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Analysis of Possibilities of Reclamation Waste Dumps after Coal Mining

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Abstract

In the Ostrava-Karvina coal district, approximately 281 dumps and 46 waste dumps are located. These are anthropogenic embankments of gangue formed at different times during the nearly 200-year tradition of coal mining in Czech parts in Upper Silesian Coal Basin. The aim of this publication is to analyse the possibility of reclaiming these waste dumps. Basic boundary condition of reclamation gangue material is composition and shape of the embankment. The publication defines the different possible shapes of gangue bodies and the possibility of their rehabilitation. Waste dumps are various shapes, it may be a conical waste dump, pile type shape, board shape, shape of the terrace, shape of slope, ridge shape, straight shape, or may take the form of flat coverings. Reclamation types are closely tied to land use planning. Waste dump bodies can remain in their original deposit with no or minimal intervention on its surface as needed. Another possibility represents the partial excavated waste dump to the body and then modification of its geometry according to the needs of the land use planning. Option, how reclaim territory include also the variant of full excavation of waste dump body and completely terrain reclamation.

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1. Introduction

Mining activity, which at the time of its operation represented a source of riches, left behind a series of devastated

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areas with many places becoming uninhabitable. In the past, during the existence of these industrial facilities, environmental pressure was not as high as it is today. In the Ostrava-Karvina coal district of coal, a waste dump is a very common foundation soil. Although the mining activity gradually stopped many years ago, these areas still represent the problem in the present. Ostrava agglomeration is a relatively densely populated environment. Number of built-up areas is constantly increasing and at the same time, pressure is increasing on reclamation of waste dumps. These places are often the sources of excessive dust, uncontrolled air raid trees and plants, creating unsightly landscape morphological features. They can also be a source of contamination of adjacent waters and soils. Possibilities of reclamation that can be implemented in the Ostrava-Karvina coal district are described in this publication.

2. The shapes of waste dumps

When selecting a suitable type of reclamation, existing geometry has to be taken into account. Body waste dumps vary significantly with their methods of formation. Several types can be distinguished, such as conical waste dump, piles type of shape, board shape, shape of the terrace, shape of slope, ridge shape, straight shape, or they may take the form of flat coverings. Each of these waste dumps has its own specifics and each must be analysed during reclamation with a different approach. Their shapes are due to the deposition technology, but also due to the surrounding topography on which the body was deposited. Waste dumps are also described in the publication [6].

Conical waste dumps constitute a dominant of the body in the landscape. Their height greatly outweighs the width of the body. In the Ostrava-Karvina coal district, it is the gangue Ema. If these bodies are formed in an otherwise flat terrain, they can be a distracting and an unaesthetic element. A suitable choice should result in the reduction of the original height. Waste dump shape is commonly similar to the conical shape. The difference is primarily in its base. The base is extensive across the board. Top of the waste dump is flatter and not so sharp. This is the type waste dump, which is a formed unfinished storage of body. As in the case of a conical waste dump, the incorporation of the body is very troublesome due to the surrounding relief. Remediation and reclamation possibilities are also presented in other publications [1].

Another type is a board shape. In this type, horizontal component dominates over the vertical. This shape in Ostrava-Karvina coal district is represented by the most common example, which is the gangue Jan Šverma. This is a very large flat shape. Compared to the previous types, waste dumps of a board shape form well integrated into its surroundings. Waste dumps of a terrace shape are very similar to the waste dumps of board shape. This includes the waste dump Zárubek. These waste dumps have very low thickness and, they are extensive in the bottom part. These waste dumps unlike previous forms were used efficiently even at its deposition. They were deposited near watercourses, in which filled parts in floodplains and serve as measures against floods or against erosion. In addition, they were also sprinkled into the subsidence areas to levelling. Terrace waste dumps can be created from any other dumps if they are created terraces on the slopes. In a significantly fragmented relief was formed waste dump the shape of slope. Along the natural slope so very simple to integrate and do not cause a disturbing element of his surroundings.

Another possible form, occurring in the Ostrava-Karvina coal district is shape of ridge. Ridge form dominates the shape of a long ridge with at different angles of slopes. The upper part of the body is flat and rounded. Storing of the body took place with the help of the cableway. Their surface has been adapted for easy relocation of gangue. It occurs mostly near rivers. An example of this type gangue is Eduard Urx in Petřkovice. Straight waste dump were placed into the concave landforms. Serve to flatten of the surrounding relief. Also, exist type's waste dumps called flat coverings. This type is very widespread across the board. Its height is compared to the size of in surface negligible.

Basic shapes waste dumps were created in the Ostrava-Karvina coal district many years ago. Gradually, according to local morphology, technology, filling and by the volume of dredge gangue developed these shapes. Individual shapes have changed over time and merged. Nowadays, a number of these waste dumps overgrown with vegetation. Original shapes of can therefore look in the current landscape is very difficult [6].

3. Reclamation possibilities of coal waste dumps

Removal of damage caused by mining activities is not a problem concerning only Ostrava-Karvina coal district. This is a worldwide problem. Attention to what individual states engaged in the removal of damages associated with economic situation of the country. It is a long process. In a series of legislative and legal measures is the obligation to rehabilitate damaged areas on the surface. It is a long process. It develops gradually changing technological process of mining and the development of new knowledge in the field of remediation and reclamation. Each country has its own specific climate, geology, soil and economic and social conditions in the mining sector. The objective is the same, it is the choice of such reclamation processes, which will enable quick connection of devastated areas into productive process and restore the natural landscape and healthy environment. The impacts of mining on the landscape are shown in numerous publications [4].

The basic task about land reclamation is the creation of surfaces in accordance with the concept of landscape and ecologically balanced environment. In the Czech Law no. 44/1988. (Mining Act), and Act no. 61/1988 of Coll. about mining activities, explosives and the State Mining Authority is the responsible organization to quantify the estimated cost of remediation of and reclamation plans of opening, preparation and extraction. This must include a proposal to create the necessary financial reserves and the proposed timing of their work. This is valid for existing mining companies. The major part of mining companies in the Czech Republic was stopped and privatized after the 1990 year. The result was devastated landscape, which was not before 1990 the extent of the interest. At present, these old environmental burdens in the Czech Republic are in the hand of the state, which is responsible for their removal. From 1993 until 1995, there was handled for the Ostrava-Karvina coal district General Plan called for reclamation. It included long-term studies to complete cessation of extractions individual mines, and have already established joint-stock companies. They are given a comprehensive strategy of reclamation. However, they have not yet endorsed and therefore it is only a non-binding document [2].

Reclamation can be divided into a group of technical measures and a group of biotechnical measures. A group of technical measures include ground shaping, landfills fertile soil, amelioration for the improving the properties of soils, drainage, construction of communication networks and many others. To a group of biotechnical measures, then we include a special agricultural reclamation special seeding practices, a set of interventions associated with caring for forest cultures, planting and maintenance of recreational areas.

The ultimate aim of reclamation activities is to create such a landscape, which will correspond to the interests of society. When selecting the reclamation is necessary to take into account not only the ecological conditions, but also socio-economic conditions and conditions territorial technical.

According to the method reclamation are distinguished agricultural reclamation, in which includes meadows, pastures, gardens, orchards, etc. Furthermore, forestry reclamation. This includes traditional crops, soil conservation, stabilization, recreation, etc. scattered greenery. Reclamation hydrogeological includes ponds, storage tanks, sports and recreational water, industrial water, are also suitable for hydroelectric use. Reclamation of recreational includes parks, swimming pools, garden colonies, or playground. There is also another group of devastated land use. May be a site suitable for industrial or residential use. They can be used as a building material in embankments, roads, railways and others. It can also be used as raw material for construction, industrial, melioration. Thus the affected of territory can also be used as a repository for municipal or industrial waste.

Possibilities of reclamation always depends on the type of environment. Given the conditions in the Ostrava-Karvina coal district, in which it is the reclamation of environment affected by underground mining may be considered for the following types of reclamation. Possibilities of land use planning in the mining landscape in a number of publications [3, 5].

3.1. Reclamations with minimal change

Removal waste dumps, which interfere aesthetically and ecologically of territory especially in urban agglomerations may not always be the aim of reclamation. Waste dump can be integrated into their surroundings and the dominant feature of this significant element can in turn be beneficial to their surroundings. Such is the case in Ostrava-Karvina coal district on waste dumps Ema. It is forming at the highest point of the city of Ostrava. Thanks to its location has been kept in its original store and extent reclamation is so minimal. The waste dump while it is due to local thermal activity in many places dangerous, but not considering its removal.

Thermal activity is undesirable from the point of view of safety of tourists, it is however subject of solution. The waste dump is partly overgrown with vegetation and thermal activity in areas without vegetation. They appear here only specific plant species typical of warmer areas. Surface temperatures are in fact higher the year-round than in their communities Reclamation intervention is still minimal. There are only a forest path leading to the top of the body waste dump. Due to the position near the zoo could be a path connected to the zoo. Reclamations would represent only minimal surface treatment, so that the surface is attractive and accessible for tourists.

Thus, usable surface area of coal's waste dump is unique. Especially if there also faced with thermal activity. The minimum intervention in the waste dump of the body brings substantially smaller investment than we would have spent on the removal of the body. A reclaimed waste dump, which remains in its original store, mostly associated with geometry of the body. If it is a Waste dump with featureless shape, can be considered their leaving in the original shape. The decisive factor is, of course, the land use planning.

Part of the waste dumps of coal, which remain in their original deposit, should be temperature monitoring. If remediation is not performed to exclude thermal activities, there is always a risk of thermal activity over time.

Another possibility is the applicability Waste dump of the body as foundation soil. This variant can be taken into consideration when it comes to height featureless of the body. It is necessary slope in terms of stability, but also in terms of the suitability of an access road during construction work. The height of the waste dump body is suitable for foundation of buildings, and set recommended values for different types of soils and rocks. You will of course vary considerably.

In soft and plastic soils of waste dumps, the height not exceed 10 meters. This is a category of very unstable soils. Clay and claystones are considered unstable, with a height ranging from 15 to 20 meters. It was considered relatively stable, drained sandy-clay soils with predominant proportion of sand or hard claystone, with a height of 20-30 meters. Stable soils are sandy, weak rock soil and rocks with a height of 30-50 meters [2]. These are commonly established in critical level. In the case of Ostrava-Karvina coal district is a gangue material composed of carbon of Upper Silesian Coal Basin. It is a rock of Petřkovice and Hrušov layers. They consist mainly of sandstone, claystone, siltstone and remnants of coal. The proportion of the individual components locally varies, as well as grain, and any other representation of foreign substances.

3.2. Reclamation of with partial intervention

In connection with the less suitable geometry of coal's waste dumps deals with a question of their excavation. These bodies can be excavating only partially. It all depends on the material composition of gangue and the concept of land use planning. Partial reduction of coal's waste dump enables significant adjustments of geometry. They can be aligned with surrounding morphology and thus forming a natural complex with the surrounding environment. Reducing of body of waste dump can be done for a wide range of purposes. In the city, it can be a valuable building land. Construction of residential units, shopping centres or production halls is affected areas reasonable solution. This consideration is essential in terms of ecology. Now there is occupation of topsoil soil for future development. The soil, which has high value in terms of farming, is so degraded. In contrast, the use of waste dump body is a suitable choice for any construction. Thus, the effect of territory is not from the perspective of agriculture no value. In most cases, only in the upper part covered by suitable soils for reclamation allow to grass over area.

Another option is to use the area for leisure activities. Especially in the urban agglomeration of are leisure areas the quality of life for residents is very important. Thus the use of space in recent years greatly expanding. This could be for bicycle paths, playgrounds, parks and more. Where would waste dumps body situated outside the built-up agglomeration surrounded only vegetation, realization park would be unsuitable solution.

3.3. Reclamations with complete extracting

Another possible solution how to approach the reclamation of the territory is complete removal of waste dump body. This option can be used when leaving the body. Waste dump or a partial excavation is not appropriate. Complete excavation is particularly suitable when body of waste dump contaminate their surroundings, and there is intense thermal activity.

Land use devoid waste dump body can be used as in the previous case to a variety of purposes. Depends on the place where the body was deposited and from basement rocks. However, if the on waste dumps totally excavating, we can consider the area as a completely normal foundation soil. The area can be used for development in the form of residential units, shopping centres, manufacturing plants and many others. Through the territory may lead local roads, highways, pedestrian trails and bicycle paths. Area can also be used to build recreational centres such as tennis hall, football pitches, cultural buildings and others. As in the case of the above types of reclamation of territory can be built parks, area simply grass over bringing in fertilizable soils.

4. The procedure of reclamation

The future reclamation is being considered at a time when there is only to creation of the plan for opening, preparation and extraction of deposits. We can therefore say that reclamation takes place already during mining works, where there should be a gangue deposition so that it can be conveniently rehabilitate in the future. Linked to this is the creation of financial reserves of the organization. In the case of removing coal waste dumps in the Ostrava-Karvina coal district, does a waste dump exist without the prior concepts of rehabilitation? Waste dumps exist in our environment for many years, and as already mentioned, it is the old environmental burdens, whose disposal is the responsibility of the state. We cannot affect in this case therefore the way they deposition for future reclamation, as it is mentioned in the decree Czech Mining Office no. 104/1988 of Coll.

4.1. Phase of biotechnical

The first stage could begin to solve is biotechnical reclamation. These works are picked at the end of mining operations. Biotechnical rehabilitation divided into a technical phase, in which we include terrain modification, landfills of reclaimable soil and more. The second phase is then a biological phase, in which includes work related to the recovery of geological and water environment, agro-technical work and more.

In general, the aim of this stage is efface consequences of extractive industries, which were reflected in the current landscape, the environment, improving the socio-economic space of human society. It is therefore generally about the formation of forest areas, gardens or ponds, or the creation of recreational areas and areas for other activities of man. Due to the nature geological environment and in the Ostrava-Karvina coal district are of course possibilities kinds of reclamation somewhat limited.

Technical reclamation is primarily intended to create conditions that will allow us to follow the implementation of biotechnical of reclamation phase. At the same time preparing territory for subsequent land use, according to the approved project under the land use planning. The technical phase of reclamation involves landscaping of habitats, suitable soil landfills, basic soil amelioration, hydromelioration modification and technical support, which includes the construction of roads.

When creating waste dumps often from a heterogeneous rock is frequently different settlement of the surface and creating additional changes of a micro-relief. Based on the geomechanical properties of the deposited soil and rocks and in various long term there are additional settlement masses. For landscaping habitats are used according to the scope of work the bulldozers, scrapers, excavators and transporting fuel trucks or other transport vehicles. The selected technology is based according to the volume soil that we carry and move them away.

For shorter shifts, fuel version is more economical for bulldozers, up to a distance of 100 m. If it is a greater distance, it is necessary to use wheeled vehicles. It is important to realize that it is necessary to ensure lasting stability of these of anthropogenic bodies that might follow a long-term involvement of the surrounding countryside [2].

Part of the landscaping is also bringing in appropriate soils. It is the soil with suitable qualitative characteristics of future soil substrate. These soils are deposited on the surface of the treated plots. If the rehabilitated land cover soil substrate, we talk about reclaiming indirect. These are areas for the future of agriculture, orchards and vineyards. If reclamation is not utilized for soil-forming substrates, it is a direct reclamation.

Another important part of the reclamation is hydromelioration. Adjusting the water regime is an essential part. Especially in the case of underground mining is affected groundwater. Soil substrates are not in contact with groundwater. To modify the properties of sorbents were used mostly marl and bentonite. These are plowed to a depth of about 60 cm. Described applications prevents erosion phenomena [2].

The aim of hydromelioration is influence the qualitative and quantitative characteristics of the groundwater and create the best properties for the use of surface water. The technical solution is always based on the concept of the drainage site. When selecting the designs, we should realize that we are creating artificial natural environment to the best possible incorporation into the surrounding natural environment. Therefore, we should use materials, which are in the nature of the original.

Another integral part of technical aspects of reclamation. This includes the construction of road networks respectively connections to other areas of reclaimed road or forest roads. Thus, there belongs building paved roads. It represents a gravel drainage course, geotextiles to increase the bearing capacity and mortar upper layer of, or layer of porcellanite. The inclination of roads must be safe for sledding trucks. Furthermore fencing to protect against wildlife or fencing orchards, vineyards, etc. We are also constructed buildings for workers, including implementing reclamation, warehouse tools. These are temporary objects. Alternatively, is a permanent objects that are use consistently according to plan.

After completion of the technical phase of reclamation, biotech is realized organic phase. It is divided into agricultural and forestry reclamation. Reclamations Agriculture includes cropland, pastures, orchards and more. Forestry reclamation includes planting of forestry for example. It also includes reclamation hydric; it is a revival of running or standing water. Another category consists of other reclamation. This includes called managed succession serving, for example, land use as recreational areas, golf courses, hippodrome, and city parks, construction sites, etc. For example, use old subsidence areas to the creation of water reservoirs called as a water reclamation.

In the Ostrava-Karvina coal district are used primarily reclamation forestry and in second place other reclamation.

4.2. Forestry reclamation

In the case of forestry, reclamation applies number of principles. In the Czech Republic are devastated districts of different conditions. That is why the suitability of different crops planted. These forests created in the territories devastated by mining activities belong under the Forest Act in the category of protective forests. These are called special purpose forests. These forests fulfil a number of functions. They have a social function in the case of recreational and urban forests. They set in the territory of climate and water conditions in the reclaimed landscape, helping soil processes, reduce soil erosion. It is advisable to establish the surrounding natural vegetation using natural air raids.

Forestry reclamation depends on the properties of soil territory, selection of quality seedlings, selection of species composition of soils for various types of reclaimed bodies, planting technique, planar arrangement vegetation and for the treatment, protection of forest crops against animals and others. Of deciduous trees are used for example sycamore maple oak or linden. From the auxiliary trees are used alder, rowan, birch, willow and others. For shrubs can be planted honeysuckle, privet, elderberry and more [2].

4.3. Other reclamation

The second most common type of the above types in the Ostrava-Karvina coal district is other type. In this case, the territory used to development of recreational areas for development and many others. An example is the waste dumps Jeremenko, where now stands the department store Hornbach. As already mentioned, it is necessary to deal with the problems of compactness, differential settlement, thermal activity, and many other physical-mechanical properties. In this group, we can also include the reclamation territory used as a waste repository.

5. Conclusion

Given the extent of territory affected by underground mining of hard coal in the Ostrava-Karvina coal district, it is necessary to effective incorporation appropriate choice of reclamation. Ostrava-Karvina coal district is an area of relatively dense settlement. Given the position of the reclaimed areas and possibilities reclamation in connection with the material composition of dumps, there is most often applied to forestry reclamation and reclamation from other categories. This category consists mainly of land use for recreational purposes, sports and multi-purpose areas, or areas.

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