STUDIES AND RESEARCH ON ENVIRONMENTAL POLLUTION TO INDUSTRIAL WASTE DEPOSITS

STUDII ŞI CERCETĂRI PRIVIND POLUAREA MEDIULUI DE CĂTRE DEPOZITELE DE DEŞEURI INDUSTRIALE

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Abstract. *The Moldovan area has a large number of industrial waste deposits containing mine waste, slag, ash, technological waste etc. The presence of the deposit causes the air, soil, subsoil, surface and underground waters, flora and fauna and the mental state of the people to be polluted. The case study made at a landfill site highlights the multiple forms of induced pollution and their serious consequences on the environment. The deposit consists of a mixture of slag, foundry residues, industrial liquids, etc., which are extremely aggressive in air, soil, surface and underground waters. Physical and chemical indicators analyzed for soil in the area adjacent to the landfill were pH, Cd (cadmium), Mn (manganese), P (lead), SO4 (sulphate), etc. The pollution phenomenon affects all forms of environment in a serious form and the impact is indefinite.*
Key words: air, ash, impact, soil, slag, underground

Rezumat. *Zona Moldovei prezintă un număr mare de depozite de deşeuri industriale ce conțin steril de mină, zgură, cenuşă, reziduuri tehnologice etc. Prezența depozitului determină poluarea aerului, solului, subsolului, apelor de suprafață şi subterane, a florei şi faunei, dar şi a stării psihice a oamenilor. Studiul de caz întocmit la un depozit de deşeuri siderurgice evidențiază multiplele forme de poluare induse şi consecințele grave ale acestora asupra mediului. Depozitul este format dintr-un amestec de zgură, reziduuri de turnătorie, lichide industriale etc., care au un caracter extrem de agresiv asupra aerului, solului, apelor de suprafață şi subterane. Indicatori fizico-chimici analizați pentru solului din zona învecinată depozitului de deşeuri au fost pH-ul, Cd (cadmiu), Mn (mangan), P (plumb), SO_4 (sulfați) etc. Fenomenul de poluare afectează într-o formă gravă toate formele de mediu, iar impactul este pe o durată nedeterminată.*
Cuvinte cheie: aer, cenuşă, impact, mediu subteran, sol, zgură

INTRODUCTION

The environment is the whole of the Earth's natural components and the conditions of their existence. Components are defined by air, water, soil and subsoil, flora and fauna, time-based social values, interactions between these components, etc. Pollution is a process of alteration of biotic and abiotic living

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environments, but also of the values created by human society. Pollution can be a degradation of the environment caused by natural factors and anthropogenic factors.

One of the 13 areas of regulation through the "acqui" in the field of the environment is represented by the vast and complex field of "waste management", which contains specific regulations on industrial waste deposits (Luca *et al.,* 2012).

In Romania, about 950 such constructions are considered as industrial landfills. Among these, according to their nature, the following classification is allowed: industrial waste landfills, about 354; mining tailings dumps, about 251; tailings ponds / basins, about 209 and other types. All these industrial landfills involve special problems of environmental pollution (Bălan, 2010; Luca *et al*., 2012).

MATERIAL AND METHOD

Studies and research have been carried out for a number of industrial waste dumps located in Moldova. Each warehouse has specific design, construction, exploitation and environment pollution. The paper (Bălan, 2010) presents a synthesis of the pollution induced by these deposits. A special situation is represented by the landfill, especially slag, belonging to S.C. ARCELOR MITTAL S.A. Galati (former Galati Steel Works).

The construction of the slag deposit started in 1968. The waste was stored in the warehouse resulting from the technological process of the Galati Steel Works (fig.1). The analyzed slag pit is located in the western part of the steel mill and borders with the Balta Mălinei to the north, west and south, and to the east, the road of exploitation of the commune of Şendreni commune. The site of the dump starts at 10.00 m on a plateau between the Cătuşa and Mălina valleys and the agricultural lands of Smârdan and Movileni. The hydrography of the area is dominated by the tributaries of the Mirena River and the tributary of the Siret left tributary. Industrial wastewater treatment is carried out in tailings ponds located at the edge of the slag pit (fig. 2).

Fig. 1 Waste landfill in operation

The landfill occupies an area of approx. 110 ha. The average storage height is approx. 50 m and it varies over the entire surface depending on the exploitation rate of the deposit. Located in the west of the steel mill, the heap began by occupying the eastern bank of Lake Malina, advancing to the other water-covered areas. The advancement occurred horizontally but also with a continuous slope, so starting from 40-46 m level, the discharge fronts area reached approx. 60 m.

a b

Fig. 2 Ponds for liquid and industrial wastewater decantation: a - general view of the pond with the settling basins; b - detail of the pond partition.

Primary data was processed using the statistical calculation programs and hydrological, hydraulic and pollutant computing programs applicable to the case study (Charbeneau, 2000; Appelo and Postma, 1996).

RESULTS AND DISCUSSIONS

The raw material used in the iron and steel industry is iron ore and coke. As a result of technological processes, there are large quantities of residues with different degrees of pollution. But they are large in volume and impose problems with their processing and storage. Much of the waste in the steel industry falls into the category of hazardous waste. The main types of waste are: blast furnace slag, steel slag, ash, sludges etc. The polluting substances present varying concentrations and the representative ones are dissolved salts (chlorides), heavy metals (arsenic (As), copper (Cu), lead (Pb), zinc (Zn), cadmium (Cd), chromium (Cr), manganese (Mn), iron (Fe), etc.).

During the period 1968 - 2008, they were transported on the site of the slag dump approx. 36 million tons of blast furnace slag and approx. 14 million tons of steel slag. These have been distributed over the heap surface in a more or less selective manner. Between 2003 and 2006, 3,0 million tons of blast furnace slag, 1,50 million tons of steel slag and 600,000 tonnes of other waste were deposited in the warehouse. An estimated weight of the materials stored in the warehouse is as follows: furnace slag - approx. 47%; steel slag - approx. 30%; Refractory wastes and others - approx. 23 %. The volumetric density of the deposited material is 2100 kg/m^3.

Part of the waste is recovered periodically, in order to recover the useful substances and use them for other purposes. In many cases, these wastes were stored in unsuitable conditions without land preparation, wind and rain transporting these wastes in large areas and infecting in many cases both groundwater and surface water, thus seriously affecting the environment.

Currently it has a selective management of slag waste. Separate areas have been set up for waste disposal. In the near future, the maximum waste recovery will be achieved by the excavation and processing of the dross in the dump without, however, affecting the stability and safety of the deposit. Waste that can not be recycled will be stored in distinct, controlled and selective areas according to technology.

To assess the environmental impact of landfill pollution, tables 1 and 2 present analyzes results of the performed on soil samples taken from the eastern side of the plant site over a longer period of time.

Table 1

Analysis of chemical indicators determined in control section of the dump area (inside the plant) (Bălan, 2010)

Ground proof code	Parameters				
	pH	**Cd**	**Mn**	**Pb**	**SO_4^-**
U. M		mg/kg	mg/kg	mg/kg	mg/kg
E / area	8.18	1.42	1370	53.2	460.2
E / 30 cm	8.20	1.58	1399	46.7	880.2
Normal values[1]		1	900	20	-
Alert threshold[1]		**5**	**2000**	**250**	**5000**
Intervention threshold[1]		**10**	**4000**	**1000**	**50000**
[1]Ord. 756/1997					

The analysis of the data presented in table 1 shows exceedances of normal values for cadmium, manganese, lead and pH values for soil samples collected in the plant. The other values fall within the permitted limits imposed by the standards.

Table 2

Analysis of chemical indicators determined in control section of the dump area (outside the enclosure) (Bălan, 2010)

Ground proof code	Parameters				
	pH	**Cd**	**Mn**	**Pb**	**SO_4^-**
U. M		mg/kg	mg/kg	mg/kg	mg/kg
E / area	8.26	1.61	1270	38.2	601.4
E / 30 cm	8.22	1.83	1184	37.5	909.8
Normal values[1]		1	900	20	-
Alert threshold[1]		**3**	**1500**	**50**	**2000**
Intervention threshold[1]		**5**	**2500**	**100**	**10000**
[1]Ord. 756/1997					

Data analysis shows that soil samples have a pH value above 8.0, which gives the soil an alkaline character in the area. The concentration of lead in all analyzed samples is above the normal values, without exceeding the intervention threshold or for sensitive uses.

Given the location of the sampling points towards the slag heap and the prevailing wind direction, the negative effect of its activity on the soil environmental factor can be highlighted.

The analysis of the data presented in table 2 shows for the outer area of the steel plant compartment overshoot of the normal values of the metal content (same as in the combustion chamber). The pH value for soil samples collected outside the enclosure is significantly higher and shows a high degree of alkalinity. The other values fall within the permissible limits.

The analysis carried out within the deposit during the research revealed the following risk situations (Bălan, 2010):

- the natural or artificial waterproofing of the deposit is not carried out;
- the landfill does not have a drainage system for collecting and treating the leachate;
- there are no guard channels for collecting the meteoric waters;
- the landfill does not have a collection and exhaust system for the storage gas;
- meteoric waters infiltrated into the landfill are not collected and discharged through a suitable drainage system;
- groundwater is contaminated by uncontrolled infiltration from the landfill.

The meteoric waters that infiltrate the deposited material infiltrate into the soil from where it reaches the groundwater and then into the emissary (Mălina pond). Also, the water leaked on the slope of the deposit produces an erosion phenomenon after which it is evacuated in the Mălina pond. Part of this water is absorbed by the mass of the deposit or the soil in the adjacent area. Infiltrated water influences the quality of the underground water and the water in the Mălina pond.

On the southern part of the heap there is the Mălina South tailings pond, through which the wastewater taken over by the C8 collector from the transshipment of the steel and furnace slag is discharged into the Mălina pond.

Since there is no drainage and collecting system for the leachate generated by the percolation of the deposit by the meteoric waters, the slag through its site influences both the quality of the underground water and the emissary (the Mălina pond). The waters of Mălina pond are discharged into the Siret River with an important contribution of industrial pollutants (Mănescu, 2013).

By overcoming the area of storage and distribution of industrial waste in the western part of the waste dumps, there were recorded some slopes in the slope of the deposit in 2004 and 2005. This phenomenon has caused clogging processes and even obstructions of the water outlet channel in the Mălina North area.

Proper monitoring of the operation of the landfill requires strict monitoring of the liquid, gaseous and solid emissions. It aims at verifying the compliance of emissions with the conditions imposed by the rules in force (environmental permit, water management permit).

The groundwater monitoring process should be performed for parameters: pH, suspensions, fixed residue, CCOCr, chlorides, sulphates, nitrates, ammonium, Fe, Ca, Mg, phenols, cyanides, Cr, Zn, Mn, Pb, Ni. The samples shall be taken from the observation drills executed on the site and adjacent to it. The samples are analyzed and the results are compared with the values imposed by the standards and norms in force (Stematiu, 2002). For groundwater monitoring, two drillings executed up to a depth of 21.0 m are used (Bălan, 2010).

CONCLUSIONS

1. The safe disposal of industrial landfills must be carried out in accordance with the regulations in the field correlated with those laid down in European legislation.

2. Slag deposits from steel plants require special attention due to the components included. They sensitively influence the stability and circulation of surface and underground water.

3. Safeguarding of the landfill must be carried out during the exploitation phase by adopting measures to control the extension and elevation of the landfill, but without affecting and polluting the site environment. Research in the case study indicates various stages of groundwater and surface water pollution.

4. In the exploitation and conservation phases, a permanent monitoring of the site-specific parameters as well as of the site environment must be carried out to minimize environmental pollution.

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