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SELECTION OF TRANSPORT SYSTEM FOR TRANSPORT OF ASH AND SLAG FROM THE TPP UGLJEVIK AT THE OP BOGUTOVO SELO UGLJEVIK***

Abstract

At the open pit "Bogutovo Selo" – Ugljevik, the coal mining is performed with a capacity of 1,750,000 tons annually of out-of-mine brown coal for the needs of the Thermal Power Plant "Ugljevik". Ash and slag are generated as product in operation of the power plant in the amounts of of 420,000 m^3 i 80,000 m^3, respectively. These amounts have to be disposed in the area of the open pit "Bogutovo Selo". This paper presents a selection of transport system for ash and slag for the next period.

Keywords: *Open Pit "Bogutovo Selo" – Ugljevik, ash and slag, transport system*

INTRODUCTION

The Mine and Thermal Power Plant Ugljevik ad Ugljevik is a subsidiary that operates within the Mixed Holding "Electric Power Industry of the Republic Srpska". The prevailing activity of the company is the production of thermoelectric energy and coal mining and selling. Mining of brown coal in this coal basin has been carried out since 1899, and until 2006 was excavated about 35 million tons of coal. By 1985, the coal production was intended for mass consumption, and since 1985, mostly to the needs of TPP Ugljevik 300 MW and about 3% for broad consumption. Geological coal reserves in this basin are 429.9 million tons.

Coal mining is carried out at the open pit "Bogutovo Selo". Mining at this open pit is carried out since 1978. Projected annual production of the open pit "Bogutovo Selo" is 1 750 000 tons of run-of-mine brown coal.

For continuous operation of the thermal power plant in the next 23 years, the location for disposal are selected, i.e. for dumping of ash and slag in the area of the open pit "Bogutovo Selo" [1]:

- Large west landfill of the North Mining District
- Interior landfill of the South Mining District.

It is also necessary to select the most economical method of transport and disposal - mass depositing by the amounts of ash and slag based on the operation of thermal power plant. These amount are 420 000 m^3/year for ash and 80 000 m^3/year of slag. For the next period of 23 years, the total amount that needs to be disposed are 9 m^3 of slag and 660 000 and 1 840 000 m^3 of ash [1]. In selecting the types of transport, three variants

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were analyzed with defined technological schemes of preparation, transport and disposal according to the required capacities:

- Transport with belt conveyors
- Hydraulic transport
- Truck transport.

TRANSPORT WITH BELT CONVEYORS

This transport system consists of three vibro feeders and belt feeders for ash and one vibro feeder and belt feeder for slag in the thermal power plant. Because of the mutual position of locations planned for disposal at the open pit regarding to the thermal power plant, as well as the terrain configuration, four stationary belt conveyors are provided. On the site of disposal, one disposal belt conveyor and belt conveyor are provided on arrow of conveyor. Technological scheme of preparation, transport and disposal of conveyor belts is shown in Figure 1.

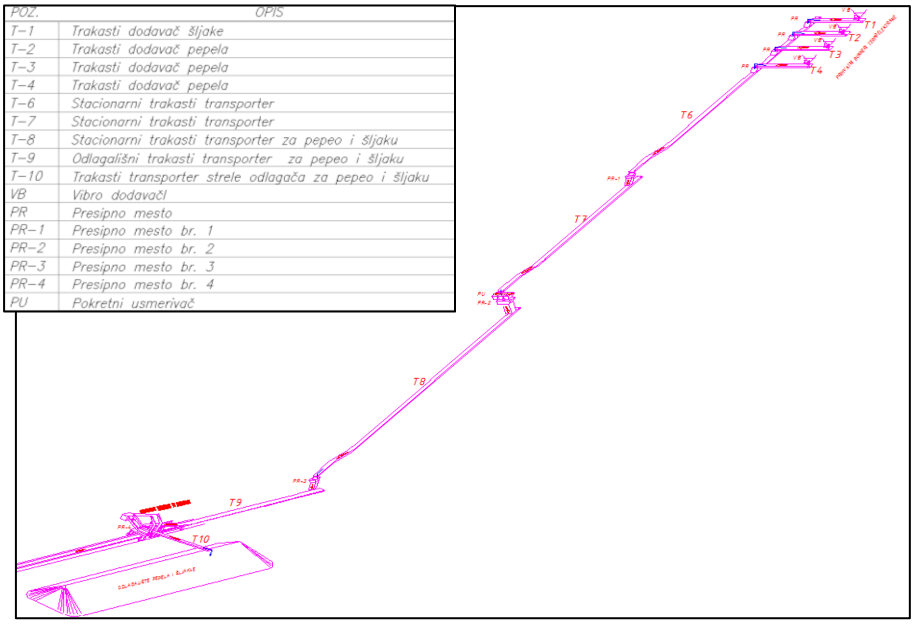

Figure 1 *Technological scheme of transport with belt conveyors*

Calculation of belt conveyors [7,9], disposer, construction facilities and works, as well as electrical installations was done for all elements of the system. The required investments for transport with belt conveyors are given in Table 1.

Table1 *Investments for transport with belt conveyors*

Item	Total, KM
Mechanical equipment	18 194 231
Construction works	2 170 950
Electrical equipment	1 034 017
Replacement of parts for a period of 23 years - 10% from the previous	2 139 920
Total	23 539 118

HYDRAULIC TRANSPORT

Plant for preparation and hydro transport of slag and ash transport will be located in a new built facility on the plateau below the existing silo. At this position, there are four already built concrete silos, three for ash and one for slag. The plant for preparation the hydro mixture will be located at this site and hydro transport to the landfill, i.e. a predicted landfill of slag and ash. A part of the plant for additional fragmentation of slag will be located in the circuit of thermal power plant, while a part of the plant for hydraulic transport with pumps for thick hydro mixture - pump station will be located in the extension of the basic plant for preparation of slurry and directly below the silo.

Formed slag, previously cooled with water is directed by gravel feeder into crusher for primary grinding and so fragmented falls on a belt conveyor. It is anticipated then that the slag is transported by belt conveyor to a reversible belt conveyor onto the crusher-mill for further comminution of slag. The cooling water which cools the slag in the slag remover boiler, together with suspended particles of slag, is collected in a drainage pit of boiler where the pumps pump it into the reservoir of thin hydro mixture of slag.

Additionally granulated slag in the device for additional comminution directly falls with the help of rinsing circulating water in the reservoir of thin hydro mixture of slag. Classification and thickening of thin hydro mixture of slag are developed. Sieve undersize, drained rinsing water and hydrocyclone overflow are directed into a concrete thickener. Overflow of thickener is relatively clean water that is collected in the tank of recirculation water, where it is distributed to all the necessary places.

Sieve oversize falls on a reversible feeder that such prepared slag directs alternately into two silos. Thick hydro mixture exits from two spiral horizontal mixers and enters the pump station of hydro transport system. The pump station can be found and

The additional pumping systems are situated into pump station for distribution the process and sealing water. Technological scheme of hydraulic transport for ash and slag is shown in Figure 2.

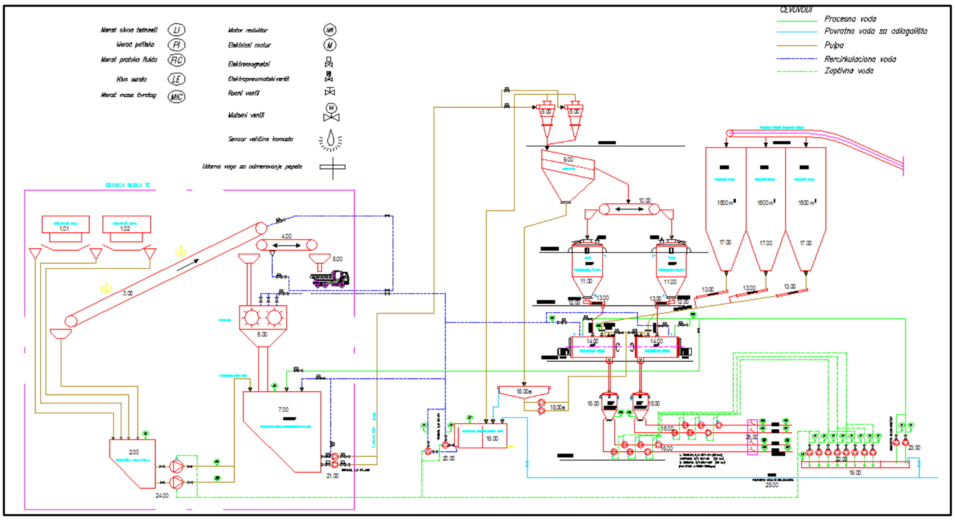

Figure 2 *Technological scheme of hydraulic transport for ash and slag*

Calculation of all elements of hydraulic transport, construction facilities and works as well as electrical installations for all elements of system was carried out. This transport system needs construction a water intake of fresh water as well as preparation of landfill [2, 3, 4] which includes the preparation of base, construction the circumferential dike as well as setting the waterproof foil, Figure 3.

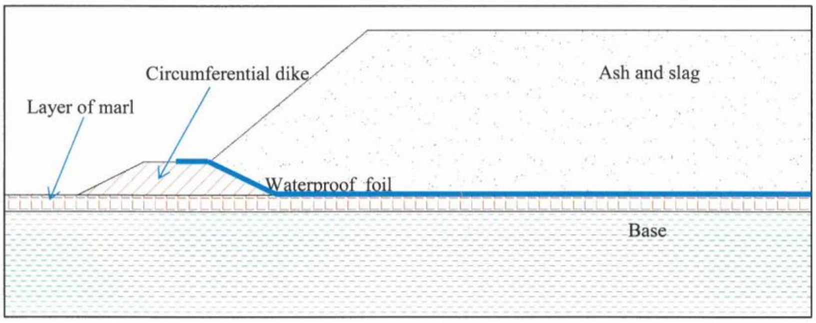

Figure 3 *Cross-section of landfill during hydraulic transport*

The investments required for transport by conveyor belts are given in Table 2.

Table 2 *Investments for hydraulic transport*

Item	Total, KM
Mechanical equipment	24 751 800
Construction works	1 949 165
Hydro-construction works	201 631
Electrical equipment	665 500
Replacement of parts for a period of 23 years - 10% from the previous	2 756 810
Base preparation	16 193 330
Total	46 518 236

TRUCK TRANSPORT

Truck transport of ash and slag [5, 6, 8, 9] would be conducted by the existing transport routes and does not require the special preparation works. Scheme of truck loading is shown in Figure 4, a diagram of transport route on the Inner land fill is shown in Figure 5. The required number of trucks was determined by a computer program Talpac with the replacement periods in 8 years. The investments required for truck transport are given in Table 3.

Table 3 *Investments for truck transport*

Item	Total, KM
Trucks Renault Kerax 430.35	4 800 000
Trucks Iveco AD/AT 720 T41T	7 200 000
Total	12 000 000

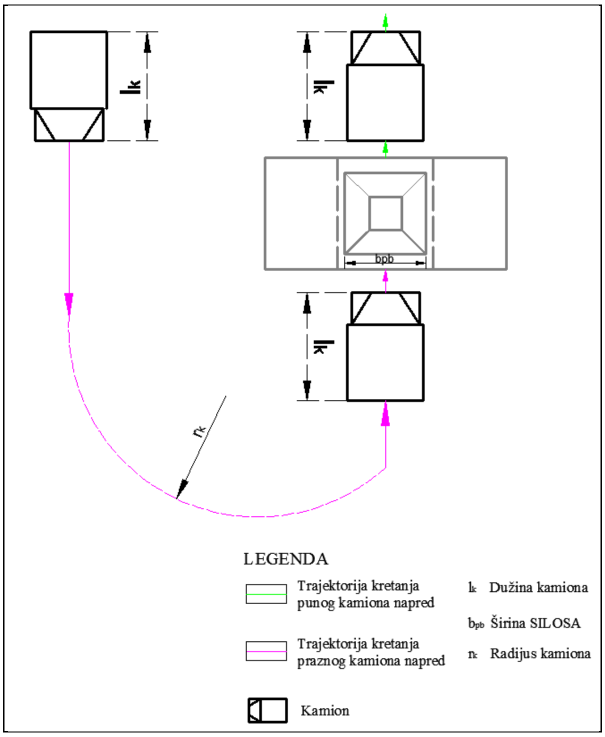

Figure 4 *Scheme of truck loading*

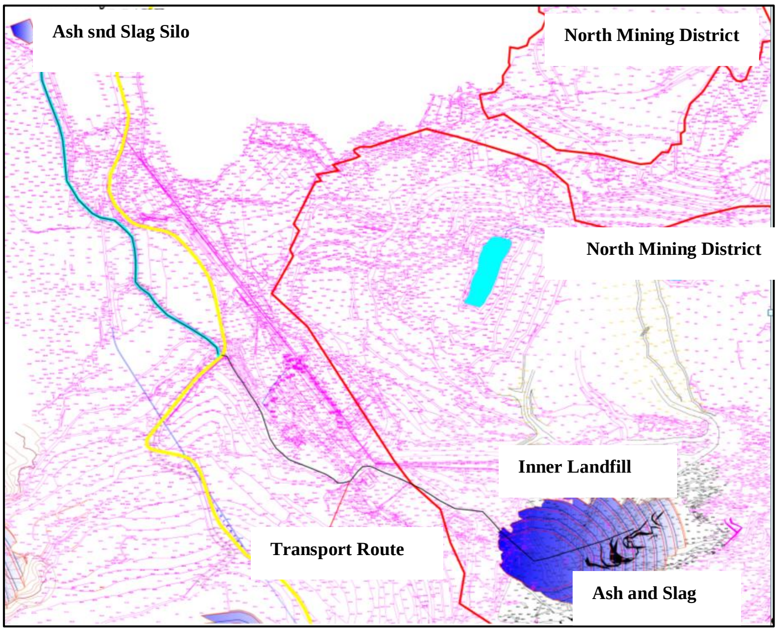

Figure 5 *Scheme of transport of ash and slag on the Inner landfill*

CONCLUSION

Based on technological schemes, the analysis of investments for each of the variants for a period of 23 years was carried out. The investments essential to select the type of transport are shown in Tables 1 - 3.

After the analysis, the conclusion is that the best economic effects are achieved by truck transport in terms of investments in the transport of ash and slag from the thermo power plant to the locations intended for disposal at the open pit.

Experiences from the open pit "Bogutovo Selo" – Ugljevik have to be used at the open pits of RTB Bor. Proper selection of transport system and maximum recovery the existing resources result into optimal solution in terms of investments, maintenance and energy consumption.

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IZBOR TRANSPORTNOG SISTEMA ZA TRANSPORT PEPELA I ŠLJAKE SA TE UGLJEVIK I NA PK BOGUTOVO SELO UGLJEVIK***

Izvod

Na površinskom kopu „Bogutovo Selo“ – Ugljevik eksploatacija uglja se izvodisa kapacitetom od 1.750.000 tona rovnog mrkog uglja godišnje za potrebe termoelektrane „Ugljevik“. Pri radu termoelektrane kao produkt nastaju pepeo i šljaka u količinama od 420.000 m^3 i 80.000 m^3 respektivno. Ove količine treba da se odlože u prostoru površinskog kopa „Bogutovo Selo“. Ovim radom prikazan je izbor transportnog sistema pepela i šljake za naredni period.

Ključne reči: *Površinski kop „Bogutovo Selo“ – Ugljevik, pepeo i šljaka, transportni sistem*

UVOD

„Rudnik i termoelektrana Ugljevik“ ad Ugljevik je zavisno preduzeće koje posluje u okviru Mješovitog holdinga „Elektroprivreda Republike Srpske“. Pretežna delatnost preduzeća je proizvodnja termoelektrične energije i eksploatacija i prodaja uglja. Eksploatacija mrkog uglja u ovom ugljenom basenu izvodi se od 1899. godine, i do 2006. godine otkopano je oko 35 miliona tona uglja. Do 1985. godine proizvodnja uglja je bila namenjena širokoj potrošnji, a od 1985. godine najvećim delom za potrebe TE Ugljevik snage 300 MW i oko 3% za široku potrošnju. Geološke rezerve uglja u ovom basenu iznose 429,9 miliona tona.

Eksploatacija uglja se vrši na površinskom kopu „Bogutovo Selo“. Eksploatacija na ovom kopu izvodi se od 1978. godine. Projektovana godišnja proizvodnja površinskog kopa „Bogutovo Selo“ je 1.750.000 tona rovnog mrkog uglja.

Kako bi se obezbedio kontiualan rad termoelektrane u sledeće 23 godine, izabrane su lokacije za odlaganje - deponovanje pepela i šljake u prostoru površinskog kopa „Bogutovo Selo“ [1]:

- Veliko zapadno odlagalište Severnog revira;
- Unutrašnje odlagalište Južnog revira.

Takođe, potrebno izabrati najekonomičniji način transporta i odlaganja – deponovanja masa prema količinama pepela i šljake, na bazi rada termoelektrane. Ove količine iznose 420.000 m^3/god za pepeo i 80.000 m^3/god za šljaku. Za naredni period od 23 godine ukupne količine koje treba da se odlože iznose 9.660.000 m^3 šljake i 1.840.000 m^3 pepela [1]. Prilikom odabira

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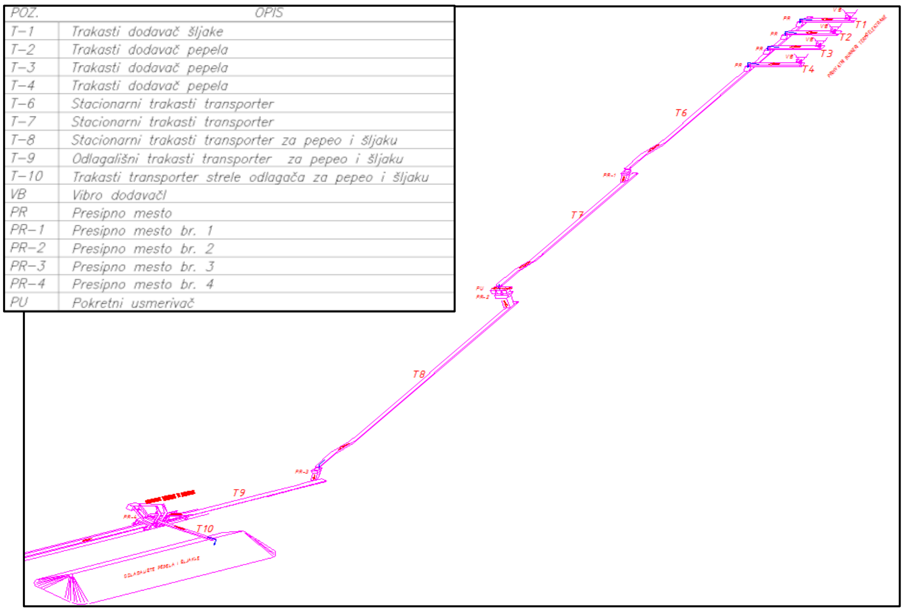
*** *Ovaj rad je jednim delom proistekao iz projekta TR37001 „Uticaj rudarskog otpada iz RTB Bor na zagadjenje vodotokova, sa predlogom mera i postupaka za smanjenje štetnog dejstva na životnu sredinu“, koji je finansiran sredstvima Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije*

vrste transporta analizirane su tri varijante za koje su definisane tehnološke šeme pripreme, transporta i odlaganja prema potrebnim kapacitetima:

- Transport transporterima sa trakom;
- Hidraulički transport;
- Kamionski transport.

TRANSPORT TRANSPORTERIMA SA TRAKOM

Ovaj transportni sistem se sastoji od tri vibro dodavača i trakastih dodavača za pepeo i jednog vibro dodavača i trakastog dodavača za šljaku u termoelektrani. Zbog međusobnog položaja lokacija predviđenih za odlaganje na kopu u odnosu na termoelektranu, kao i konfiguracije terena, predviđena su četiri stacionarna trakasta transportera. Na lokaciji odlaganja predviđen je jedan odlagališni trakasti transporter i jedan trakasti transporterom na streli odlagača. Tehnološka šema pripreme, transporta i odlaganja transporterima sa trakom prikazana je na slici 1.



Sl. 1. *Tehnološka šema transporta transporterima sa trakom*

Izvršen je proračun trakastih transportera [7, 9]. odlagača, građevinskih objekata i radova, kao i elektroinstalacija za sve elemente sistema. Ulaganja potrebna za transport transporterima sa trakom data su tabelom 1.

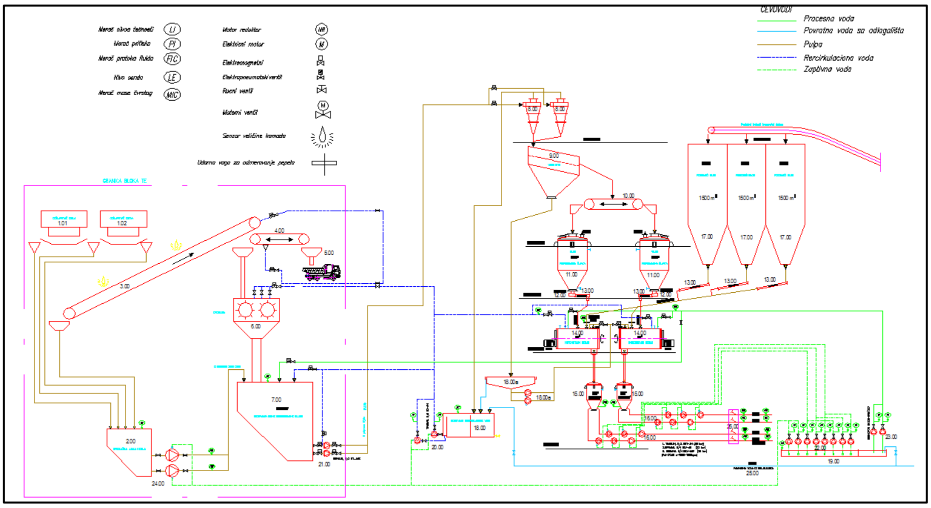
Tabela 1. *Ulaganja za transport transporterima sa trakom*

Stavka	Ukupno, KM
Mašinska oprema	18 194 231
Građevinski radovi	2 170 950
Elektro oprema	1 034 017
Zamena delova tokom perioda od 23 godine – 10% od prethodnog	2 139 920
Svega	23 539 118

HIDRAULIČKI TRANSPORT

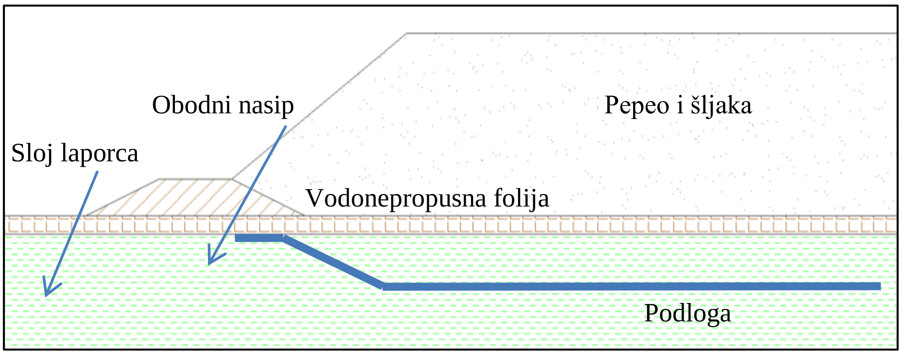
Postrojenje za pripremu i hidrotransport šljake i pepela nalaziće se u novoizgrađenom objektu na platou ispod postojećih silosa. Na toj poziciji, nalaze se četiri već izgrađena betonska silosa, tri za pepeo i jedan za šljaku. Na ovoj lokaciji će se locirati pogon za pripremu hidro mešavine i hidraulički transport do odlagališta tj. predviđene deponije šljake i pepela. Deo pogona za dodatno usitnjavanje šljake biće lociran u krugu termolelektrane, dok će deo pogona za hidraulički transport sapumpama za gustu hidromešavinu-pumpna stanica da se nalazi u produžetku osnovnog pogona za pripremu hidromešavine, a neposredno ispod silosa.

Stvorena šljaka, predhodno ohlađena vodom, se grabuljastim dodavačem usmerava u drobilicu za primarno usitnjavanje i tako usitnjena pada na trakasti transporter. Predviđeno je zatim, da se šljaka trakastim transporterom vozi do reverzibilnog trakastog transportera u drobilicu - mlin, za dodatno usitnjavanje šljake. Rashladna voda, kojom se šljaka hladi u odšljakivaču kotla, zajedno sa suspendovanim česticama šljake, sakuplja se u drenažnoj jami kotla gde se pumpama prepumpava u rezervoar retke hidromešavine šljake. Dodatno usitnjena šljaka u uređaju za dopunsko usitnjavanje direktno upada uz pomoć spirne recirkulacione vode, u rezervoar retke hidromešavine šljake. U hidrociklonima dolazi do klasiranja i zgušnjavanja retke hidromešavine šljake. Prosev sita, oceđena spirna voda kao i preliv hidrociklona se usmeravaju u betonski zgušnjivač. Preliv zgušnjivača predstavlja relativno čistu vodu koja se sakuplja u rezervoar recirkulacione vode, odakle distribuirana svim potrebnim mestima. Otsev sita pada na reverzibilni dodavač koji tako pripremljenu šljaku usmerava naizmenično u dva silosa. Iz horizontalnih dvospiralnih mešača izlazi gusta hidromešavina i ulazi u pumpnu stanicu hidrtransportnog sistema. U pumpnoj stanici nalaze se i dodatni pumpni sistemi za distribuciju procesne i zaptivne vode. Tehnološka šema hidrauličkog transporta pepela i šljake prikazana je na slici 2.



Sl. 2. *Tehnološka šema hidrauličkog transporta pepela i šljake*

Izvršen je proračun svih elemenata hidrauličkog transporta, građevinskih objekata i radova, kao i elektroinstalacija za sve elemente sistema. Kod ovog sistema transporta potrebna je i izrada vodozahvata sveže vode kao i priprema odlagališta [2, 3, 4] koja obuhvata pripremu podloge, izradu obodnog nasipa kao i postavljanje vodonepropusne folije, slika 3.



Sl. 3. *Poprečni presek odlagališta pri hidrauličkom transportu*

Ulaganja potrebna za transport transporterima sa trakom data su tabelom 2.

Tabela 2. *Ulaganja za hidraulički transport*

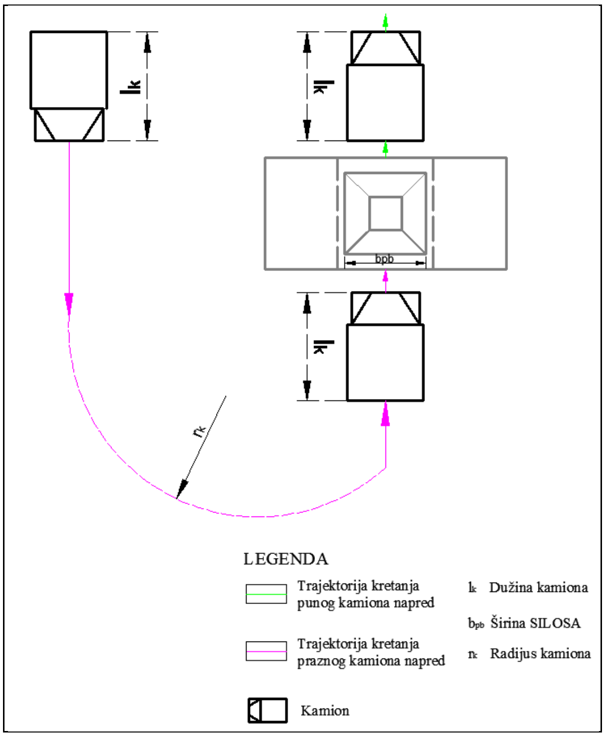
Stavka	Ukupno, KM
Mašinska oprema	24 751 800
Građevinski radovi	1 949 165
Hidrograđevinski radovi	201 631
Elektro oprema	665 500
Zamena delova tokom perioda od 23 godine – 10% od prethodnog	2 756 810
Priprema podloge	16 193 330
Svega	46 518 236

KAMIONSKI TRANSPORT

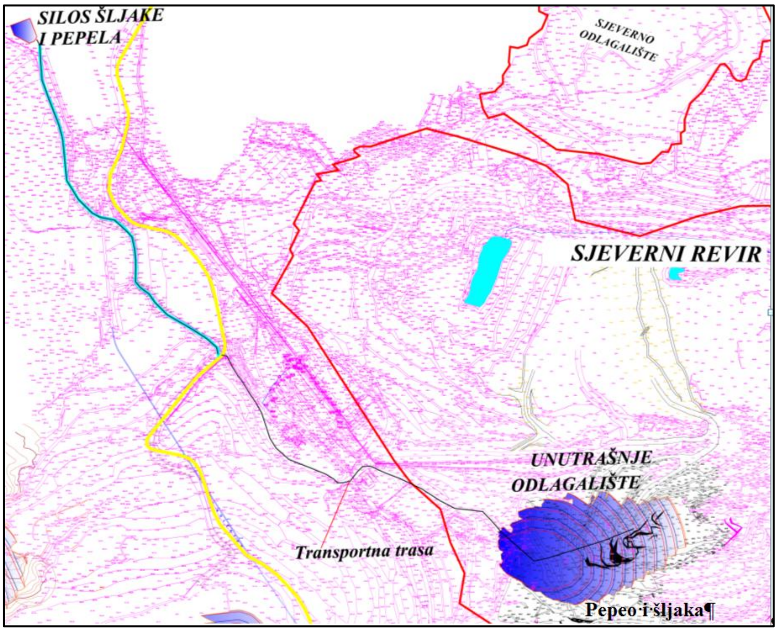
Kamionski transport pepela i šljake [5, 6, 8, 9] obavljao bi se postojećim transportnim putevima i ne zahteva posebne pripremne radove na pripremi. Šema utovara kamiona prikazana je na slici 4, a šema transportnog puta na Unutrašnje odlagalište prikazana je na slici 5. Potreban broj kamiona određen je računarskim programom Talpac sa periodom zamene na 8 godina. Ulaganja potrebna za kamionski transport data su tabelom 3.

Tabela 3. *Ulaganja za kamionski transport*

Stavka	Ukupno, KM
Kamioni Renault Kerax 430.35	4 800 000
Kamioni Iveco AD/AT 720 T41T	7 200 000
Svega	12 000 000



Sl. 4. *Šema utovara kamiona*



Sl. 5. *Šema transporta pepela i šljake na Unutrašnje odlagalište*

ZAKLJUČAK

Na osnovu tehnoloških šema izvršena je analiza investicionih ulaganja za svaku od varijanti za period od 23 godine. Ulaganja bitna za odabir vrste transporta prikazana su u tabelama 1 – 3.

Nakon analize zaključak je da se kamionskim transportom postižu najbolji ekonomski efekti sa aspekta ulaganja na transportu pepela i šljake od termoelektrane do lokacija predviđenih za odlaganje na površinskom kopu.

Iskustva sa površinskog kopa „Bogutovo Selo" - Ugljevik, trebaju da se iskoriste i na površinskim kopovima RTB-a Bor. Pravilnim izborom sistema transporta i maksimalnim iskorišćenjem postojećih resursa, dobija se optimalno rešenje sa aspekta ulaganja, održavanja, i potrošnje energije.

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