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ANALYSIS OF METHODS FOR BACKFILLING MINING DURING UNDERGROUND EXCAVATION OF POTASH ORES

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Annotation. *The paper presents the problems of developing potash ores during underground mining and characterizes the method of hydraulic backfilling in potash deposits. The filling of mined-out space allows for solving the problems of maintaining the earth's surface, preserving farmland taken for waste storage, and preventing the salinization of fresh ground and surface waters with excess brines.*
Keywords: *Tyubegatan potash deposit, rock salt, salt dump, salt waste, Dehkanabad potash fertilizer plant, anti-filtration protection, tailings storage, negative impact on the environment and groundwater.*

Backfilling of mined-out space is a set of technological and technical processes for filling the mined-out space with backfill materials during underground mining [1-22]. The backfill is used to take the load from rock pressure to prevent collapse, control rock pressure, excavate preserved security pillars, reduce losses of minerals, prevent sudden gas emissions and underground fires, retain rock from mining operations, reduce rock mass deformations, increase the safety of mining operations, etc.
Backfill is mainly used to fulfil one or several of the following tasks:
Reduction of surface subsidence
Prevention of sinkholes
Prevention of rock bursts or induced seismicity
Support of mined-out area
Prevention of pressure on working face
Secondary excavation of minerals (pillar removal)
Preservation of natural barrier systems
Reduction of groundwater flow into the excavations
Prevention of subsequent illegal access to abandoned mines
Extension of the lifetime of a mine
Reduction of thermal impact and gas release

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The filling of the mined-out space, depending on the completeness of its filling, can be complete or partial, and according to the method of forming the filling material and its transportation - hydraulic, pneumatic, hardening, dry rock, gravity, mechanical and combined.

The hardening backfill is a mixture of inert (sand, screenings, crushed rock) materials with binders (cement, lime, slag, ash) and water. It is prepared on the earth's surface at backfill complexes, where materials are dispensed and mixed into a backfill mixture, which is supplied to the mined-out space through backfill pipes. The water used in the hardening fill is spent on the chemical process of cement hydration (the formation of cement stone that binds particles of bulk inert material into a solid body). Hardening of the fill occurs most intensively in the first days after its placement in the mined-out space and continues for three months. At this time, the strength of the backfill mass increases. The required backfill strength is achieved by selecting the cement consumption per 1 m^3 of the backfill mixture. Filling the goaf with hardening mixtures is a rather expensive process. Therefore, it is used to extract rich and valuable ores to ensure maximum extraction from the subsoil.

Hydraulic filling is an aqueous mixture of inert materials. Water is necessary to ensure mobility (fluidity) of the pulp so that it can be transported through pipelines. After filling the mined-out space with a hydraulic filling, water is drained through an insulating bridge. The hydraulic fill becomes a loose (unbound) artificial mass after the water is drained.

Dry backfill is crushed rock placed into a mined-out space using self-propelled mining machines or pneumatic transport. Rocks from the excavation of left-hand workings or dump rocks transferred from the surface into the mine are used.

When using any type of backfill, a reduction in mining capacity to effective capacity is achieved.

There is a known method of hydraulic backfilling in potash deposits [14]. The hydraulic filling is an aqueous mixture of inert materials to ensure mobility of the pulp and its further transportation through pipelines. After filling the mined-out space of the massif, the used water is drained through an insulating bridge. The hydraulic filling becomes a loose artificial mass only after the water is drained.

Fig. 1. Waste from flotation processing plant.

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In the world, hydraulic backfilling in the development of potash deposits is mainly used in Germany (Hannover and Strasfurt basins), and Spain (Catalan deposit, Navarre) and only 5% of potash ore is mined using a chamber system with hydraulic backfilling [8-12, 14, 18]. In Russia, hydraulic backfilling in the development of potash deposits is used at the Verkhnekamsk potash mine.

When hydraulic backfilling, waste from chemical and concentration factories is used as backfilling material (Fig. 1), which is inevitably obtained after the beneficiation of mined ore. This waste consists of potassium and magnesium sulfate, sodium, potassium and magnesium chloride, as well as insoluble clay particles.

The technological diagram of the hydraulic backfill of potassium ore deposits is shown in Fig. 2.

Waste from the flotation concentrator is fed into special mixing bins, which are located near the mine shafts. Pipelines are laid underground from mixing tanks on the surface to the chambers being laid (Fig. 3). Waste in mixing bins is washed away and hydro-transported using circulating saturated brines, which are then filtered from the stored chambers and collected in intermediate, local and general mine brine collectors. After clarification, the brines are pumped into settling tanks on the surface. The supply of waste from flotation processing plants to mixing tanks is carried out by conveyor belts, overhead roads or pipelines.

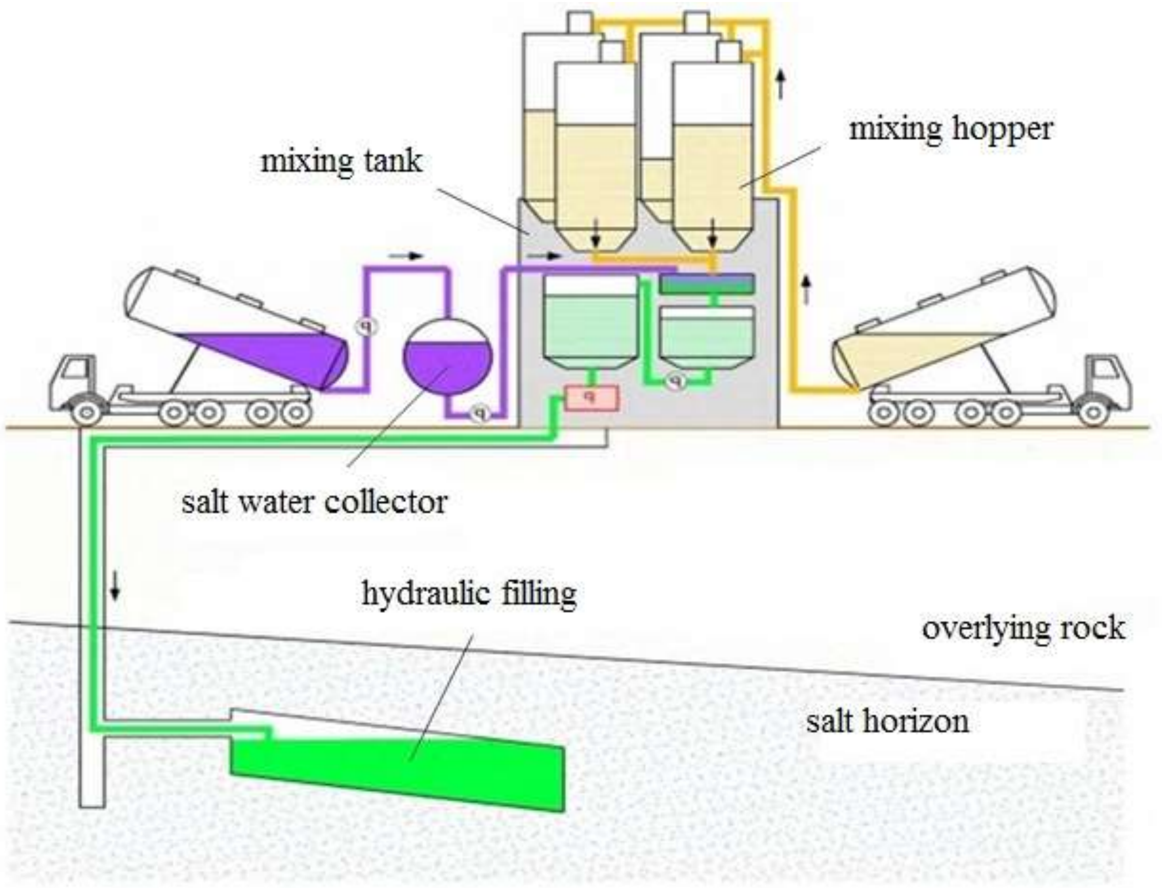

Fig 2. Technological diagram of hydraulic backfilling of potassium ore deposits

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Fig. 3. The process of hydraulic laying in laying chambers

The advantage of hydraulic backfilling is the stability of the work performed, regardless of the mode of supply of salt waste. The main disadvantages are increased brine consumption, labour-intensive maintenance and the need for visual monitoring.

The convergence of the roof and ground of the goaf before the filling of the goaf at ore deposits is usually a few centimetres, so they are neglected in the calculations.

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The amount of underfill depends on the type of backfill the exit of its placement into the mined-out space, and the angle of inclination of the stairs. In attacking deposits, any type of backfill is placed under its weight into the spacer between the high and lying sides of the mined-out space.
On flat deposits, it is impossible to ensure complete filling of the mined-out space under the roof even when using hardening and hydraulic gravity filling with small (6-70) spreading angles over the square. This is due to both the unevenness of the blood and the shrinkage of the filling mixture during the process of hardening or drainage of water. During the hardening process, the fill shrinks by approximately 5%. Therefore, even when the mined-out space is filled with hardening roofing backfill after it hardens, a void (underfill) is formed under the roof. To eliminate voids, additional filling of the goaf is used through wells drilled at the highest point above the void.
Thus, filling the mined-out space with backfill allows either to avoid the formation of a failure or to reduce the deformation of the earth’s surface. In both cases, the likelihood of preserving undermined objects in working condition increases or the costs of their post-sediment repairs decrease. In some cases, a bookmark allows you to refuse to transfer the objects being worked on. These factors allow us to consider the backfilling of mined-out space as an effective, but very expensive mining measure for the protection of mined-out objects and structures.
Maintaining the overlying strata with collapsing ore pillars in conjunction with the backfilling of mined-out space is a combined mining measure for the protection of mined objects on the earth's surface, the essence of which is as follows.

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