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ПУТИ СОКРАЩЕНИЯ ЗАСОЛЕНИЯ И ВОССТАНОВЛЕНИЯ ПОЧВ В РАЙОНАХ ПРОИЗВОДСТВЕННОЙ ДЕЯТЕЛЬНОСТИ ОАО «БЕЛАРУСЬКАЛИЙ»

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В статье представлен обзор и анализ известных технических решений по снижению засоления территорий, расположенных в географических регионах разработки месторождений калийных солей, в частности, в районах деятельности ОАО «Беларуськалий». Отрицательные последствия эксплуатации месторождений калийных солей проявляются в оседании земной поверхности над отработанными месторождениями и отчуждении площадей плодородных земель в местах складирования отходов калийного производства.

При воздействии атмосферных осадков на солеотвалы и шламохранилища образуются и накапливаются хлоридно-натриевые рассолы, что приводит к химическому загрязнению почв с тенденцией расширения площадей засоления. Кроме того, выбросы соляной пыли от обогатительных фабрик, оседая на почве, загрязняют верхний плодородный слой. В связи с этим особую актуальность приобретают предотвращение и минимизация засоления почв, а также рекультивация в районе производственной деятельности предприятия.

Проведенный анализ запатентованных разработок позволил выделить методы предотвращения засоления почв при формировании солеотвалов, позволяющих снизить негативное воздействие на окружающую среду. Показано, что особую актуальность представляет рекультивация засоленных земель. Рассмотрены методы уменьшения засоленности, показана эффективность применения биологической рекультивации засоленных земель с использованием растений-галофитов.

Проведенный анализ комплекса технических решений в направлении экологически безопасного освоения месторождений калийных солей показывает, что применение биологической рекультивации почв в районе деятельности калийного производства позволит вернуть в хозяйственный оборот почвы, а также снизить техногенное воздействие на окружающую среду.

Ключевые слова: отходы производства калийных удобрений, рекультивация, биологическая рекультивация, растения засоленных болот.

THE WAYS OF SOIL SALINIZATION REDUCTION AND SOIL RESTORATION IN THE AREAS OF JSC «BELARUSKALI» INDUSTRIAL ACTIVITY

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The article is a review of the prominent technical solutions regarding potash salt deposits mining. The article shows the efficiency of application of biological restoration of saline soil by using salt marsh plants.
Keywords. *waste of potash production, recultivation, biological recultivation, salt marsh plants.*

Introduction

The specificity of minerals deposits mining lies in their temporary character. Due to this, minerals mining are effectual to be carried out in the way that the new landscape, scarf, ettle and engineering installations being formed, are possible to be used efficiently for other economic purposes later on.

A number of negative environmental impacts of JSC ‘Belaruskali’ industrial activity have been detected during potash salt mining in Starobin deposits. The negative aftereffects are observed in depressing the upper layer of soil above the exhaust deposits as well as alienation of fertile soil in the potash wastes disposal sites [1, 2].

‘Belaruskali’ tail facilities are associated with dumping the salt tailings piles (terricones) from solid halite waste ore, as well as constructing and exploitating sludge storage tanks for dumping liquid clay-salt slurry. Totally, the two-thousand-hectare area has accumulated more than 650 million tones of wastes during the 50 years of the Starobin potash mines having been in operation. Salt tailings piles vary from 120 up to 150 meters. With the current methods of ore beneficiation being used, the amount of wastes and the area occupied by them will be increasing. At present, there are 13 sludge depositories with the total

area of more than 1,1 thousand hectares, located in the territory of the enterprise. About 104 million tones of halite clay-salt slurries have been dumped in the operating sludge depositories [3].

The main part

The latest and the most constructive approach to reducing the environmental problems in the region is the application of eco-management [4]. The main strategies of environmental management are the following:

- environmental situation management;
- reduction of the negative impact to the environment;
- prevention of the negative impact to the environment.

One of the efficient instruments for ecological management is the system of managing the environment (EMS), run by the enterprise. The EMS of the JSC 'Belaruskali' is developed in accordance with the requirements of ISO 14001:2004. EMS gives an opportunity for the identification of the most environmentally hostile impacts, actualise them, thus, enhancing environmental protection, which stimulates the enterprise for the pragmatic application of the most efficient and profitable technologies available in the appropriate and economically viable sites [5]. EMS is a constituent of the overall enterprise administrative system.

A high concentration of soluble salts in the water (up to 95 %) is a distinctive feature of halite and slurry wastes. Being affected by atmospheric precipitation, sodium chloride brines are formed and accumulated in the salt tailings piles and sludge depositories, which leads to chemical contamination of soil with a tendency of expanding the salinity area. The other reasons for soil salinization advancing are as follows: wind and water erosion, salt dust pollution from the conglomerate mills, which generally aggravate the overall picture of salinity. Settling on the ground, salt pollutants contaminate the upper fertile layer of the soils [1-3].

Due to this, the methods of preventing and minimizing soil salinization, as well as the ways of its restoration in the areas of the enterprise industrial activity are regarded as most relevant.

One of the most viable tendencies of preventing and minimizing salinization is the rational arrangement of salt tailings piles and sludge depositories considering zonation of mine fields of the operating and potentially productive mine groups. The possibility of reusing wastes sludge as the basis of extendable salt tailings piles, which allows to reduce both the sludge wastes areas and the costs of creating impervious screen at their base significantly, is identified [3, 6].

The technology of reclaiming wastes depositories, which makes it possible to reuse sludge wastes tanks for dumping sludge wastes, has been developed by the specialists of JSC 'Belminchemind' [1]. The most preferable in terms of using sludge wastes as a source of both useful product KCL and minerals is the manufacture of the fertilizers and ameliorants that have been tested in agriculture.

Management of land alienation problem as a result of its salinization is urgent because of the annual growing environmental footprint to the soils due to their natural specificity, favourable for this particular phenomenon occurrence. Based on this fact, the development of the methods of liquidation of potash wastes depositories as well as restoration of soils is the issue of the utmost priority. The technique of liquidation of salt tailings piles on potash mines, saturated with saliferous water across their beds, by underground injecting the saliferous water into the aquifer is suggested [5].

A great many of developments are aimed at enhancing the methods of underground storage of potash industry mines wastes of different kinds, such as solid halite, liquid clay-salt and other industries toxic wastes. The technology of sharing the underground halite and slime wastes storage so as to avoid further construction of sludge storage depositories, as well as reduce the area meant for 'Belaruskali' tail facilities is developed [7, 8]. Sharing wastes storage with 25 % of clay slime is stated not to significantly affect the variation ratio in overall mixture strength; vice versa it may exceed it, compared to pure halite content. The given work [9] suggests the technique of industrial liquid wastes underground storage involving injecting heterogeneous wastes into hydraulically isolated from each other portions of the soil layer.

Currently, the opportunity for applying the impervious screen made of polyethylene film to prevent contamination of subsoil water with KCl and NaCl brines, sludge storage depositories operated in potash production are being studied [10].

The dumping methods of improving potash production wastes and reducing the wastes storage area are under development.

The analysis of patented innovations allows to identify the methods of preventing soil salinization in

the formation of salt tailings piles [11], increasing the efficiency of damp proofing by gunniting its surface with clay-salt slime [12], increasing the efficiency of damping [13] by filling excavated zones of the rocks and concentric allocation of rock refuse into the damp with the orientation of small and middle fractions in the upper layer of the damp, letting to reduce the negative impact on the environment [14].

Soil salinization creates extremely unfavourable conditions for planting and, thus, does a lot of harm to agriculture, alienating large land areas (picture 1).

Picture 1 – Technology-related zone in the vicinity of salt damps (a)
and sludge storage tanks (b)

Reclamation (improvement) of disturbed mined soil simmers down to their desalination and creation of favourable conditions for water-salt balance for growing plants. Therefore, restoration of saline soil in the areas of JSC 'Belaruskali' industrial activity is of special relevance. The decrease in soil salinity and soil desalination can be achieved by means of various methods such as: mechanical removal of salt, salt plowback, superficial washing and biological restoration.

Biological restoration (grassing down disturbed mined soil) is one of the recommended methods to deal with the problem. Biological restoration is aimed at binding stabilization of the surface soil with the plant rooting system, creating dense grass stand and preventing erosion on disturbed mined soil and waste piles, and also resumption of soil self-purification and soil formation.

The most efficient method of biological restoration of salinity soil is planting salt marsh plants. The soil being high in salt, salt marsh plants, which are ecologically, physiologically and biochemically specialized plants, are capable of normal functioning and developing. Because of accumulating plenty of salt, salt marsh plants have a high osmotic pressure of the cell sap. When the rooting system of the salt marsh plants has a high moisture tension, exceeding the osmotic pressure of the soil solution, they are capable of absorbing salinity soil water [15, 16].

Orach salt-resistant *(Atriplex holocarpa),* Lucerne the blue salt-resistant (*Medicago holocarpa)*, Pribrezhnitsa the saline *(Aeluropus littoralis),* Common licorice (*Glycyrrhiza glabra*) (picture 2) and others are actual successful growing practices in moderate climate

Festuca grass (*Emberiza citronella),* Bluegrass meadow *(Poa praténsis),* Mock sypress (*Kochia scoparia*) (picture 3), are the most valuable soil desalinization plants in the Republic of Belarus, in our view, possessing a high biological productivity and indiscriminate to soil conditions. Besides, the plants mentioned above are perennial grasses valuable as field crops and medical herbs. Soil desalinization by using the given salt marsh plants lets remove harmful to crop plants salts from the soil (10-15 % per year) and increase the productivity of salinity soil to 20-25 %. The period of soil desalinization by using salt marsh plants is about 4-5 years for medium-salinity soil and about 6-7 years for high-level salinity soil.

a

b

c

d

a – Orach salt-resistant; b – Lucerne the blue salt-resistant;
c – Pribrezhnitsa the saline; d – Common licorice
Picture 2 – Salt-resistant plants

a

b

c

a – Festuca grass; b – Bluegrass meadow; c – Mock sypress;
Picture 3 – Salt marsh plants

Summing up

Thus, the analysis of advanced environmentally sound technology solutions to potash deposits development carried out shows that currently there is a viable option for mineral deposits development observing the required environmental measures aimed at reducing the inevitable man-induced impact and considering the possibility of further effective use of land. Biological soil restoration practice (along with other environmental management methods) in the areas of potash industry functioning will allow to revert

to the soil use, as well as reduce the environmental footprint.

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