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TECHNOLOGIES OF MAN-MADE PLACER DEVELOPMENT IN ACTIVE AND CLOSED WASTE STORAGES

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ТЕХНОЛОГИИ РАЗРАБОТКИ ТЕХНОГЕННЫХ РОССЫПЕЙ ВО ВРЕМЯ И ПОСЛЕ ЗАВЕРШЕНИЯ ЭКСПЛУАТАЦИИ ХРАНИЛИЩ ОТХОДОВ ОБОГАЩЕНИЯ

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ТЕХНОЛОГІЇ РОЗРОБКИ ТЕХНОГЕННИХ РОЗСИПІВ ПІД ЧАС ТА ПІСЛЯ ЕКСПЛУАТАЦІЇ СХОВИЩ ВІДХОДІВ ЗБАГАЧЕННЯ

Abstract. The article describes a technology for valuable components extracting from the man-made waste storages at the Krivbass ore-dressing and processing enterprises which are considered as promising man-made placers. Two approaches to such placers developing are considered which assume valuable component extraction both after closing and in process of operation of the waste storages. It is shown that implementation of practice of valuable components co-extraction from areas between dam and pond in conjunction with technology of combined waste storing requires changing of technological scheme in the maps of inwash district, and, to this end, it is rational to combine several operations. Technological parameters of the co-extraction from the man-made placers by means of hydromechanical facilities were grounded. The required performance of hydro-transport facilities needed for delivering tailings to the current inwash horizon and concentration of the discharged pulp were specified.

Keyword: man-made placers, dike dam, waste storage, pond, area between the dam and pond.

Mining processing plants (MPPs) of the iron-ore basin of Krivoy Rog (of Krivbass) were started to exploit from the middle of the last century and for the work term that is more than a half of the century they have accumulated in their storages significant amounts not only of the waste rock, of the process water but also of the valuable components that were not extracted from the feed mineral stock for a variety of reasons.

Today the cost price of the mineral raw materials production in the quarries increased and it is equal to the cost price of these components production out of the wastes of the last century. And the wastes storages themselves reached the highest possible marks and their further exploitation becomes impossible. Herewith there is no land for the new wastes storages and the storages that are closed constitute a serious environmental danger to the whole region of Krivoy Rog.

Thus the transformation of the wastes storages of mining processing plants (MPPs) of Krivbass into the anthropogenic deposits with the production beginning in the process of their exploitation and after the wastes storing finishing for the subsequent rehabilitation and the conservation is the only one solution that preservesthe competitiveness of the production and the stable development of the region.

However the existing world experience in the use of the recoverable resources refers to the industrial wastes of nonferrous, precious and rear-earth metals processing such as gold, platinum, copper, aluminum, plumbum and zinc that is caused by the high demand for these metals and the high cost of their concentrates [1 - 3]. In addition in the world practice the anthropogenic alluvial deposits production from the wastes storages is carried out after the finishing of the storage exploitation and the stopping of the wastes storing in them. In the homeland conditions it is required a technology that enables the development of the anthropogenic alluvial deposits in the operating wastes storages without the interrupting of the ingress of new tailings. Thus international experience cannot be transferred to the homeland conditions without adapting it to the peculiarities of the mining processing plants (MPPs) of Krivbass and profitability of such technology should be evaluated taking into account the profitability of the whole mining processing plant (MPP).

Studies of this issue show that for the further functioning of mining processing plants (MPP) of Krivbass the modernization of the existing technologies of the wastes storing with the elements of the reorganization of the storage and the implementation of the by-product development of the anthropogenic alluvial deposits are needed [4, 5]. In this case it is suggested to extract the concentrate that gets into the enrichment process wastes and deposits on the beach area near the floodwall (Fig. 1) and to return it into the concentrating bound after the map alluviation and the draining of the area near the dike dam. The worked-out area can be refilled by the enrichment process wastes that were spissated to the paste concentration that makes it possible to introduce the technologies of the inspissation and the storing of such pulps into the wastes storages that are exploited [1, 6, 7].

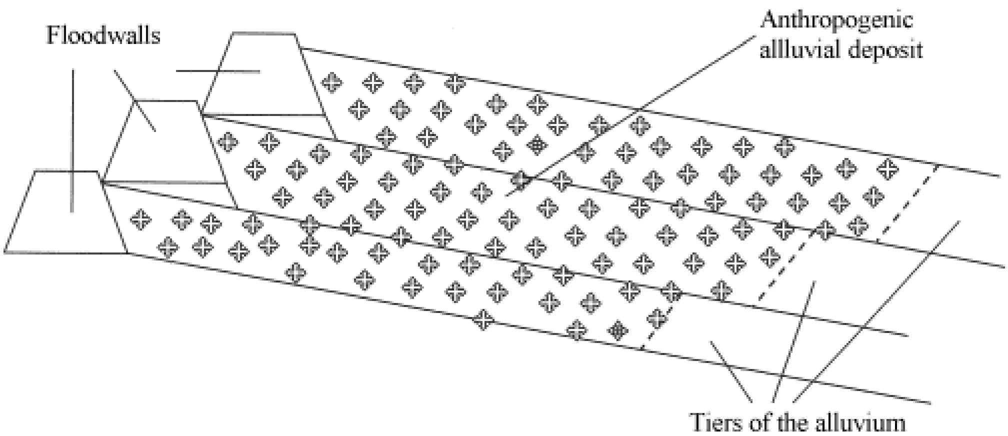


Figure 1 – The structure of the anthropogenic alluvial deposits formed during the wastes storing

By this decision the following algorithm of the transition to a new level of the pulp output is assumed [5]: on the perimeter after finishing of the map alluviation to start mining work of excavating in the beach area near the dike dam and then to fill the area with the highly concentrated pulp consisted of the slim particles and only then to move to the next level of the wastes storing. As a result the slim particles that were previously deposited in the pond at this tier of the alluvium do not get into it that ensures the successful clarification of the recirculated water to the required standards.

It is reasonable to implement this technology at the storages where the first or the second tier of the alluvium is sluiced because it makes the extraction of the anthropogenic alluvial deposits possible only at the current tier.

During the filling of the wastes storages that are exploited by the homeland mining processing plants (MPPs) the technology of the storing is used that based on splitting of the perimeter of the current level of the retaining prism into the sections of the alluvium where the enrichment process wastes that were delivered by one hydrotransport installation are accumulated [7]. It is recommended to select the length of this section of the alluvium in a range from 1000 to 3000 m that is based on the experience of the exploitation of the previous wastes storages. It is recommended to divide the sections of the alluvium by the subsidiary dike dams that were built inside the wastes storages perpendicular to the floodwall minimum into 5 alluviation maps. The operating procedures at the alluviation maps within the same section of the alluvium are carried out in accordance with the process schemes that are based on the following sequence of the processing steps. (Table 1) [7].

Table 1 – The current process scheme of the maps of the section of the alluvium

The stage number	The sequence number of a map in the section of the alluvium				
	I	II	III	IV	V
1	alluvium	reserve	installation	dike dam	drying
2	drying	alluvium	reserve	installation	dike dam
3	dike dam	drying	alluvium	reserve	installation
4	installation	dike dam	drying	alluvium	reserve
5	reserve	installation	dike dam	drying	alluvium

It is assumed that the duration of each of the processing steps is the same because while one alluviation map is dried up, diked, equipped with the pipelines and is in reserve, the other four maps are sluiced sequentially by the tailings. Thus when the first map goes out of the reserve the works on the wastes storing are transferred to a new tier of the alluvium.

With the implementation of the by-product extraction of the anthropogenic alluvial deposits the operating procedures with the alluviation maps within one section should be changed. In this case with the regard to the necessity of the extraction of the anthropogenic alluvial deposits and the renewal of the carrying capacity of the beach in the basis of the process scheme the following sequences of steps should be: enrichment process wastes alluvium; drying of the beaches; extraction of the anthropogenic alluvial deposit; filling of the worked-out area; drying of the newly formed beach or the shrinkage; installations of the floodwall; installation of the instrument desk; being in reserve.

While changing of the technological procedures with the new set of the processing steps it is rational to save the time of the map alluvium with the enrichment process wastes. The time of the map alluvium with the enrichment process wastes is determined by the capacity of the existing hydrotransport installations. It is possible to change this value only in the process of the modernization of the hydrotransport complex of the mining processing plants (MPPs) by changing of the pumping equipment. Not significant changing in the pump delivery can be achieved by setting of the impeller of the other diameter, by changing of the rotation frequency of the impeller or by air supply in the case of using the scheme "in one lift". However, none of these methods is widely used in the conditions of the homeland mining processing plants (MPPs) [4, 7 - 10]. Especially not appropriate is the productivity decrease of the hydrotransport installations that take away the tailings into the storage. Because their main task is to provide that the concentrating industry was not flooded. Thus the actual task is the task to keep constant the total pulp consumption that comes into the alluvial tier when the process scheme is changed.

If the pulp consumption that is given to the map remains permanent then the number of the maps at the section together with the length of the section increase. In this case it is need to use eight maps instead of five. And the extraction process is started in every map after its drying and then the worked-out area is filled by the secondary processing wastes, the area near the dike dam is dried, the floodwall is dumped, the distributing pipelines are installed and put into reserve. The working-off time of the tier of the alluvium increases on 40% but it is possible to decrease the number of sections because one section can be broken up and two others can be complemented by the maps that released.

For the considered approach it is important to coordinate the work modes of the hydrotransport installations that give the wastes into the maps, the extraction equipment and installations that provide the storing of the secondary wastes. It will be provided if the time of the map filling will exceed the time of the man-made placers extraction:

$$T_k \geq T_P, \quad (1)$$

where T_k – the time of the map filling with the wastes; T_P – the time of the man-made placers extraction in the map of the alluvium.

With taking into account of the geometrical peculiarities of the zone of dry tailing forming in the maps of the alluvium (fig. 2), the duration of the man-made placers extraction in the map of the alluvium and the time of the map filling with the wastes can be estimated with the formulas:

$$T_P = \left[2\wp - 3\wp_0 + \left(tg\alpha + tg\varphi\right)\lambda\right]\lambda \frac{BL^2}{2Q_S}, \quad (2)$$

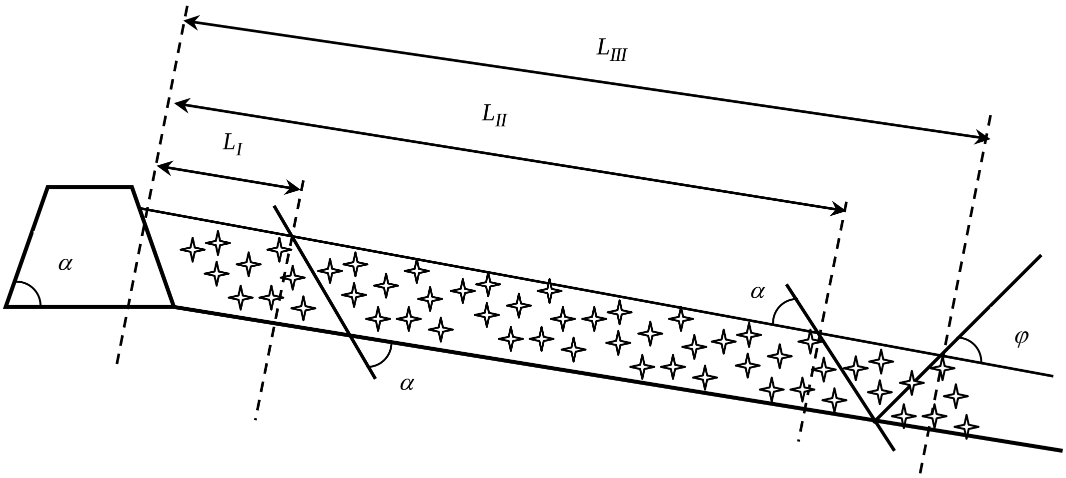


Figure 2 – Geometrical parameters of the man-made placers bedding

$$T_k = \frac{1-m}{1-C_V}\frac{W}{Q_0}, \tag{3}$$

$$\lambda = \frac{h_P}{L}, \tag{4}$$

$$\wp = \frac{L_{II}}{L}, \tag{5}$$

$$\wp_0 = \frac{L_I}{L}, \tag{6}$$

that makes it possible to rewrite the inequality (1) in the following way:

$$\frac{Q_S}{Q_0} \geq \frac{1-C_V}{1-m}\frac{\wp - 1{,}5\wp_0 + \lambda tg\alpha}{1+\lambda tg\alpha}, \tag{7}$$

and to propose the following formula for the estimation of the hydrotransport installations productivity that provide the disposal of the wastes into the current tier of the alluvium and also for the concentration of the output pulp

$$Q = \frac{P_0 L^2}{K_\Gamma M_W M_C T_C}\frac{1+\lambda tg\alpha}{1-C_V}\lambda, \tag{8}$$

$$C \geq \frac{(1-C_V)^2}{1-m}\frac{\wp - 1{,}5\wp_0 + \lambda tg\alpha}{\lambda(1+\lambda tg\alpha)^2}\frac{K_\Gamma M_W M_C T_C}{P_0 L^2}Q_0, \tag{9}$$

where Q – the hydrotransport installations productivity that provide the disposal of the enrichment process wastes into the current tier of the alluvium; Q_S – the volume flow rate of the man-made placer; B – the width of the map; m – the porosity of the wastes in the zone of dry tailings; C_V – the bulk concentration of a pulp that comes in the map; Q_0 – the volume flow rate of a pulp that comes in the map; L – the lengths of the line of the zone of dry tailings from the dam embankment till the obstructing dike dam; W – the filling peculiarity of the map, the solid particles volume that are put on the zone of dry tailings of the map when it is fully filled; h_P – the height of the tier of the alluvium; α – the angle of the slope of the dam embankment; φ – the angle of the inner friction of the placer particles with the given humidity; L_{II} – the distance from the inner slope of the dam embankment starting from which the enrichment process wastes are not considered to be man-made placer; L_I – the distance from the inner slope of the dam embankment starting from which the enrichment process wastes are considered to be man-made placer; T_C – the duration of the working shift; $K_Г$ – the coefficient of the hydrotransport installation readiness; M_W – the quantity of the working days in the year; M_C – the quantity of the working shifts in a day; P_0 – the scheduled lengths of the section of the alluvium; C – the bulk concentration of a pulp that was got from the man-made placer.

For this approach it is important to coordinate the work modes of the hydrotransport installations that give the wastes into the maps, of the extraction equipment and installations that provide the storing of the secondary wastes. The quantity of the sections of the alluvium corresponds to the quantity of the hydrotransport installations that perform the enrichment process wastes withdrawal. In this regard it is possible to reduce the quantity of the sections of the alluvium but the increasing of their quantity requires a capital expenditure for the pumping stations equipment. In this case it is possible to increase the pulp concentration so that a smaller quantity of stations can provide the determined traffic and to correct slightly the parameters of the maps. But if it is necessary to save the quantity of sections of the alluvium then it is need to save the quantity of maps that is corresponded to them and that is possible only while performing simultaneous processing steps.

After the analysis of possible options the process scheme with the simultaneous processing steps at the five maps is possible to represent as follows (table 2).

For implementing of such process scheme it is necessary to fulfill several conditions:

- the extraction processes should be carried out from the dike dam of the map without lowering of the extraction equipment to the beach or the extraction equipment that is used should not require the drying of the beach to get started;
- the distance from the inner slope of the dike dam from which the wastes are considered to be the anthropogenic alluvial deposits makes it possible to start dumping of the floodwall of a new tier without filling of the worked-out area by the secondary processing wastes.

Table 2 - The current process scheme of the maps of the section of the alluvium with the by-product extraction of the anthropogenic alluvial deposits and the simultaneous rocessing steps

The stage number	The sequence number of a map in the section of the alluvium				
	I	II	III	IV	V
1	alluvium	reserve	installation shrinkage	dike dam filling	drying extraction
2	drying extraction	alluvium	reserve	installation shrinkage	dike dam filling
3	dike dam filling	drying extraction	alluvium	reserve	installation shrinkage
4	installation shrinkage	dike dam filling	drying extraction	alluvium	reserve
5	reserve	installation shrinkage	dike dam filling	drying extraction	alluvium

An application of this technology at the third and higher tiers of the alluvium limits the capacity that was released for the storing of new particles. The length of the beach area near the dike dam where it is expected to make the extraction of the anthropogenic alluvial deposits is 20% of the length of the surface alluvium. In consideration of that the height of the dike dam does not exceed 3 m and the length of the beach may vary from 50 to 500 m the extraction from the workable section at the current tier of the alluvium can be carried out from several tiers that are situated below (Fig. 2). In this case the extracted anthropogenic alluvial deposit is sent for the recycling, its wastes are stored in the newly created area (Fig. 3). However in the case of the extraction from several tiers of the alluvium a part of the anthropogenic alluvial deposit remains in the body of the retaining prism under the floodwalls (Fig. 3) and to extract this part of the alluvial deposit is possible with the technology that provides the reduction of the capacities of the storage (Fig. 4).

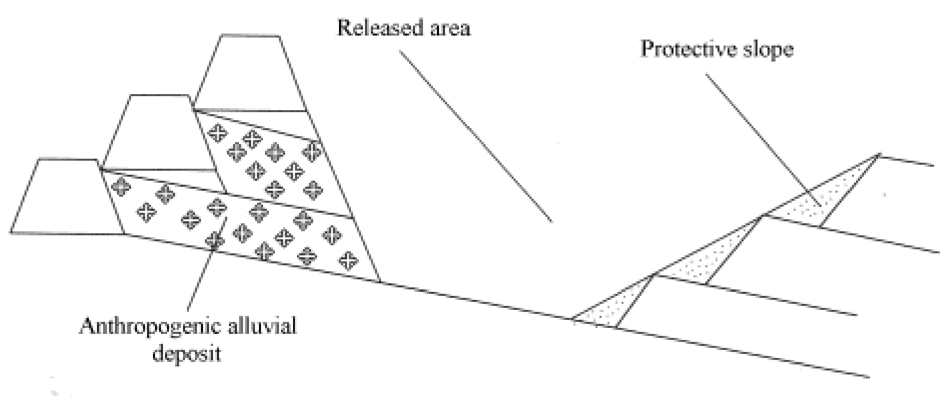


Figure 2 – The release of the additional capacity for the wastes storing through the development of the anthropogenic alluvial deposits at several tiers of the alluvium

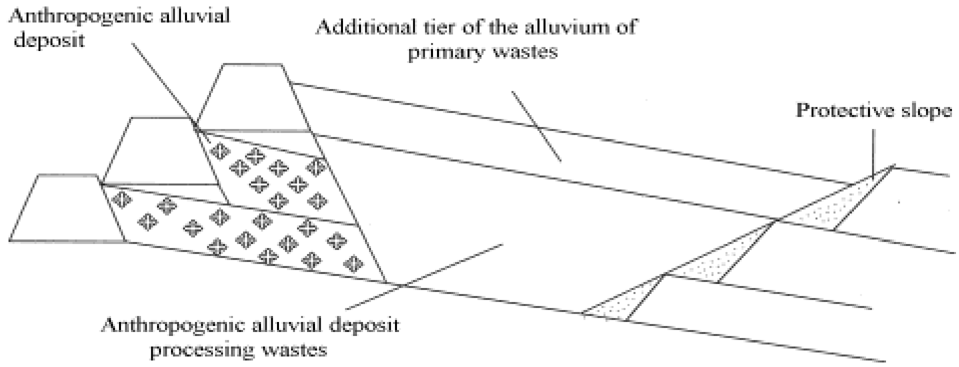


Figure 3 – The storing of the additional amount of the wastes after the development of the anthropogenic alluvial deposits at several tiers of the alluvium

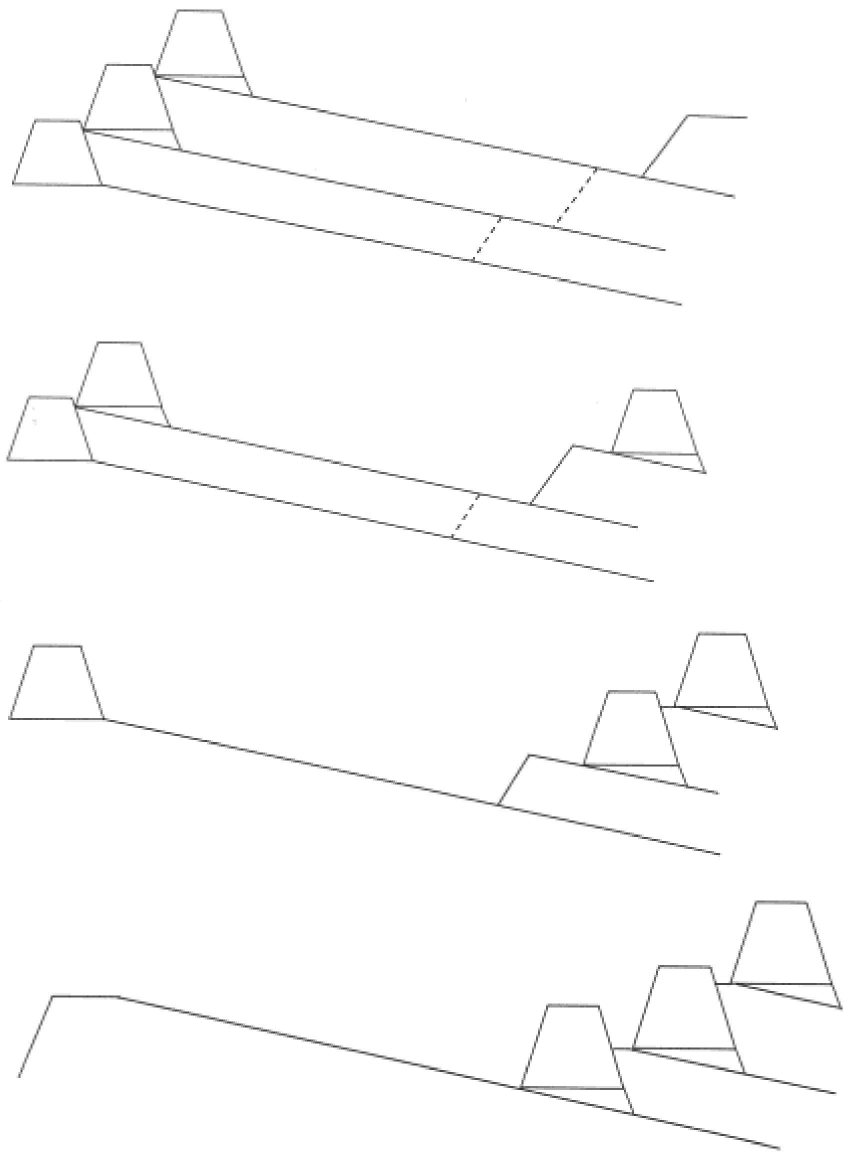
For the extraction from several tiers of the alluvium (Fig. 2, 3) the slope of the worked-out area that is far from the dike dam is strengthened by the dumping that protects the material of the beach from dusting and getting wet because it contains clay and pulverescent particles. The anthropogenic alluvial deposits processing wastes should not be mixed with the primary deposits of the enrichment process wastes because the first do not contain thin, clay and pulverescent particles and can be stored on the beach.

The remaining place allows to organize an additional tier of alluvium and to store the additional amount of the primary deposits wastes as a pulp with a low concentration or with the concentration of a paste (Fig. 3).

For the drainage of the material of the additional tier of the alluvium the protective dumping is broken by the drilling of a number of wells. However in the case of the extraction from several tiers of the alluvium a part of the anthropogenic alluvial deposit remains in the body of the retaining prism under the floodwalls (Fig. 3).

In this connection for wastes storages of this type that were taken out of service the technology of the anthropogenic alluvial deposits extraction can be used that assumes the reduction of the capacity of the wastes storages (Fig. 4).

In the case of the anthropogenic alluvial deposits extraction from the wastes storages that were taken out of service the extraction processes are started with the excavation of a part of the beach near the dike dam of the upper tier of the alluvium (fig. 4a). Then it is implemented the reexcavation of the floodwall to a new location (fig. 4.b). After that the corresponding processes are repeated in the subsequent tiers of the alluvium (fig. 4c, 4.d). Recycling wastes of the anthropogenic alluvial deposits are used for the dumping of the remaining beaches and the sections of the underwater alluvium to prevent dusting and their complete conservation. This makes it possible to refuse from the process water intake for the maintaining of the pond level, to protect beaches from dusting and then completely to dehydrate the core of the storage covering it from above by the wastes of the anthropogenic alluvial deposits processing after the extension of the floodwalls.



а)

б)

с)

д)

Figure 4 – The technology of the anthropogenic alluvial deposits extraction from the wastes storages that were taken out of service

In all cases the extracted anthropogenic alluvial deposits can be transported to the concentrating factory by the vehicles or the hydrotransport using as a carrier fluid the clarified or not completely clarified recycled water. Taking into account the geodesic level difference typical for the wastes storages conditions (table. 3) the hydrotransport of the anthropogenic alluvial deposits to the concentrating factory can be carried out by the gravity [3, 5, 9]. The extracted anthropogenic alluvial deposit can be added to the primary deposits at some point of the concentrating repartition or for its processing the section near the wastes storage can be equipped. In the second case the delivery costs for the anthropogenic alluvial deposit and the removal of wastes of its processing will be minimal.

Table 3 - The geodesic level difference of wastes storages of mining processing plants (MPPs) in Krivbass

The title of the wastes storage	The dike dam height, m
«Vojkovo» SMMP	from 50 till 74
«Objedenjonoje» SMMP and ArselorMetall	from 40 till 59
«Mirolubovskoje» ArselorMetall	55
wastes storage of the InMPP	112
wastes storage of the CMPP	10
wastes storage of the SevMPP	76

For choosing of the parameters of the mining in all considered technological solutions it is important to estimate the volume of the material in the tier of the alluvium and the volume of the man-made placer in the tier which in the case if the man-made placer development is carried out at the several tiers of the alluvium simultaneously are calculated with the following formulas:

$$W = BH^2\left(1-\frac{a}{H}\right)\frac{\sin(\alpha-\beta)}{\sin\alpha}\frac{\psi}{\mu}; \tag{10}$$

$$W_0 = BH^2\left(1-\frac{a}{H}\right)\frac{\sin(\alpha-\beta)}{\mu\sin\alpha}(1-\sigma); \tag{11}$$

$$\sigma = \left(1-\frac{a}{H}\right)\left(tg(\alpha-\beta)+tg\varphi\right)\frac{\sin(\alpha-\beta)}{2\mu\sin\alpha}; \tag{12}$$

$$\mu = \frac{L}{H}, \tag{13}$$

$$\psi = \sum_{k=1}^{N}(\eta_k-\sigma); \tag{14}$$

where W – the amount of the anthropogenic alluvial deposits in the tier of the alluvium; B – the length of the zone of the alluvium; H – the height of the floodwall; a – excess of the floodwall crown over the alluvial beaches; α – the declivity angle of the external slope of the floodwall to the horizon; β – the declivity angle of the alluvial beach to the horizon; σ – the dimensionless thickness of tier of the alluvium; η – the part of the beach length where there is the anthropogenic alluvial deposit; μ – the horizontal equivalent of the tier of the alluvium; W_0 – the capacity of the tier of the alluvium; φ – the angle of the natural slope of the particles of the anthropogenic alluvial deposit; L – the beach length; ψ – the coefficient that takes into account the anthropogenic alluvial deposit losses; k – the current number of the tier of the alluvium; N – the quantity of the tiers of the alluvium where there is the development of the anthropogenic alluvial deposit; η_k – the part of the beach length where there is the anthropogenic alluvial deposit at the k tier.

Taking into account that for the conditions of the wastes storages of the mining processing plants (MPPs) in Krivbass ratios $\varphi \approx \alpha$ и $2\alpha-\beta \approx 2\alpha$ are correct it is possible to calculate with a high level of the accuracy that

$$\sigma \approx \left(1 - \frac{a}{H}\right)\frac{\sin(\alpha - \beta)}{2\mu}. \qquad (15)$$

In this case instead of the formulas (11) and (15) the following relations can be used:

$$W = \frac{2(N\tilde{\eta} - \sigma)\sigma}{\sin\alpha} BH^2; \qquad (16)$$

$$W_0 = \frac{2(1 - \sigma)\sigma}{\sin\alpha} BH^2; \qquad (17)$$

$$\tilde{\eta} = \sum_{k=1}^{N} \frac{\eta_k}{N}. \qquad (18)$$

As a result of the studies the technical solutions concerning the anthropogenic alluvial deposit development in the mining processing plants (MPPs) of Krivbass were developed, they make it possible:

− to return to the concentrating repartition up to 20% of the concentrate that gets into the enrichment process wastes and deposits on the beach area near the floodwall after the map alluvium and the drainage of the zone near the dike dam;

− to refill the worked-out area with the enrichment process wastes that were thickened to a concentration of the pasta and to increase the capacity of the wastes storages;

− to use rationally the anthropogenic alluvial deposits processing wastes for the dumping of the beaches that left and areas of the underwater alluvium with the aim to prevent the dusting and their complete conservation during the anthropogenic alluvial deposits development in the wastes storages that were taken out of service;

− to abandon the process water intake for the maintaining of the pond level, to protect beaches from dusting and then completely to dehydrate the core of the storage covered it from above by the wastes of the anthropogenic alluvial deposits processing after the extension of the floodwalls.

For the first time it was proposed and grounded the technology of the valuable component by-product extraction from the beach areas near the dike dam based on the experimentally established fact that with the allocated alluvium because of the solid material fractionating the particles containing ferrous minerals deposit immediately after the outlet of the pipeline on the section that does not exceed 20 % of the length of the formed beach. The idea of the technology is in recess this part of the beach after the map drying until the formation of new tier of the floodwall.

The studies show that the implementation of the valuable component by-product extraction from the beach areas near the dike dam together with the technology of combined wastes storing makes it possible: to extract a part of the valuable component remaining in the enrichment process wastes at the stage of storages filling; to abandon the exploitation of the storage as anthropogenic deposit after storing finishing; to avoid significant capacities of the reexcavation of the floodwalls of the upper levels; to improve the environmental safety and the resource-saving of the existing technologies.

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Аннотация. В работе предложены технологии добычи полезных ископаемых из хранилищ отходов обогащения ГОКов Кривбасса, которые рассматриваются как перспективные техногенные месторождения. Рассмотрены два подхода к разработке таких месторождений, которые предполагают добычу техногенных россыпей как после закрытия хранилища отходов, так и в процессе его эксплуатации. Показано, что внедрение попутной добычи ценного компонента с придамбовых участков пляжа совместно с технологией комбинированного складирования отходов требует изменения технологической схема карт участка намыва, что рационально сделать, объединив выполнения нескольких операций. Обоснованы параметры технологии попутной добычи техногенных россыпей с использованием средств гидромеханизации. Установлена необходимая производительность гидротранспортных установок, обеспечивающих отведение отходов обогащения на текущий ярус намыва, а также концентрации отводимой пульпы.

Ключевые слова: техногенное месторождение, дамба обвалования, хранилище отходов, прудок, пляж.

Анотація. В роботі запропоновані технології видобутку корисних копалин з сховищ відходів збагачення ГЗКів Кривбасу, які розглядаються як перспективні техногенні родовища. Розглянуто два підходи до розробки таких родовищ, які припускають видобуток техногенних розсипів як після закриття сховища відходів, так і в процесі його експлуатації. Показано, що впровадження супутнього видобутку цінного компонента з придамбових ділянок пляжу спільно з технологією комбінованого складування відходів вимагає зміни технологічної схеми карт ділянки намиву, що раціонально зробити, об'єднавши виконання декількох операцій. Обґрунтовано параметри технології супутнього видобування техногенних розсипів з використанням засобів гідромеханізації. Встановлена необхідна продуктивність гідротранспортних установок, що забезпечують відведення відходів збагачення на поточний ярус намиву, а також концентрації пульпи, яка відводиться.

Ключові слова: техногенне родовище, дамба обвалування, сховище відходів, прудок, пляж.

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ПРОЦЕСИ РОЗЧИНЕННЯ І РЕГЕНЕРАЦІЇ МІНЕРАЛІВ В ПІСКОВИКАХ ВУГІЛЬНИХ РОДОВИЩ

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ПРОЦЕССЫ РАСТВОРЕНИЯ И РЕГЕНЕРАЦИИ МИНЕРАЛОВ В ПЕСЧАНИКАХ УГОЛЬНЫХ МЕСТОРОЖДЕНИЙ

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PROCESSES OF MINERAL DISSOLUTION AND REGENERATION IN THE SANDSTONES OF COAL DEPOSITS

Анотація. Розчинення і регенерація мінералів є неодмінними складовими літо- і катагенезу теригенних відкладів. Дослідження таких процесів у пісковиках вугільних родовищ засвідчує безперечний вплив цих явищ на фізичні, механічні, колекторські властивості не тільки пісковиків – у геохімічних перетвореннях беруть участь всі породи стратиграфічного розрізу. Пористість, фільтрація, щільність, газонасиченість, пластичні деформації та інші характеристики порід залежать від мінералів, їхньої поведінки зі зміною умов середовища. Серед пісковиків вугільних родовищ найпоширеніші мінерали – це кварц і карбонати. Вони полігенетичні - присутні в уламках, у складі цементу і досить стійкі (особливо кварц) щодо механічного руйнування. Але від дії хімічних реагентів карбонати розчиняються повністю, а кварц – частково. Зміна умов (катагенез) призводить до відновлення цих мінералів. Чинники цих процесів: температура, тиск, водневий потенціал і флюїди діють дискретно на швидкість реакцій, на структурні варіації мінералів, на зміну їхніх властивостей і породного масиву загалом.

За кількістю облямівок вторинного кварцу і появою кількох генерацій кальциту моделюються палеотектонічні рухи, які сприяли їх утворенню.

Ключові слова: пісковики, катагенез, розчинення, регенерація, кварц, карбонати

Вступ. Явища корозії уламкового матеріалу осадочних порід (кварцу, польових шпатів, карбонатів, літокласт та ін.) науковцям відомі давно і фіксувались на всіх стадіях їхнього формування – від діагенезу до метагенезу. У породах віком від протерозою до пліоцену і навіть серед четвертинних відкладів [1] спостерігались процеси розчинення та відновлення мінералів. Найпоширенішими мінералами у складі порід вугільних басейнів є кварц, польові шпати, карбонати, слюди. Наші дослідження зосереджені на поведінці кварцу та карбонатів у складі пісковиків як провідних мінералів, які впливають на газоємністні, фільтраційні та інші властивості порід. Вони реагують на зміну тиску, температури, геохімічні умови (рівень водневого потенціалу – pH). Процеси розчинення кварцу і карбонатів полістадійні і швидкість їх залежить від зазначених вище чинників. Варіації тиску призводять до структурних дефе-