Ways to improve stability of transportless unsteady-base dumps in terms of Mokhovsky open pit, Kuzbassrazrezugol Holding Co.

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Abstract. Under consideration are issues of overburden stockpiling in mining with direct dumping. The dependence of resistance of the deposit rock in a breakage area versus a shear generated by disturbance of its monolithic status at the contact with rock refuse is established. Technological schemes of coal seam mining by a hydraulic excavator and overburden removal by draglines at Mokhovsky coal open mine, Kuzbassrazrezugol Holding Company, are proposed in the present paper.

1. Introduction
In Russia the direct dumping process is proved to be of actual value to remove overburden at coal open mines: Taldinsky, Krasnogorsky, Sibigrinsky, Chernigovsky mines in Kuznetsky Coal Basin, Mugunsky in the Irkutsk Region, Irbeisky, Nazarovsky in the Kranoyarsk Krai and so on. The mining processes with overburden rehandling to internal dumps are employed in development of horizontal and flat mineral deposits. They are also efficient to mine coal-seam outcrops in development of inclined and steep deposits with filling of a worked out space with overburden. At open-pit coal mines the search for ways to expand application area of mining with direct dumping is an actual problem [1–3]. The aim of the present paper is to master the coal seam mining process and to improve the internal dump stability in terms of Mokhovsky coal pit, Kuzbassrazrezugol Co.

2. Features of the mining system
Parent rocks of coal bearing seams at Sartakinsky production area, Mokhovsky coal pit, involve fine- and very fine-grained sandstones of variable hardness, aleurolites and scarcely argillites. Sandstone used to be hard, dense of 4–6 hardness ratio in Protod’yakov’s scale.

Varieties of course- and medium-size aleurolite are clay sandstones with physical-mechanical properties close to those of sandstones of 3–6 hardness ratio in Protod’yakov’s scale. Fine and very fine aleurolites are close to argillites, stability is medium or weak at hardness ratio of 4–6. Argillites occur in a scarce amount and present homogeneous, viscous, hardly bound rocks, known for weak stability, prone to swelling, its hardness ratio is 3–4.

Stockpiling of internal direct dumps on the above rocks serving a weak base for overburden material deposition aggravates their stability.

The mining and geological conditions at Sartakinsky production area are complicated by the following factors:
— the floor of seam 6 is weak and represented with intensively jointed aleurolites and argillite beds;
— underlying jointed sandstones in the floor of seam 6 are confined to below-occurring feeding water-bearing horizon.

The height of parent rock bench is 25 m, width of a pass is 35 m, width of broken rock disintegration depends on a height of a bench to be blasted and amounts to 30–85 m, the maximum total height of a dump can reach 50–53 m. Thereupon, the re-excavation factor varies within 0.25–1.0, average discharge factor is 0.16.

At the production area the preliminary loosening was followed with removal of parent overburden rock by ESh-11/70 dragline with bucket capacity of 10 m³; excavated overburden was discharged to fill a worked out space at the bottom floor of the lower coal seam 6; bedding angles of the seam vary from 7 to 13°, thickness along layer intersection is 5–6 m [2].

The extraction of the seam by longitudinal passes at the production area inevitably resulted in glides of internal dumps stockpiled on its floor. Moreover, a length of Severny production block in the mining zone did not exceed 400–500 m, but at the neighboring worked out section an internal dump was founded by using the transport mining system in the close vicinity to the production block. The constrained space made it difficult for transport devices to operate under the floor conditions in the production zone of coal seam 6 with increasing mining depth. 11 million cubic meters of overburden were re-excavated and removed from available stockpiles at the neighboring section in order to build an entry trench; thus, the industrial waste-to-ore ratio increased up to about 9 m³/t, though its critical value being 8 m³/t. Considering all the above factors served the grounds to cancel temporarily the coal seam mining in Sartakinsky block. The mining operations in future depended on solution of the following problems: to develop the process enabling to develop coal seam 6 without transport driving in the production zone along the floor and to improve the stability of a dump, founded on a weak base.

According to the analysis of mining operations the production zone of coal seam 6 becomes accessible for transport only through available rock piles. The mining scheme is shown in Figure 1.

To improve stability of dumps it was decided to arrange mining front at angle 25° to the coal seam strike. At such a pass the 7–13° incline angle to horizon in cross-section normal to direction of a full-fledged pass tends to flatten down to 3–8°. In fact, such extraction of a coal stream is equivalent to mining by discrete short blocks with stowing of worked-out space with overburden material.

In every pass the extraction of coal seam 6 starts with entry to the roof from an available dump of neighboring section where the transport mining system is practiced (height mark is +191 m). In extraction by diagonal passes the production seam is “cut” by two excavator passes into two triangle prisms (Figure 1a), the tip of the first prism is in the beginning of every pass at the point of entry at roof of the coal seam; the tip of the lower prism locates in the end of a pass nearby northern end of the production block [4–6].

After final coal is extracted in the pass nearby the eastern wall on the floor of the coal seam; a waste rock layer is piled, thickness of this layer is equal to thickness of seam 6 (up to mark +191 m) in order to provide an entry way to the roof of the seam in the follow-on pass and so on. Width of this pile is equal to width of a bench (35 m).

In view of the fact that the floor of coal seam 6 in the zone of direct dumping system is represented with jointed aleurolites with interlayers of frayed material, it is necessary to employ engineering preparation of the base designed for stockpiling of waste material at the attempt to eliminate the factors which are capable to induce an unstable state and to break stable parameters of dumps in the period of the coal pit exploitation. The engineering preparation implies that after coal seam extraction is finished, it is required to manufacture a loosened layer zone of triangle shape in cross-section of average depth up to 6 m in view to provide a greater stability of a would-be waste dump (Figure 1b) [7].

Loosening of rocks in the floor of the seam is performed by blasthole charges. Blastholes are drilled with drill rigs, capable to operate on an inclined base. It is possible to make a leveled site by using a ripper-dozer (Figure 2).
Figure 1. The process scheme to mine Severny production block: (a) coal seam 6; (b) overburden overlying seam 6 by ESh-11/70 dragline.
The small level of blasting in the course of loosening zone production exerts an insufficient effect on stability of available waste dumps. As it is stated above, an incline of excavator pass in the full-scale front of mining operations amounts up to 8° and is directed towards a neighboring mining area; so the above loosened sites work as a drainage in the dump base, they provide water run-off and improve long-lasting stability of a dump [7–8].

3. Conclusions
It is established that engineering preparation of the base of a would-be waste dump provides 15–20% increase in resistance to shear in floor rocks at a loosened site thanks to breakage of its consolidation at contact with waste rocks, thereto the acting stress is lowered twofold approximately due to redistribution of stresses, the stability factor of the lower dump level grows from 1.3 up to 1.9, while the stability factor of the dump as a whole increases by 30%. To conclude, the opportunity appears to expand the application scope of mining with direct dumping.

The new-proposed technological scheme to mine a coal seam by a hydraulic excavator guarantees the wanted specifications dealing with disposition and operation of the mining and transport machinery.

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