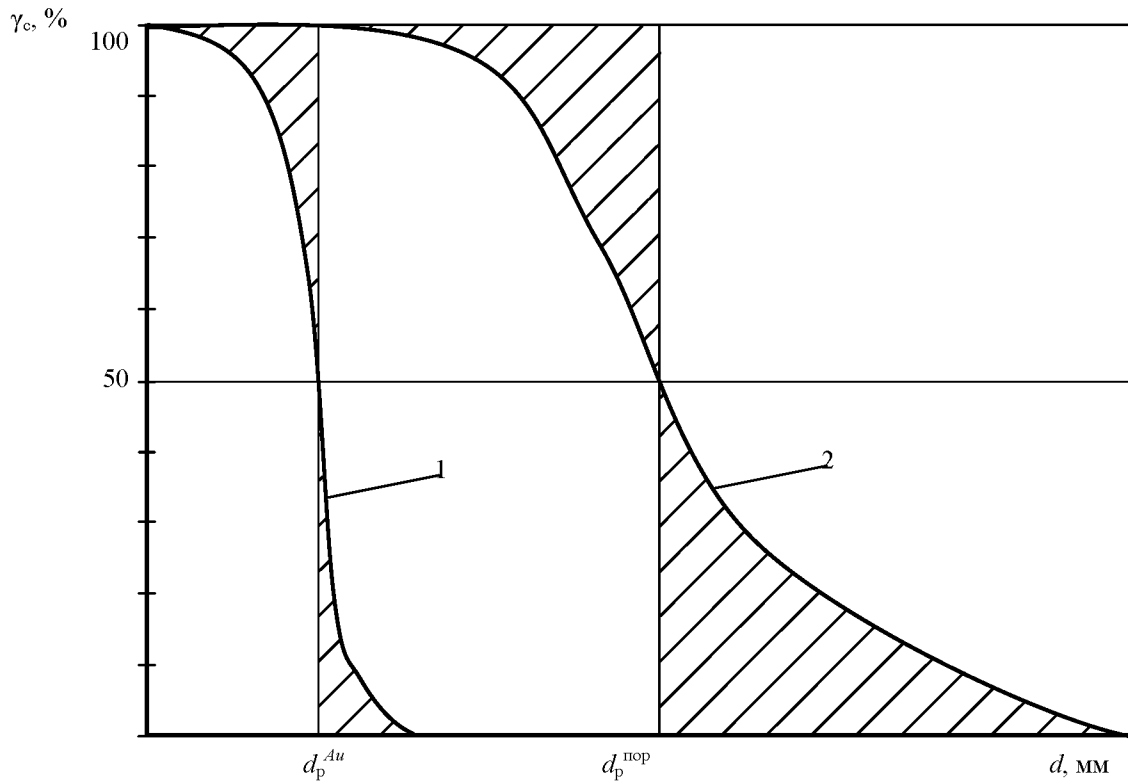


Figure 1 - The separation characteristics on gold (1) and on rock (2) when hydrocyclone operating in open loop: γ_{cH} – access to the drain; d – particle fineness; d_p^{Au} – fineness separation on gold; d_p^{nop} – fineness separation on rock

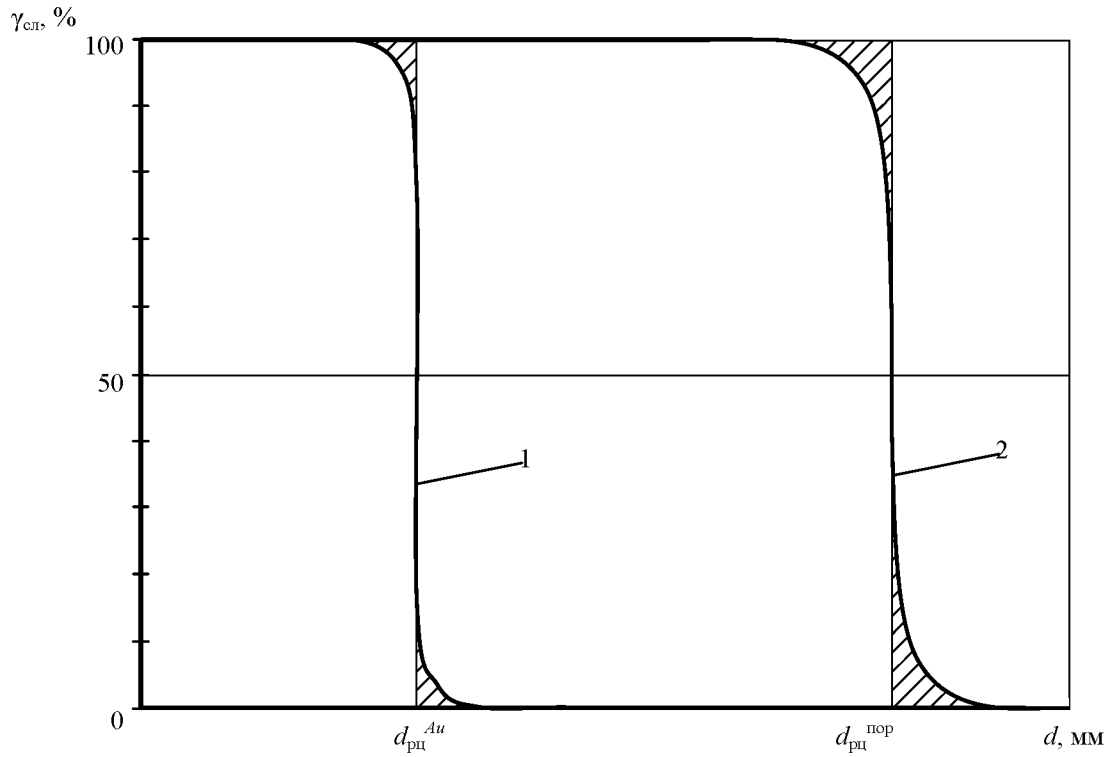


Figure 1 - The separation characteristics on gold (1) and on rock (2) when hydrocyclone operating in the circulating concentration mode: γ_{cH} – access to the drain; d – particle fineness; d_{pH}^{Au} – fineness separation on gold; d_{pH}^{nop} – fineness separation on rock

On the resulting of separation characteristics shaded areas show the interlocking of drain and sand. To avoid loss of particles in a given size to the drain of hydrocyclone its operation mode should be such that the fineness separation on gold is equal $d_{\text{pu}}^{\text{Au}}$. Then separation characteristics is close to the ideal, which is shown in Fig. 2.

To ensure minimum losses in the drain of gold with fineness more $d_{\text{pu}}^{\text{Au}}$ it is necessary to select hydrocyclone and set its mode of operation in which $d_{\text{p}}^{\text{Au}} \approx 0,5d_{\text{pu}}^{\text{Au}}$.

We have studied circular-grinding concentration using a roll grinder IV-100, designed in accordance with [4]. Installing the circulation module consists of a hydrocyclone, cumulative sump, pump. In the installation it is used the hydrocyclone with diameter of 100 mm and a cone angle of 32 °. The diameter of the loading tube of hydrocyclone is 19 mm, sand tube - 5 mm. The capacity of the cumulative sump is 15 liters. For power supply it is used the centrifugal pump BC-0.4-20-U11 "Agidel", capacity of up to 3 m³/h through the water [5].

Circulating-grinding concentration was subjected to gold-material enrichment product with a mass fraction of 0.16% gold, 82% of size class plus 0.1 mm.

Source material in amounts of 10 Kg was subjected to the circulation-grinding concentration with hydrocyclone drain selection of samples for every two minutes. These discrete drainage samples and ending sands were subjected to fire assay. Results of studies after mathematical treatment are shown in Table. 1 and Fig. 3.

Table 1 - Results of the circulation-grinding concentration of gold-bearing product

Duration of concentration, min.	Name of product	Enrichment indicators		
		Output, %	Mass fraction of gold, %	Gold extraction, %
2	Sands of hydrocyclone 1	70,90	0,22	99,70
4	Sands of hydrocyclone 2	40,70	0,39	99,40
6	Sands of hydrocyclone 3	15,10	1,05	99,15
8	Sands of hydrocyclone 4	9,40	1,68	98,91
10	Sands of hydrocyclone 5	5,10	3,1	98,69
12	Sands of hydrocyclone 6	2,46	6,4	98,49
14	Sands of hydrocyclone 7	0,99	15,8	98,30
16	Sands of hydrocyclone 8	0,61	25,74	98,12
18	Sands of hydrocyclone 9	0,33	47,49	97,94
20	Sands of hydrocyclone 10	0,18	86,93	97,80
	Source material	100,00	0,16	100,00

It was established that the circulation-grinding concentration, implementing the proposed technical solutions, can effectively enrich the rich gold-bearing products to give placer gold product with a mass fraction of gold more than 86% when the gold extraction in it of 97.88%.

In general, the circulation-grinding concentration is an effective method of gold concentration in the circulating product of grinding cycle and can be recommended in the final stages of finishing gold-bearing products in the preparation of commercial products for the refining of gold.

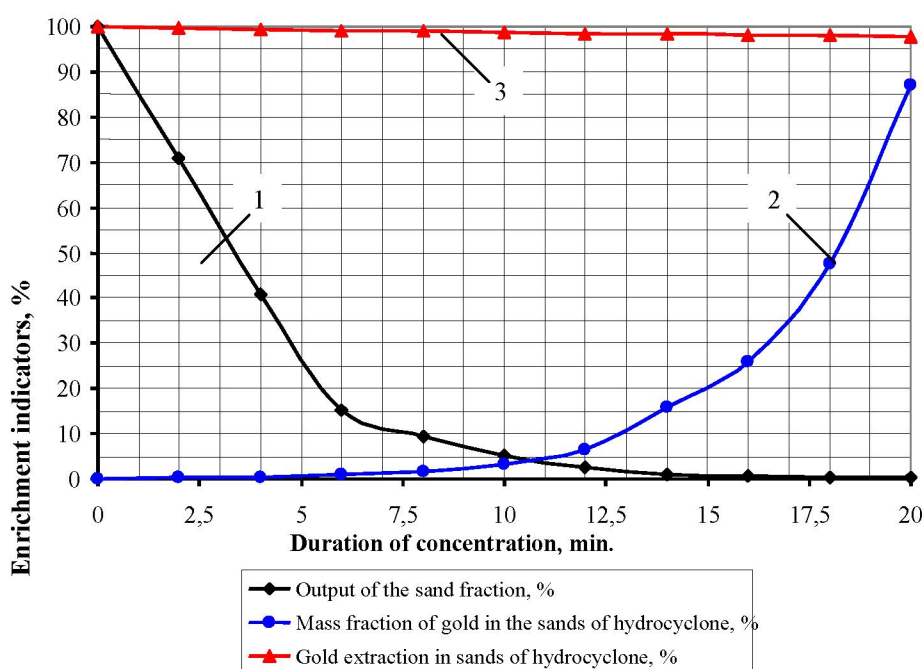


Figure 3 - Dependence of output of sand fraction (1), mass fraction of gold (2) and extraction of gold (3) on the duration of concentration

REFERENCES

- [1] Morozov Ju.P. Teoreticheskoe obosnovanie i razrabotka novyh metodov i apparatov izvlechenija tonkodispersnyh blagorodnyh metallov iz rud tehnogenogo syr'ja. Diss... dokt. tehn. nauk. Ekaterinburg. – 2001. – 397 s.
- [2] Hamidulin I.H. Razvitie processa cirkuljacionnoj koncentracii. Magisterskaja dissertacija. Ekaterinburg. 2006. – 73 str.
- [3] Morozov Ju.P., Hamidulin I.H., Falej E.A., Cherkasov V.Ju. Nakopitel'nye tehnologii gravitacionnogo izvlechenija zolota pri obogashhenii sul'fidnyh rud // Izvestija vuzov. Gornyj zhurnal. 2013. № 7. S. 102-106.
- [4] Patent № 2132233 (RF). Valkovij izmel'chitel' /Morozov Ju.P., Afanas'ev A.I., Timofeev N.I. i dr. //Zajavl. 20.10.97. - № 97117203/03. Opubl. 27.06.99. – Bjull. № 18.
- [5] Hamidulin I.H., Komlev S.G., Morozov Ju.P. Obogashhenie tehnogenykh produktov cirkuljacionnoj koncentraciej // Izv. vuzov. Gornyj zhurnal. 2015. № 7. S. 106–109.
- [6] Avtorskoe svidetel'stvo № 54220 (RK). Ustanovka dlja izvlechenija zolota iz upornykh sul'fidnyh rud / Bitimbaev M.Zh., Dzhumabaev E.I., Mejramkulov M.H.
- [7] Bitimbaev M.Zh., Chemecov G.E. i dr. Teoreticheskaja osnova primeneniya ul'trazvuka dlja intensivizacii vyshhelachivaniya, sorbcii i desorbcii metallov // Sbornik trudov IGD im. D.A. Kunaeva, t.67. – Almaty, 2008.

ЛИТЕРАТУРА

- [1] Морозов Ю.П. Теоретическое обоснование и разработка новых методов и аппаратов извлечения тонкодисперсных благородных металлов из руд техногенного сырья. Дисс... докт. техн. наук. Екатеринбург. – 2001. – 397 с.
- [2] Хамидулин И.Х. Развитие процесса циркуляционной концентрации. Магистерская диссертация. Екатеринбург. – 2006. – 73 стр.
- [3] Морозов Ю.П., Хамидулин И.Х., Фалей Е.А., Черкасов В.Ю. Накопительные технологии гравитационного извлечения золота при обогащении сульфидных руд // Известия вузов. Горный журнал. 2013. № 7. С. 102-106.
- [4] Патент № 2132233 (РФ). Валковый измельчитель /Морозов Ю.П., Афанасьев А.И., Тимофеев Н.И. и др. //Заявл. 20.10.97. - № 97117203/03. Оpubл. 27.06.99. – Бюлл. № 18.
- [5] Хамидулин И.Х., Комлев С.Г., Морозов Ю.П. Обогащение техногенных продуктов циркуляционной концентрацией // Изв. вузов. Горный журнал. 2015. № 7. С. 106–109.
- [6] Авторское свидетельство № 54220 (РК). Установка для извлечения золота из упорных сульфидных руд / Битимбаев М.Ж., Джумабаев Е.И., Мейрамкулов М.Х.

[7] Битимбаев М.Ж., Чернецов Г.Е. и др. Теоретическая основа применения ультразвука для интенсификации выщелачивания, сорбции и десорбции металлов // Сборник трудов ИГД им. Д.А. Кунаева, т.67. – Алматы, 2008.

М.Ж. Бітімбаев, Ю.П. Морозов, И.Х.Хамидулин

ЖАБЫҚ ҰСАҚТАУ ЦИКЛДА АЛТЫННЫҢ ЖИНАЛУЫНЫҢ ЗАҢДЫЛЫҒЫН ЗЕРТТЕУ

Аннотация. Алтын кендерді өндеудің ерекше айырмашылығы алтынның ұсақтауда айналатын цикл кезінде өнімде жиналып қалуы. Валдық ұсақтау кезінде және жұмыс режимін жетілдірген кезде гидроциклонның жұмысы тиімді түрде алтын кенді өнімді қайта өңдеп, алтын кенді шлихтарды аффинажға өте жоғарғы ұсақтауда алтынды жинайтындығы көрсетілген.

Түйін сөздер: циркуляциялы-ұсақтау концентрациясы, механизм, ұсақтау және ласификациялау құрылғылары.

М.Ж. Битимбаев¹, Ю.П. Морозов², И.Х. Хамидулин²

¹ Эксперт ТОО «Корпорация Казахмыс», член совета директоров АО «ГМК Казахалтын»;

² ФГБОУ ВО «Уральский государственный горный университет», г. Екатеринбург, Россия

ИССЛЕДОВАНИЕ ЗАКОНОМЕРНОСТИ НАКОПЛЕНИЯ ЗОЛОТА В ЗАМКНУТЫХ ЦИКЛАХ ИЗМЕЛЬЧЕНИЯ

Аннотация. Особенностью переработки золотосодержащих руд является накопление золота в циркулирующих продуктах циклов измельчения. Показано, что использование измельчения в валковом измельчителе и использование усовершенствованного режима работы гидроциклона позволяет эффективно перерабатывать богатые золотосодержащие продукты с получением золотосодержащих шлихов для аффинажа при высоком извлечении в них золота.

Ключевые слова: циркуляционно-измельчительная концентрация, механизм, аппараты измельчения и классификации, показатели концентрации золота.

Сведения об авторах:

Бітімбаев М.Ж. – «Корпорация Казахмыс» ЖШС expertі, «ГМК «Казахалтын» АҚ Директорлар кеңесінің мүшесі;
Морозов Ю.П. – ФГБОУ ВО «Орал мемлекеттік тау-кен университеті» (Екатеринбург қ-сы, Ресей), байыту кафедрасының профессоры;

Хамидулин И.Х. – ФГБОУ ВО «Орал мемлекеттік тау-кен университеті», инженер.