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STORAGE OF THE INDUSTRIAL WASTE OF THE MINING AND SMELTING INDUSTRY OF KAZAKHSTAN, LANDFILLS ARRANGEMENT, EFFICIENCY AND OPERATIONAL FEATURES

Abstract. The possibility of organizing the production of bentonite mats as multifunctional watertight screens was thoroughly studied on the basis of the Taganskoye deposit in East Kazakhstan that is represented by three industrial horizons of alkaline, alkaline-earth and pharmaceutical bentonites, by their characteristics being one of the highest quality not only in Kazakhstan, but outside the country as well. Tagansky bentonite has a wide range of applications in various industries due to its unique chemical composition, including as a multifunctional material for the installation of watertight screens in the construction and rehabilitation of waste landfills of various origins. The article raises the question of the use in current practice of mandatory requirements for the arrangement of artificial protective screens during the construction of landfills, which should completely eliminate or minimize pollution of environmental components, the introduction of which could contribute to the development of local production of innovative materials based on Kazakhstan's bentonite deposits.

Key words: mining and smelting industry, natural resources, industrial waste, geomembrane, watertight screen, bentonite mats.

At present, the activity of enterprises of the mining and smelting industry poses a very perceived threat to both the ecosystem as a whole, and the environment of the regions of Kazakhstan. Progressive depletion of ores leads to an increase of the man-made mineral formations in the form of waste, tailing, and slag dumps, and sludge collectors. In this regard, the problems of their safe disposal and storage are of a great relevance for the regions with developed mining and smelting industries.

The richest natural resources of Kazakhstan define the mining industry as one of the main sectors, which constitutes a significant economic value of the country [1]. Kazakhstan is the third country in the world in terms of proven uranium resources localized in six uranium regions: Shu-Sarysu, Syrdarya, Northern Kazakhstan, the Caspian, and Balkhash. Kazatomprom State Holding Company is a leading uranium producer in the world. Kazakhstan plays a major role in the world market of copper, uranium, titanium, ferrous alloys and steel, is a monopolist in the Eurasian subcontinent for chromium. The competitive environment development has a significant influence on the regional market of iron, manganese, coal and aluminum [2].

Mining and processing of minerals is accompanied by the formation of industrial wastes, which include:

- waste and overburden dumps;
- tailing dumps - concentration waste repositories for mineral or coal-containing rocks;

– slag and ash dumps - wastes of pyrometallurgical processing and burning of coal.

The main sources of industrial waste in Kazakhstan are enterprises for:

– mining and concentration of mineral ores, coal;
– large chemical plants;
– metal manufacturers;
– coke and by-product plants;
– thermal coal power plants.

According to the Ministry of Ecology, Geology and Natural Resources, more than 43 billion tons of waste has been accumulated in Kazakhstan, about 600 million tons of which are toxic and this number is increasing by 700 million tons annually, including about 250 million tons of toxic waste [3]. The country has accumulated significant amounts of persistent organic pollutants, chromium and heavy metals such as lead, cadmium and zinc [4].

An average of about 1.500 tons of industrial and municipal waste per country's citizen exceeds the level of waste accumulation by European states. The largest volume weight of wastes are from the mining and concentration plants of Karaganda - 29.4%, East Kazakhstan - 25.7%, Kostanay - 17% and Pavlodar - 14.6% regions. The enterprises engaged in the mining of coal, ferrous metals, and rock phosphates located in Kostanay, Karaganda, Aktobe, East Kazakhstan, Pavlodar, Zhambyl, West Kazakhstan and Atyrau regions have accumulated significant waste dumps from mining and processing industries. According to the Land Balance, as of November 1, 2018, the Republic of Kazakhstan has 248.42 thousand hectares of disturbed lands, which house overburden and rock dumps, tailing and ash dumps, coal and mining quarries, oil fields and pits. The largest number of disturbed lands is in Karaganda, Kostanay, Mangistau, Akmola, East Kazakhstan, Aktobe, and Pavlodar regions. There are environmentally fragile impact areas in all industrial regions: spoil heaps, dumps, quarries of territories disturbed by mining [5].

For instance, the development of gold and rare metal deposits in the area of the North Kazakhstan region causes arsenic and heavy metal pollution of lands. Disposal, neutralization, burial, trans-border transportation of waste is one of the most urgent issues in the country. Up until this day, toxic waste is dumped and stored in various storage facilities, often without observing relevant environmental standards and requirements. Soil, groundwater, and surface waters of many regions are subject to intense contamination as a result of that.

Currently, industrial waste burial at enterprises occurs in accordance with the hazard class outside the industrial site of the entity and the territory of inhabited locality, with the exception of ash and slag dumps/ash dumps of operating power and heating plants, thermal power plants when it is impossible to place them outside the settlement and production site.

Industrial landfills are usually located in pools - gorges, basins, at a distance of several kilometers from the enterprise. Natural clay deposits with low filtering properties are used as the landfill foundation; landfills are fenced off by a dam, which is sluiced from the tails, and additionally strengthened. In the landfill map, the solid phase of the tailings gradually settles, sometimes with the help of specially added reagents — coagulants and flocculants [6].

Despite the requirements strengthening in the field of environmental protection associated with the escalation of land pollution with toxic substances, enterprises strive to cut the cost of arranging landfills, as this significantly affects their economic performance. At the same time, this sector enterprises are offered new technologies and materials that are able to mitigate harmful impact on the environment [7,8]. Basic safety requirements for industrial waste landfills are aimed at minimizing the destruction damage, filtration losses and dusting, as well as the landfills should not obstruct the natural drainage of surface water from the adjacent territory, the bottom and sides must have the necessary, reliable waterproofing layer.

Application of new technologies and modern materials provides the opportunity to optimize the storage of industrial waste, as well as to prevent the penetration of pollutants into the environment when disposing of high hazard class waste by creating multifunctional watertight screens. Modern technologies for isolating the bottom and slopes of containers for waste disposal must meet multifunctional requirements, such as: possess a certain filtration factor throughout the entire period of operation, have thermal and chemical resistance, mechanical strength and structural homogeneity.

However, still, the general traditional materials for their construction are natural clay formations (from loam soil to bentonite-like clays), which may be present in sufficient quantities during the deposit development. Such watertight screens have a number of significant weaknesses: the lack of instrumental methods for monitoring the screen tightness; high risk of screen cracking; weakening of insulating properties; labour consuming construction technology; hence their negative impact on the natural environment.

Recently, the use of geosynthetic membranes has become widespread for the aggressive contents isolation [9]. Polymer watertight screens have a number of unequivocal advantages, including ease of arrangement, relatively low price, and this is a more modern solution in comparison with the traditional construction of landfills for industrial waste, tailing dumps and sludge collectors (figure 1).

Figure 1 – The Use of Geosynthetic Screens in the Development of industrial waste storage

However, the use of geosynthetic membranes does not dismiss the arrangement of combined screens together with a clay cushion, which serves as an additional insulating foundation, increasing reliability and watertight properties, and as a result of the susceptibility of membranes to mechanical damage, their effectiveness significantly increases over the long term.

The best solution for isolating the storage pot technologically is the use of bentonite mats - innovative in properties, which are a combination of polymer geomembranes with a layer of bentonite, a natural mineral component. Bentonite mats are a multifunctional composite material in the form of a needle-punched bracing made of polypropylene fibers, which has inside powder or granules of sodium bentonite - one of the montmorillonite clay types of natural origin, with mat sizes 4-5 m wide and up to 40-50 m long (figure 2).

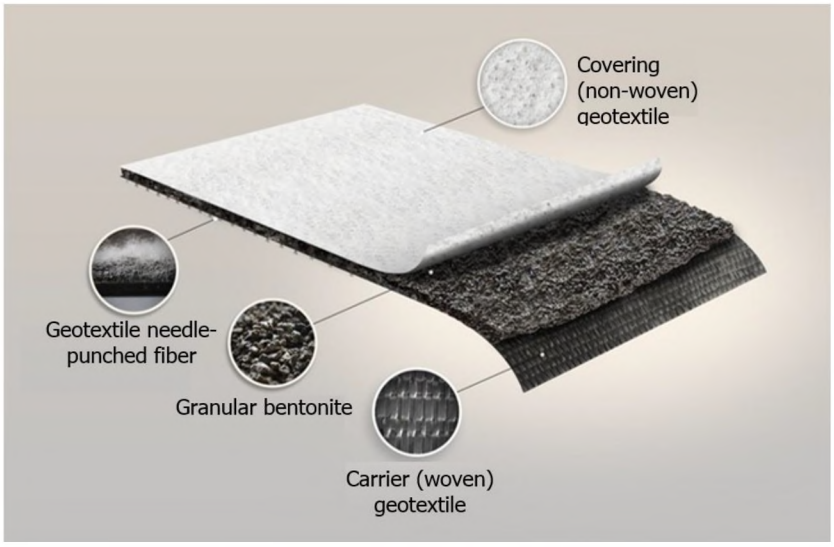

Figure 2 – Bentonite mat structure

The main advantages of liner materials based on sodium bentonite are:

Self-repair - clay closes the damage occurring during the watertight screen installation or operation due to the swelling property when interacting with water, thereby restoring its water-proof properties

High water-proof properties - the filtration rate of bentonite mats of 10^{-11}-10^{-12} m/s characterizes extremely low water permeability.

High strength, resistance to tearing and damage - bentonite mats are resistant to dynamic punctures, shear and soil settlement; they allow the movement of wheeled heavy equipment on them when bedding.

Low footprint - due to its high cation exchange capacity the bentonite clay exhibits sorption properties, absorbing heavy metal ions, halogens.

Cost effective and easy matting -

– does not require special preparation of the foundation;
– no need for welding seams;
– matting is not limited by weather conditions, mats remain flexible at temperatures up to -70 C°.

Durability - the operational period of bentonite mats is comparable with the service life of the structure.

With reference to the long-term functioning of landfills, the impact of which will affect future generations, the availability of already present technical solutions to minimize their adverse effects on the environment, there is a need to revise the design requirements for tailing dumps and process waste landfills.

In modern practice of the construction of landfills, the mandatory requirements for the arrangement of artificial protective screens must be introduced, which should eliminate or narrow down pollution of environmental components.

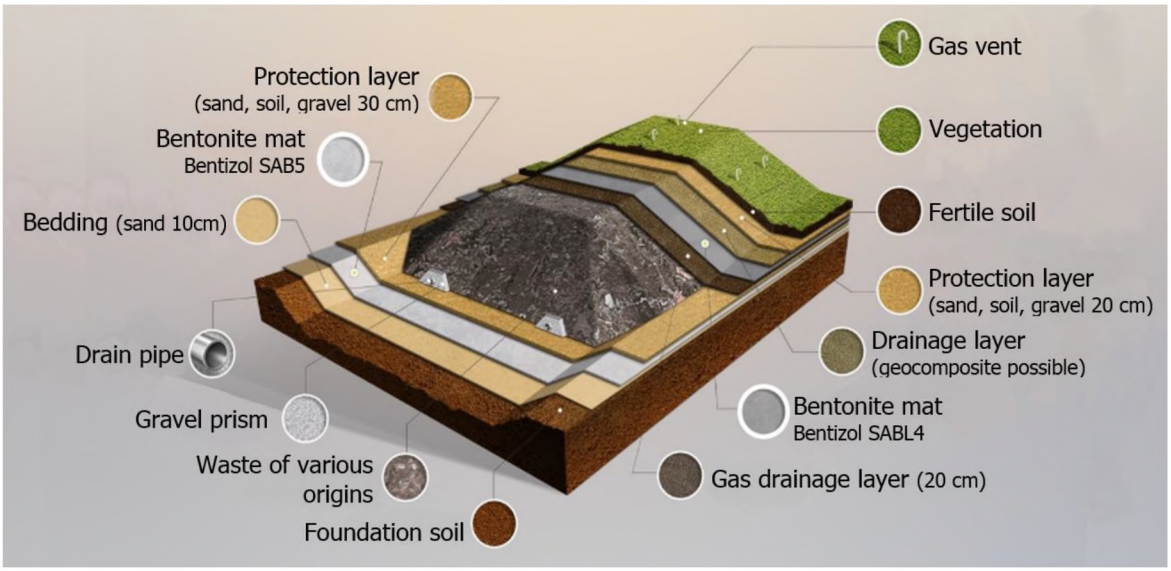

Figure 3 – BentIzol Bentonite Mats Application during Construction and Reclamation of the Landfill

The introduction of such requirements could contribute to the development of local innovative material production based on Kazakhstan's bentonite deposits. For instance, on the basis of the Taganskoye deposit in East Kazakhstan, which is represented by three industrial horizons of alkaline, alkaline-earth and pharmaceutical bentonites. They are one of the highest quality according to their characteristics, both in and out of Kazakhstan. Due to its unique chemical composition, Tagansky bentonite has a wide range of applications in various industries [10,11]. Bentonit Ltd. (Russian Federation) is one of the five world producers of bentonite products who owns the rights to develop the deposit through a subsidiary of Altaiskie Materialy LLP Bentonit Ltd. is considerably experienced in the bentonite mats production under the BentIzol brand, which is a new multifunctional material for the

installation of watertight screens in the construction and reclamation of landfills of various origins. The most effective compared to traditional and polymer materials (figure 3), the production of which can be established in Kazakhstan if there is an appropriate market niche.

Thus, bringing the norms for the arrangement of waterproof and watertight screens to world standards in the construction of industrial waste storage facilities will, on the one hand, solve the problems of their reliability and reduce environmental footprint over the long term, and on the other hand will also help to establish a new innovative production with the creation of the additional employment in Kazakhstan.

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ҚАЗАҚСТАННЫҢ ТАУ-КЕН МЕТАЛЛУРГИЯ САЛАСЫНДАҒЫ ӨНЕРКӘСІП ҚАЛДЫҚТАРЫН САҚТАУ, ПОЛИГОНДАРДЫ ЖАЙҒАСТЫРУ, ТИІМДІЛІГІ МЕН ПАЙДАЛАНУ ЕРЕКШЕЛІКТЕРІ

Аннотация. Қазіргі уақытта тау-кен және металлургия саласындағы кәсіпорындар қызметі тұтастай алғанда экожүйеге де, Қазақстан аймақтарының экологиясына да айтарлықтай қауіп төндіреді. Кеннің прогрессивті жұтаңдануының бос жыныс үйіндісі, қалдық қоймасы, қожды үйінділер және қоқыржинағыш түрінде техногендік құралым көлемін ұлғайтады әкеледі. Жерді улы заттармен ластау процесінің күшеюіне байланысты қоршаған ортаны қорғау саласындағы қатаң талаптарға қарамастан, кәсіпорындар полигондарды ұйымдастыруға жұмсалатын шығынды барынша арзандатуға тырысады, өйткені олардың экономикалық көрсеткіштеріне айтарлықтай әсер етеді. Осыған байланысты қалдық қоймасын, қожды үйінділер мен қоқыржинағыштарды қауіпсіз орналастыру және сақтау проблемалары тау-кен металлургия өнеркәсібі дамыған аймақтарда өте өзекті болып саналады.

Мақалада авторлар Қазақстанның тау-кен және металлургия салаларындағы кәсіпорындар шығаратын өнеркәсіптік қалдық көлеміне талдау жасады. Қазақстан Республикасының тау-кен кәсіпорындарының полигондарында қалдық орналастыруда қолданылатын дәстүрлі және заманауи геосинтетикалық сүзгіге қарсы экран артықшылығы мен кемшіліктері егжей-тегжейлі қарастырылып талданды. Сонымен қатар, авторлар Шығыс Қазақстандағы «Таған» кен орны негізінде, сипаттамаға сәйкес, Қазақстанда ғана емес, одан тыс жерлерде де жоғары сапалы болып келетін сілтілік, сілтілі жер және фармацевтикалық бентониттердің үш өнеркәсіптік горизонтымен ұсынылған көп функционалды сүзгіге қарсы экрандар ретінде бентонит төсеніштерін өндіруді ұйымдастыру мүмкіндігі жете зерделенді. Таған бентонитінің бірегей химиялық құрамына байланысты түрлі салада, соның ішінде шығу тегі әртүрлі полигонды қалпына келтіру және құрылыс кезінде сүзгіге қарсы экранға арналған көпфункциялы материал ретінде кең қолданылады.

Мақалада қазіргі тәжірибеде полигон құрылысы кезінде қоршаған орта компоненттерінің ластануын толығымен жоюға немесе азайтуға тиісті жасанды қорғаныс экрандарын орналастыруға қойылатын талаптар міндетті түрде қолданылуы туралы мәселе көтерілді.

Мұндай талаптарды енгізу Қазақстандағы бентонит кен орындары негізінде жергілікті өндірісте инновациялық материалдарды дамытуға ықпал ете алады.

Түйін сөздер: тау-кен және металлургия саласы, табиғат ресурстары, өндірістік қалдықтар, геомембрана, сүзгіге қарсы экран, бентонит төсеніші.

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ХРАНЕНИЕ ПРОМЫШЛЕННЫХ ОТХОДОВ ГОРНО-МЕТАЛЛУРГИЧЕСКОЙ ОТРАСЛИ КАЗАХСТАНА, УСТРОЙСТВО ПОЛИГОНОВ, ЭФФЕКТИВНОСТЬ И ОСОБЕННОСТИ ЭКСПЛУАТАЦИИ

Аннотация. В настоящее время деятельность предприятий горно-металлургической отрасли несет весьма ощутимую угрозу как для экосистемы в целом, так и для экологии регионов Казахстана. Прогрессирующее обеднение руд влечет увеличение объемов формирования техногенных образований в виде отвалов пустых пород, хвостохранилищ, шлаковых отвалов и шламонакопителей. Несмотря на ужесточение требований в области охраны окружающей среды, связанного с усилением процесса загрязнения земель токсичными веществами, предприятия стремятся к максимальному удешевлению обустройства полигонов, так как это существенно влияет на их экономические показатели. В этой связи, проблемы безопасного размещения и хранения хвостохранилищ, шлаковых отвалов и шламонакопителей являются весьма актуальными для регионов с развитой горнодобывающей и металлургической промышленностью.

В данной статье авторами проведен анализ объемов промышленных отходов предприятий горнодобывающей и металлургической отраслей Казахстана. Подробно рассмотрены и проанализированы ДОСТоинства и недостатки традиционных и современных геосинтетических противофильтрационных экранов, используемых при размещении отходов на полигонах предприятий горнодобывающей промышленности Республики Казахстан. Также авторами детально изучена возможность организации производства бентонитовых матов в качестве многофункциональных противофильтрационных экранов, на базе месторождения «Таганское» в Восточном Казахстане, которое представлено тремя промышленными горизонтами щелочных, щелочноземельных и фармацевтических бентонитов, по своим характеристикам являющихся одними из наиболее высококачественных не только в Казахстане, но и за его пределами. Благодаря уникальному химическому составу, Таганский бентонит имеет широкий спектр применения в самых разных отраслях промышленности в том числе и в качестве многофункционального материала для устройства противофильтрационных экранов при строительстве и рекультивации полигонов отходов различного происхождения.

В статье поднимается вопрос использования в современной практике сооружения полигонов, в обязательном порядке требований по обустройству искусственных защитных экранов, которые должны полностью исключать или сводить к минимуму загрязнение компонентов окружающей среды.

Внесение таких требований могло бы поспособствовать развитию локального производства инновационных материалов на базе бентонитовых месторождений Казахстана.

Ключевые слова: горнодобывающая и металлургическая отрасль, природные ресурсы, промышленные отходы, геомембрана, противофильтрационный экран, бентонитовые маты.

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