Ljubiša Obradović, Jelena Stanković*, Mile Bugarin**

DISPOSAL OF HAZARDOUS MINING WASTE - THE CURRENT SERBIAN AND EU LEGISLATION**

Abstract

By adoption the first Law on Waste Management of the Republic of Serbia in 2009 ("Official Gazette RS", No. 36/09), the necessary preconditions for introduction the order into the subject area were created. The Law on Waste Management was amended in 2010 ("Official Gazette RS", No. 88/2010). According to the guidelines of the amended Law on Waste Management, the Government of the Republic of Serbia has adopted the Regulation on disposal of hazardous waste on landfills ("Official Gazette RS", No. 92/2010). The Government has defined with this Law, for the first time, three categories of waste disposal and all parameters necessary for selection appropriate location, design and monitoring of future waste disposal. The Government regulation on landfills represents a harmonization of domestic legislation with the European Union in the field of environmental protection and waste management and with actual Directive 1993/31/EU.

Keywords: Regulation 92/2010, hazardous waste

INTRODUCTION

Disposal of waste on landfill provides and ensures the conditions to prevent or reduce as far as possible negative effects on the environment, in particular the pollution of surface water, groundwater, soil and air, and on the global environment, including the greenhouse effect. In order to avoid these negative effects, the aim is the harmonization of the national legislation of the Republic of Serbia in the field of air quality, water, waste and industrial pollution with the EU acquis, which makes a significant progress in this area.

The environmental field, in addition, is the most voluminous and constantly in development, so that under the appropriate

legal regulation in this area, the volume of EU legislation is constantly increased, what requires the constant monitoring of development the EU legislation regarding to comply with the national regulations. In the NPI document (National Program for Integration), this area is divided into the following chapters: horizontal legislation, air quality and climate changes, waste management, water protection and management, nature protection, chemicals, industrial pollution control and risk management, genetically modified organisms, noise protection, forestry and civil protection.

Since 1992, a selection of site and regulation of waste landfills in Serbia have

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** This work is the result of the Project TR: 37001: Impact of Mining Waste from RTB to Pollution of Waterways with a Proposal of Measures and Actions to Reduce Harmful Effects on the Environment, funded by the Ministry of Education, Science and Technological Development of the Republic of Serbia.

been carried out according to the Rulebook on criteria for determining the location and regulation of waste landfills from 1992 ("Official Gazette RS", No. 54/92). In accordance with this Rulebook, the general definition of landfill is: *a landfill of waste is the sanitary technical land-scaped area where the solid waste is disposed as waste material generated in the public areas, households, production process or work, traffic or use, and which has no properties of hazardous substances and cannot be processed or rationally use as industrial raw material or energy fuel.* This Rulebook classifies all types of waste in one category, so the same rules and methodologies are used in designing the future municipal and industrial landfills.

Adoption the Law on Waste Management ("Official Gazette RS", No. 36/09) has provided the legal framework for establishment the integrated waste management system. A completion of all by-laws would be expected in the next periods that will completely regulate the waste management system (various rules and regulations). One of this regulation is the Regulation on disposal of hazardous waste ("Official Gazette RS", No. 92/2010) which is in accordance with the European Union Directive on the Landfills of Waste, No. 1999/31/EC. This Regulation shall prescribe more closely the conditions and criteria for determining the location, technical and technological conditions for designing, construction and operation of waste landfills, types of waste whose disposal on the landfill is prohibited, quantity of biodegradable waste that can be disposed, criteria and procedures for acceptance and non-acceptance, i.e. disposal of waste on landfill, method and procedures of operation, contents and monitoring of landfill operation as well as subsequently maintenance upon closure of landfill. This is particularly important because the landfill in accordance with the Rulebook from 1992 is designed as a watertight with the coefficient of terrain permeability on which the landfill is built of at

least: $k = 0.00001 \text{ m/s}$ ($k = 10^5 \text{ cm/s}$), or the coefficient in meters is: $k = 0.0000001 \text{ m/s}$ ($k = 10^{-7} \text{ m/s}$). This coefficient is insufficient because it does not satisfactorily prevent pollution of groundwater and surface water due to the uncontrolled movement of leachate from the landfill into the surrounding space, but by the adoption of new Regulation, a demand for water resistance has been considerably tightened.

The problem of hazardous industrial waste is in its improper storage that does not comply with the law as well as the lack of systemic solution to this problem. Partial solution is in export of hazardous waste for permanent disposal in other countries, which accounts for only 6%. The Republic Government has adopted, in December 2008 the Conclusion on construction the facilities for physical-chemical treatment of hazardous wastes, and in June 2009, the Conclusion on temporary storage the hazardous waste of unknown owner. Separation of components that can be recycled from waste is also regulated by the law. Development of recycling industry in Serbia, with the support of the ministry, creates the conditions for opening the new job positions in the new industry. Incineration of waste with the energy evaluation does not exist at this moment, because there are no facilities for waste incineration. A part of waste, presented by the waste tires, has started to be used as the energy resource/substitutes in the cement factories in Serbia.

LEGISLATION OF EU AND SERBIA ON DISPOSAL OF HAZARDOUS WASTE AT THE LANDFILLS WITH A VIEW TO THE DANGEROUS MINING WASTE

The Law on Waste Management ("Official Gazette RS", No. 36/09 and 88/2010) has provided the legal framework for establishment the integrated waste management system. In the frame of integrated system, the permanent and safe disposal of waste takes very important or the most important place.

European Union Directive on the Landfills of Waste, No. 1999/31/EC

When the EU legislation concerning the disposal of different types of waste on landfills is in question, it is officially regulated since 1999 by the Landfill Directive No. 1999/31/EC. The Landfill Directive is binding to all member states of the European Union and the countries that are candidates or in future pretend to join the EU. This Directive defines the three basic types of landfills for inert, non-hazardous and hazardous waste.

All necessary parameters are individually defined for every landfill, relevant to the selection of appropriate locations for future landfill during its construction, operation and after termination the exploitation of landfill and its closure and remediation. During the life of the construction, operation and post-operation of the landfill, the appropriate auscultation works - monitoring of landfill are defined. Continuous monitoring and monitoring of the landfill is very important because as a rule, all landfills, particularly the hazardous waste landfill, are large potential causes of pollution to all environmental factors (air, water and earth). Timely reacting and well/timed detection of irregularities in the work and exploitation of landfills, can prevent occurrence of accident situations which are usually large scale, with unforeseeable consequences.

Regulation of the Government of RS on disposal of hazardous waste („Official Gazette RS“, No. 92/2010).

Thanks to the legal framework established by the Act on Waste Management 2009 and its first amendment 2010, the Government of RS in 2010 has adopted the Decree on the disposal of waste at landfills (" Official Gazette of RS", No. 92/2010). This Decree of the Government of RS, in fact, represents the harmonization of national legislation with the European and EU Directive on the landfill No. 1999/31/EC. In practice, the domestic regulation of landfills (92/2010) is mostly translated into the EU

Directive on landfills (1999/31/EC) with some minor amendments.

With Regulation on disposal of hazardous waste of the Government of the Republic of Serbia (as like in the European Union Directive), the landfill has been classified for the first time into three types of landfills instead of one type that was previously present. The basic types of landfill are:

- landfills for inert waste,
- landfills for non-hazardous waste, and
- landfills for hazardous waste.

Landfills for hazardous waste are objects used for disposal of waste, which are, according to their characteristics (at least one or more features), hazardous waste, according to the Rulebook on categories, controlling and classification of waste ("Official Gazette RS", No. 56/10).

Mining waste disposal

The current Law on Waste Management in its Article 4 defines several types of waste to which the law does not apply. Paragraph 6 of Article 4 states that the provisions of the Act do not apply to:

- "waste generated from mining exploration, excavation, processing and storage of mineral resources and overburden from mines and quarries".

According to definition of the current law on waste management, the overburden is excluded from its application. Project TR 37001, financed by the Ministry of Education, Science and Technological Development of the Republic of Serbia, has provided recycling of flotation tailings from the old flotation tailing dump to the aim of recovery the useful components contained in this tailings. Copper, as a useful component, recovered from flotation tailings by hydrometallurgical processes, after which the acid waste material remains that should be permanently and safely disposed on landfill.

For the purpose of classification the waste obtained after leaching, the acid waste is subjected to the standard leaching test SRPS EN 12457-2. The study obtained by elution is according to the Rulebook on categories, controlling and classification of waste ("Official Gazette RS", No. 56/10). According to this Rulebook, the waste material after leaching can be stored on hazardous waste landfill.

GENERAL REQUIREMENTS OF LANDFILL FOR HAZARDOUS WASTE

With regulation on disposal of hazardous waste ("Official Gazette RS", No. 92/2010), the important parameters are more precisely determined for defining the location of hazardous waste disposal, precise guidelines for design and construction

of this type of landfill are given, especially technical and technological conditions, content and method of monitoring and maintenance the landfill after closure.

Landfill is located, as a rule, in sheltered coves of side relief, the former land borrow pits and flat terrains that are without current and stagnant water. Steep terrain with a slope of 25% may be used for landfills with adequate application of appropriate technical measures (planning, sidewise support, supporting, etc.). The landfill cannot be located on very cracked rocky substrate, with high water permeability and undefined movement directions of groundwater in the area affected by sliding, collapse, subsidence or other earth moving mass, if such phenomena cannot be prevented by technical measures.

Figure 1 A typical cross section of the hazardous waste landfill

On the landfill, base and side are regulated; the lateral sides that will ensure the stability of the landfills provide sealing and waterproofing, which together with a system for admission and disposal of leachate prevent its penetration into the subsoil landfills. The landfill base and side shall consist of a mineral layer which satisfies permeability and thickness requirements with a combined effect in terms of protection of soil, groundwater and surface water at least equivalent to $K \leq 1,0 \times 10^{-9}$ m/s and thickness ≥ 5 m.

Table 1 Leachate collection and bottom sealing

Sealing and drainage of waste landfill bottom	For hazardous waste
Artificial sealing liner (geomembrane)	required
Drainage layer ≥ 0.5 m	required

When the geological barrier does not naturally meet the above conditions, it can be completed artificially and reinforced by others means giving equivalent protection. An artificially established geological barrier should be no less than 0.5 m thick.

In addition to the geological barrier described above, the leachate collection and sealing system must be added in accordance with the following principles as to ensure that leachate accumulation at the base of the landfill is kept to minimum:

The other methods and techniques can be used for sealing of landfill base and sides, if the requirements in Table 1 are provided.

Figure 2 Detail "A" - Sealing/drainage structure of bottom and slopes

Project of drainage layer, drainage pipes and drainage channels shall be made on calculation the water balance in order to enable system operation of drainage and treatment of leachate, operation control and maintenance of the landfill. On the landfill of hazardous waste, it is necessary to provide a separate system for collection and drainage of leachate through the drainage layer in which drainage pipes are placed for transferring to designed system and treatment. Penetration of waste into the drainage system is prevented with appropriate technical solu-

tions. For the maintenance and control of drainage pipes for collecting leachate, it is necessary to built up the sufficient number of shafts, which must be stable and rely on subsoil. For temporary retention of leachate, which is collected from the landfill body, it is necessary to set up a collecting shaft, which is resistant to the chemical influences.

After completion the period of exploitation, the landfill will be closed to further disposal formation a coverage layer, which meets the following technical conditions:

Table 2 Required measures for designing a coverage layer of hazardous waste landfill

Required measures for designing a coverage layer	Landfill category
	For hazardous waste
Artificial sealing liner	required
Impermeable mineral layer ≥ 0.5 m	required
Top soil cover ≥ 0.5 m	required

For the layer of remediation (top soil cover), the waste, made by other biological treatment technologies, can be also used

with satisfying limit values of parameters for waste disposal.

Figure 3 Detail "B" - Design of coverage layer

After closure the landfill and until its decay, the operator takes measures relating to the maintenance, supervision, control and monitoring of landfills, in accordance with this Regulation and the Law.

CONCLUSION

By adoption the Law on Waste Management of the Republic of Serbia in 2009 and its amendment in 2010, the legal framework was provided for establishment the integrated waste management system in Republic of Serbia.

As a part of an integrated waste management system, the permanent and safe disposal of waste to landfill takes an important place, or the most important one. In order to synchronize the national legislation with the European and EU Directive, the Government of the Republic of Serbia 2010 has adopted the Decree on the disposal of waste at landfills. In practice, the domestic regulation of landfills (92/2010) is mostly translated into EU Directive on landfills (1999/31/EC) with some minor amendments. With the Regulation on disposal of hazardous waste of the the Government of the Republic of Serbia (as like in the European Union Directive), the landfill has been classified for the first time into three types of landfills instead of one type that was previously present. The basic types of landfill are:

- landfills for inert waste,
- landfills for non-hazardous waste, and
- landfills for hazardous waste.

The waste generated from mining exploration, excavation, processing and storage of mineral resources, as well as the waste rock from mines and quarries is excluded from the current Law on waste management. This means that the flotation tailings, which was disposed at the Old Bor Flotation Tailing Dump are excluded from the above laws, but if the same flotation tailings is subjected to the recycling process in order to recover the remaining useful components, the law can be applied. Copper, as a useful component, recovered from flotation tailings by hydro

metallurgical processes, after which the acid waste material remains that should be permanently and safely disposed on landfill.

For the purpose of classification the waste obtained after leaching, the acid waste is subjected to the standard leaching test SRPS EN 12457-2. The study obtained by elution is according to the Rulebook on categories, controlling and classification of waste ("Official Gazette RS", No. 56/10). According to this Rulebook, the waste material after leaching can be stored on hazardous waste landfill.

As there are no constructed landfills for hazardous waste in the Republic of Serbia, in order to better introduce them, their basic characteristics and structural elements are shown, according to the Regulation on disposal of hazardous waste ("Official Gazette RS", No. 92/2010) and European Union Directive on the Landfill of Waste 1999/31/EC.

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DEPONOVANJE OPASNOG OTPADA IZ RUDARSTVA - AKTUELNA ZAKONSKA REGULATIVA EU I SRBIJE**

Izvod

Usvajanjem prvog Zakona o Upravljanju otpadom Republike Srbije 2009. godine ("Sl. glasnik RS", broj 36/09), stvoreni su neophodni preduslovi za uvođenje reda u predmetnoj oblasti. Zakon o Upravljanju otpadom je dopunjen 2010. godine ("Sl. glasnik RS", br. 88/2010). U skladu sa smernicama dopunjenog Zakona o Upravljanju otpadom Vlada RS 2010. godine donosi Uredbu o odlaganju otpada na deponije ("Sl. glasnik RS", br. 92/2010). Ovom uredbom Vlade definišu se po prvi put tri kategorije deponija kao i svi parametri neophodni za izbor odgovarajuće lokacije, projektovanje i monitoring buduće deponije otpada. Uredba Vlade o deponijama predstavlja usaglašavanje domaće zakonske regulative sa regulativom EU i njenom aktuelnom Direktivom o deponijama br. 1999/31/EC.

Ključne reči: Uredba o deponijama br. 92/2010, opasan otpad

UVOD

Odlaganjem otpada na deponiju obezbeđuju se i osiguravaju uslovi za spečavanje i smanjenje štetnih uticaja na zdravlje ljudi i životnu sredinu u toku celog životnog ciklusa deponije, posebno zagađenja površinskih i podzemnih voda, zemlje i vazduha, uključujući i efekat staklene bašte. Kako bi se ovi štetni uticaji sprečili, teži se usaglašavanju nacionalnog zakonodavstva Republike Srbije iz oblasti kvaliteta vazduha, voda, otpada i industrijskog zagađenja sa pravnim tekovinama EU, koja je u ovoj oblasti dosta napredovala. Oblast životne sredine osim što je najobimnija u stalnom je razvoju, pa se shodno potrebi pravnog regulisanja ove oblasti, obim EU propisa konstantno povećeva, što zahteva stalno praćenje razvoja EU zakonodavstva radi usaglašavanja sa domaćim propisima. U NPI dokumentu (Nacionalni program za

integraciju), ova oblast je podeljena na sledeća poglavlja: horizontalno zakonodavstvo, kvalitet vazduha i klimatske promene, upravljanje otpadom, zaštita i upravljanje vodama, zaštita prirode, hemikalije, kontrola industrijskog zagađenja i upravljanje rizikom, genetički modifikovani organizmi, zaštita od buke, šumarstvo i civilna zaštita.

Od 1992. godine izbor lokacije i uređenje deponija otpadnog materijala se u Srbiji vršio prema Pravilniku o kriterijumima za određivanje lokacije i uređenje deponija otpadnih materijala iz 1992. godine ("Sl. glasnik RS", br. 54/92). U skladu sa navedenim Pravilnikom opšta definicija deponije je: *deponija otpadnih materija jeste sanitarno-tehnički uređen prostor na kome se odlaze čvrst otpad koji kao otpadni materijal nastaje na javnim površinama, u domaćinstvima, u procesu proizvodnje*

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** Ovaj rad je proistekao iz projekta TR37001 "Uticaj rudarskog otpada iz RTB Bor na zagađenje 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.

odnosno rada, u prometu ili upotrebi, a koji nema svojstva opasnih materija i ne može se prerađivati, odnosno racionalno koristiti kao industrijska sirovina ili energetska gorivo. Ovaj pravilnik sve otpade svrstava u jednu kategoriju, tako da se za projektovanje budućih komunalnih i industrijskih deponija koriste ista pravila i metodologija.

Usvajanjem Zakona o upravljanju otpadom ("Sl. glasnik RS", broj 36/09 i 88/2010) obezbeđen je pravni okvir za uspostavljanje integralnog sistema upravljanja otpadom. U narednom periodu treba očekivati završetak svih podzakonskih akata koji će u potpunosti urediti sistem upravljanja otpadom (razni pravilnici i uredbe). Jedna od tih uredbi je i Uredba o odlaganju otpada na deponije ("Sl. glasnik RS", broj 92/2010) koja je u skladu sa Direktivom Saveta EU o deponijama otpada br. 1999/31/EC. Ovom uredbom se bliže propisuju uslovi i kriterijumi za određivanje lokacije, tehnički i tehnološki uslovi za projektovanje, izgradnju i rad deponija otpada, vrste otpada čije je odlaganje na deponiji zabranjeno, količine biorazgradivog otpada koje se mogu odložiti, kriterijumi i procedure za prihvatanje ili neprihvatanje, odnosno odlaganje otpada na deponiju, način i procedure rada i zatvaranja deponije, sadržaj i način monitoringa rada deponije, kao i naknadnog održavanja posle zatvaranja deponije. Ovo je posebno bitno iz razloga što se deponije u skladu sa pravilnikom iz 1992. godine projektuju kao vodonepropusne sa koeficijentom propustljivosti terena na kome se deponija izgrađuje od najmanje: $k = 0,00001 \text{ m/s}$ ($k = 10^{-5} \text{ cm/s}$), odnosno u metrima koeficijent iznosi: $k = 0,000001 \text{ m/s}$ ($k = 10^{-7} \text{ m/s}$). Ovaj koeficijent je nedovoljan jer ne sprečava na zadovoljavajući način zagađenje podzemnih i površinskih voda usled nekontrolisanog kretanja procednih voda iz deponije u okolni prostor, a donošenjem nove uredbe zahtev za vodonepropusnost je znatno poošten.

Problem opasnog industrijskog otpada, a tu spada i otpad iz rudnika, je u njegovom nepropisnom skladištenju koji nije u skladu

sa zakonom, kao i nepostojanje sistemskog rešenja za taj problem. Delimično rešenje je izvoz opasnog otpada na trajno zbrinjavanje u drugim zemljama koji je zastupljen sa svega 6%. Republička vlada je u decembru 2008. usvojila Zaključak o izgradnji postrojenja za fizičko-hemijski tretman opasnog otpada, a u junu 2009. Zaključak o privremenom skladištenju opasnog otpada nepoznatog vlasnika. Izdvajanje komponenti koje se mogu reciklirati iz otpada je takođe uređeno zakonom. Razvojem reciklažne industrije u Srbiji uz podršku ministarstva stvaraju se uslovi za otvaranje novih radnih mesta u novoj industrijskoj grani. Spaljivanje otpada u Srbiji uz energetska valorizaciju u ovom trenutku ne postoji, jer ne postoje pogoni za insineraciju (spaljivanje) otpada. Deo otpada koje predstavljaju otpadne gume je počeo da se koristi kao energetska resurs/supstituent u cementarama u Srbiji.

ZAKONSKA REGULATIVA EU I SRBIJE O ODLAGANJU OTPADA NA DEPONIJAMA SA OSVRTOM NA OPASAN RUDNIČKI OTPAD

Zakon o upravljanju otpadom ("Sl. glasnik RS", broj 36/09 i 88/2010) je obezbedio pravni okvir za uspostavljanje integralnog sistema upravljanja otpadom. U okviru integralnog sistema trajno i sigurno zbrinjavanje otpada zauzima veoma važno mesto ako ne i najvažnije mesto.

Direktiva EU o deponijama 1999/31/EC

Kada je u pitanju zakonska regulativa EU koja se odnosi na odlaganje različitih vrsta otpada na deponijama ona je od 1999. godine zvanično uređena Direktivom o deponijama br. 1999/31/EC. Direktiva o deponijama je obavezujuća za sve države članice Evropske unije kao i za države koji su kandidati ili u budućnosti pretenduju na članstvo u EU. Ovom direktivom se definišu tri osnovna tipa deponija za inerten, neopasan i opasan otpad.

Za svaku deponiju pojedinačno su definisani svi neophodni parametri bitni kako za izbor adekvatne lokacije za buduću deponiju, tokom njene izgradnje, eksploatacije kao i po prestanku eksploatacije deponije, njenom zatvaranju i rekultivaciji. Tokom celog životnog veka izgradnje, eksploatacije i post-eksploatacije deponije definisani su i odgovarajući oskultacioni radovi - monitoring deponije. Kontinualno praćenje i monitoring deponije je veoma bitan jer su po pravilu sve deponije a naročito deponije opasnog otpada, veliki potencijalni zagađivači svih činilaca životne sredine (vazduh, voda i zemlja). Pravovremeno reagovanje i blagovremeno uočavanje svih nepravilnosti u radu i eksploataciji deponije, može sprečiti nastanak akcidentnih situacija koje su po pravilu širih razmera sa nesagledivim posledicama.

Uredba Vlade RS o odlaganju otpada na deponije ("Sl. glasnik RS", br. 92/2010)

Zahvaljujući pravnom okviru koji je uspostavljen donošenjem Zakona o upravljanju otpadom 2009 godine kao i njegovom prvom dopunom 2010 godine, Vlada RS 2010 godine donosi Uredbu o odlaganju otpada na deponije ("Sl. glasnik RS", br. 92/2010). Ova uredba Vlade RS u stvari predstavlja usaglašavanje domaćeg zakonodavstva sa evropskim, odnosno usaglašavanje sa EU direktivom o deponijama br. 1999/31/EC. U praksi domaća uredba o deponijama (92/2010) predstavlja u najvećoj meri prevedenu Direktivu EU o deponijama (1999/31/EC) sa nekim manjim dopunama.

Uredbom Vlade RS o deponijama se (kao i u direktivi EU) po prvi put definišu tri osnovna tipa deponija umesto jednog koji je ranije postojao. Osnovni tipovi deponija su:

- deponije za inertan otpad,
- deponije za neopasan otpad i
- deponije za opasan otpad.

Deponije opasnog otpada predstavljaju objekte na kojima se odlaze otpad koji po svojim karakteristikama (najmanje jedna ili više karakteristika) predstavljaju opasan

otpad, prema Pravilniku o kategorijama, ispitivanju i klasifikaciji otpada ("Sl. glasnik RS", br. 56/10).

Odlaganje rudničkog otpada

Aktuelni Zakon o upravljanju otpadom u svom članu 4 definiše više vrsta otpada na koje se zakon ne primenjuje. U tački 6 člana 4 piše da se odredbe zakona ne primenjuju i na:

- *"Otpad iz rudarstva koji nastaje istraživanjem, iskopavanjem, preradom i skladištenjem mineralnih sirovina, kao i jalovina iz rudnika i kamenoloma".*

Prema definiciji aktuelnog zakona o upravljanju otpadom flotacijska jalovina je izuzeta od njegove primene. Projektom TR 37001 finansiranog od strane Ministarstva za nauku i tehnološki razvoj planom i programom je predviđeno recikliranje flotacijske jalovine iz starog flotacijskog jalovišta, u cilju valorizacije korisnih komponenti koju ova jalovina sadrži. Bakar kao korisna komponenta se iz flotacijske jalovine valorizuje hidrometalurškim putem. Nakon izdvajanja bakra preostaje otpadni materijal veoma kiselog karaktera koji je potrebno trajno zbrinuti na odgovarajućoj deponiji.

U cilju definisanja i karakterizacije otpada dobijenog nakon luženja, kiseli otpad je podvrgnut standardnom testu luživosti SRPS EN 12457-2. Nakon luženja izvršeno je ispitivanje eluata u skladu sa Pravilnikom o kategorijama, ispitivanju i klasifikaciji otpada ("Sl. glasnik RS", br. 56/10). Prema navedenom pravilniku otpadni materijal nakon luženja je svrstan u kategoriju opasnog otpada i može se skladirati na deponiju opasnog otpada.

OSNOVNE KARAKTERISTIKE DEPONIJE OPASNOG OTPADA

Uredbom o odlaganju otpada na deponije ("Sl. glasnik RS", br. 92/2010) bliže se određuju parametri važni pri definisanju lokacije deponije opasnog otpada, daju se precizne smernice za projektovanje i izgradnju ovog tipa deponije, posebno tehnički i

tehnološki uslovi, sadržaj i način monitoringa rada deponije i održavanje posle zatvaranja.

Deponija se locira, po pravilu, u uvalama zaklonjenim bočnim reljefom, bivšim pozajmištima zemlje i ravnim terenima koji su bez tekućih i stagnirajućih voda. Strmi tereni sa nagibom preko 25% mogu se koristiti za deponije uz primenu adekvatnih tehničkih

mera (planiranje, škarpiranje, podgrađivanje i dr.). Deponija se ne može locirati na terenu sa jako ispucalom stenovitom podlogom sa visokom vodopropustljivošću i nedefinisanim pravcima kretanja podzemnih voda i na području ugroženom klizanjem, urušavanjem, sleganjem tla ili drugim pomeranjem zemljine mase, ukoliko se takva pojava ne može sprečiti tehničkim merama.

Sl. 1. Tipičan presek kroz deponiju opasnog otpada

Na deponiji se uređuje deponijsko dno i nagibi, tj. bočne strane na način koji će osigurati stabilnost deponije, obezbediti zaptivanje, odnosno vodonepropusnost koja zajedno sa sistemom za prijem i odvođenje procedne vode sprečava njeno prodiranje u podtlo deponije. Dno i bočne strane tela deponije opasnog otpada treba da se sastoje od prirodne geološke barijere koja zadovoljava zahteve u vezi propustljivosti i debljine sa kombinovanim dejstvom u smislu zaštite tla, podzemnih i površinskih voda od $K \leq 1,0 \times 10^{-9}$ m/s i sa debljinom sloja ≥ 5 m.

Kada prirodna geološka barijera ne zadovoljava propisane vrednosti, ona se obezbeđuje oblaganjem deponijskog dna sintetičkim materijalima ili prirodnim mineralnim tamponom koji mora biti tako konsolidovan da se dobije ekvivalentna vrednost dna u smislu njegovih vodopropusnih svojstava. Prirodni mineralni tampon ne sme biti manji od 0,5 metara.

Na deponiji je potrebno obezbediti i dodatnu zaštitu dna deponije kako bi se sprečila migracija procedne vode u podtlo deponije i to na sledeći način:

Tabela 1. Zahtevani nivo zaštite dna deponije za opasni otpad

Zaptivanje i drenaža dna deponije	Za opasan otpad
Veštačka zaptivna obloga-folija (geomembrana)	zahteva se
Drenažni sloj ≥ 0.5 m	zahteva se

Za zaptivanje deponijskog dna i bočnih strana deponije mogu se koristiti i

druge metode i tehnike, ako obezbeđuju uslove iz Tabele 1.

Sl. 2. Detalj "A" - Struktura zaptivanja/drenaže dna i padine

Projekat drenažnog sloja, drenažnih cevi i odvodnih kanala izrađuje se na osnovu proračuna bilansa voda kako bi se omogućilo delovanje sistema za dreniranje i prečišćavanje procedne vode, kontrola rada i održavanje deponije. Na deponiji opasnog otpada potrebno je obezbediti poseban sistem za sakupljanje i odvođenja procedne vode kroz drenažni sloj u koji su položene drenažne cevi za njeno odvođenje u projektovani sistem za njen tretman. Prodiranje otpada u drenažni sistem sprečava se odgovarajućim tehničkim rešenjima. Za održa-

vanje i kontrolu drenažnih cevi za prikupljanje procedne vode potrebno je da se izgradi dovoljan broj šahtova, koji moraju biti stabilni i oslonjeni na podtlo. Za privremeno zadržavanje procedne vode koja se prikupi iz tela deponije potrebno je postaviti i sabirni šaht, koji je otporan na hemijske uticaje.

Nakon završenog perioda eksploatacije, deponija se zatvara za dalje odlaganje formiranjem gornjeg prekrivnog sloja koji ispunjava sledeće tehničko-tehnološke uslove:

Tabela 2. Zahtevane mere pri formiranju gornjeg prekrivnog sloja deponije za opasan otpad

Primenjene mere u smislu formiranja gornjeg prekrivnog sloja	Klasa deponije
	Za opasan otpad
Veštačka vodonepropusna obloga-folija	zahteva se
Nepropusni mineralni sloj ≥ 0.5 m	zahteva se
Sloj za rekultivaciju ≥ 0.5 m	zahteva se

Za sloj za rekultivaciju može se koristiti i otpad dobijen drugim tehnologijama biološkog tretmana, koji po sastavu zadovoljava

granične vrednosti parametara za odlaganje otpada.

Sl. 3. Detalj "B" - Projektovanje prekrivnog sloja

Nakon zatvaranja deponije sve do njenog odumiranja operater na deponiji preduzima mere koje se odnose na održavanje, nadzor, kontrolu i monitoring prostora deponije, u skladu sa ovom uredbom i Zakonom.

ZAKLJUČAK

Usvajanjem Zakona o upravljanju otpadom 2009. godine i njegovom dopunom 2010. godine stvoren je pravni okvir za postepeno uspostavljanje integralnog sistema upravljanja otpadom u R. Srbiji.

U okviru integralnog sistema upravljanja otpadom veoma važno mesto, ako ne i najvažnije zauzima trajno i sigurno zbrinjavanje otpada na deponiji. U cilju sinhronizacije domaće zakonske regulative sa regulativom EU, Vlada Republike Srbije 2010. godine donosi Uredbu o odlaganju otpada na deponiji ("Sl. glasnik RS", br. 92/2010). Ova uredba Vlade RS se praktično veoma malo razlikuje od Direktive EU o deponijama 1999/31/EC. Uredbom se po prvi put uvodi klasifikacija deponija pri čemu su sve deponije podeljene u tri osnovne kategorije i to:

- deponije inertnog otpada,
- deponije neopasnog otpada i
- deponije opasnog otpada.

Otpad iz rudarstva koji nastaje istraživanjem, iskopavanjem, preradom i skladištenjem mineralnih sirovina, kao i jalovina iz rudnika i kamenoloma je izuzet iz važećeg Zakona o upravljanju otpadom. To znači da je flotacijska jalovina koja je odložena na starom Borskom flotacijskom jalovištu izuzeta iz navedenog zakona, međutim ukoliko se ista flotacijska jalovina podvrgne procesima reciklaže u cilju valorizacije preostalih korisnih komponenti, zakon se može primeniti. Bakar kao korisna komponenta se iz flotacijske jalovine izdvaja hidrometalurškim putem nakon čega preostaje kiseli otpadni materijal koji treba trajno i sigurno zbrinuti na deponiji.

U cilju klasifikacije otpada dobijenog nakon luženja, kiseli otpad je podvrgnut standardnom testu luživosti SRPS EN 12457-2. Ispitivanjem dobijenog eluata prema Pravilniku o kategorijama, ispitivanju i klasifikaciji otpada ("Sl. glasnik RS", br. 56/10), otpadni materijal nakon luženja može se skladirati na deponiju opasnog otpada.

Kako u Srbiji ne postoje izgrađene deponije za odlaganje opasnog otpada, u cilju boljeg upoznavanja sa njima prikazane su njihove osnovne karakteristike i konstruktivni elementi, saglasno Uredbi Vlade o deponijama ("Sl. glasnik RS", br. 92/2010) i Direktivi EU o deponijama 1999/31/EC.

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