Buletinul Ştiinţific al Universităţii "POLITEHNICA" din Timişoara

Seria HIDROTEHNICA
TRANSACTIONS on HYDROTECHNICS

Tom 57(71), Fascicola 2, 2012

Soil pollution by ash dump CET Timisoara

Constantinescu Laura[1] **Nemeş Iacob**[1]

Abstract: The objective of this paper is the environmental impact on which it has the ash dump from thermal power plant of Timisoara. The main negative effects of dump on water, soil and vegetation, but also sealing of large areas can be removed or attenuate acting on the following main directions: using ash from burning coal, fixing the ash dump, cover the ash dump, direct recultivation of ash dump.
Keywords: pollution, soil, vegetation, dump, ash.

1. INTRODUCTION

Ash dump from thermal power plant of Timisoara (South CET) is located southwest of Timisoara, on the territory of Sanimhaiu Român commune, in the perimeter of Utvin village , about 6-7 km from Timişoara.

Ash dump is the result of the combustion of solid fuels such as soil-lignite coal, brown coal, and coal bottom - brought from Anina, Darova, Rovinari coalfields or Jiu Valley to obtain heat.

The utility of power plant of Timisoara is essential for heating (water, heating).

Ash from combustion is transported in liquid and deposited by sedimentation in a site.

Land area covered by ash dump is 50 ha, being deposited thickness of 3.0 m and was opened in 1987. Land for dump was for agricultural use, respectively pasture and arable. Dump surface is kept wet to prevent dust to rise.

Increased concentrations of radionuclides were found in nests at depths of 20-50 cm. The openings made in ash coffer dams at depths (1-5 m) were not recorded relevant increases of the concentration of radionuclides, which leading to the conclusion that the radionuclides present in the ash dump are poorly mobile, not moved by meteoric waters.

Their presence in isolated accumulations derived from existing primary commitments in coal deposits from the areas of mining.

2. MATERIAL AND METHOD

The paper presents the impact of the ash dump on soils and vegetation in the area surrounding the dump.

The impact of the presence of ash dump on soils in the territory of Sânmihai was achieved by analysis of soil samples taken from 5 points located between the dump and Utvin, cultivated field or pasture, two depths from surface to 40 cm depth. Sampling was done in may and august, 1997 and 2008, reaching a total of 500 tests, such as the size distribution, content of substances, heavy metals content.

To highlight the presence or absence of changes in the chemical composition of herbal, plants were analyzed in two stages (May and August) of 4 parcels, both of spontaneous plants as well as cultivated plants.

Analyses were performed according to Elaboration Methodology of Soil Studies.

3. RESULTS AND DISCUTIONS

From comparison of data presented in (Table 1, Table 2, Table 3, Table 4) it can be appreciated that the air ash deposits have changed some properties of soil as follows:

- An increase in the content of fine sand and coarse sand to the soil surface;
- Acidification of the top 10-20 cm of soil (pH values even 5.61) probably due to sulfur deposits;
- An increase of ammonium (NH_4^+) and potassium content;
- Occurrence in soil of toxic concentrations of cobalt and lead;
- Occurrence in soil of critical concentrations of copper, cadmium, zinc,
- Increasing content of nickel, magnesium, iron and manganese.

The conclusion of soils study is that there was a clear impact of the ash deposits with pollution phenomena expressed mainly by toxic concentrations of some heavy metals that can cause damages of soil life or on organisms.

To highlight the changes in the chemical composition of plants, plants were analyzed in two stages (May and August) of four plots, both Flora spontaneous and cultivated plants (Table 5).

The main observations that can detach are:

- Weaker growth and development as a result of intensity decrease photosynthesis process.

[1] "Politechnica" University of Timişoara, Department of Hydrotechnical Engineering, George Enescu Street, no.1A, Zip code 300022,Timisoara, Romania, e-mail: lauraconstantinescu_m@yahoo.com

Table 1. Analytical data of soil samples from the area surrounding the ash dump of CETimişoara (1997)

The plots	A 519		A 524		A 614		PS 614		A 615	
depth cm	0-10	-40	0-20	-40	0-10	-40	0-10	-40	0-20	-40
coarse sand %	8,8	7,2	1,8	1,3	4,0	2,8	1,4	1,6	7,7	8,3
fine sand %	40,0	42,1	46,9	47,6	49,8	49,4	37,1	32,8	47,1	43,7
dust %	19,1	19,2	25,6	23,0	24,4	23,4	25,2	27,9	19,2	19,0
clay %	32,1	31,5	26,7	28,1	21,8	24,4	36,6	37,7	26,0	29,0
pH(H_2O)	7,17	7,26	5,61	6,01	7,81	8,62	7,32	7,69	5,84	6,29
carbonates		0,10			0,16	0,42	0,10	0,16		
humus	2,86	2,4	2,77	2,45	2,52	1,76	2,9	1,72	2,81	2,56
NO_3 ppm	3,30	3,6	5,40	5,4	3,3	3,30	4,5	3,3	4,8	3,60
NH_4 ppm	6,60	6,6	5,40	6,6	5,4	7,20	6,6	5,40	5,4	7,20
N_{total} %	0,146	0,120	0,140	0,120	0,124	0,095	0,149	0,087	0,141	0,127
P_{mobil} ppm	44,7	30,0	145	155	10,6	2,4	15,6	37,2	11,4	10,0
K_{mobil} ppm	150	128	382	276	106	100	150	240	140	104
SH me/100			4,76	4,40					4,20	3,74
Na^+ %					11,26					
SB me/100			12,71	13,91					17,11	18,71
T me/100			17,47	18,31		26,11			21,31	22,45
V %			72,45	75,97					80,29	83, 34
soluble salts mg/100g	55,7	47,7	66,3	39,8	76,9	95,5	66,3	63,6	42,4	47,7

Table 2. Analytical data of soil samples from the area surrounding the ash dump of CETimişoara (2008)

The plots	A 519		A 524		A 614		PS 614		A 615	
depth cm	0-10	-40	0-20	-40	0-10	-40	0-10	-40	0-20	-40
coarse sand %	6,5	7,6	2,8	4,1	3,5	3,6	1,9	3,9	6,8	5,2
fine sand %	37,9	36,5	37,0	37,9	39,9	37,2	31,9	27,7	46,5	43,6
dust %	20,3	19,2	24,7	28,0	24,7	23,6	28,9	28,5	19,9	22,1
clay %	35,3	36,7	35,5	30,5	31,9	35,6	37,3	39,9	26,8	29,1
pH(H_2O)	6,61	7,12	7,99	6,95	7,21	7,86	7,56	8,00	7,25	7,36
carbonates			0,08	0,10			0,08	0,10	0,24	0,24
humus	2,84	2,35	2,55	2,27	2,47	2,22	2,84	1,73	2,51	2,35
NO_3 ppm	5,66	3,52	3,39	4,4	4,32	3,64	3,08	2,05	5,97	5,93
NH_4 ppm	2,80	1,40	1,35	2,05	4,66	1,54	2,73	1,36	2,81	2,09
N_{total} %	0,156	0,124	0,131	0,117	0,128	0,117	0,152	0,092	0,131	0,127
P_{mobil} ppm										
K_{mobil} ppm										
SH me/100	2,13	2,01	1,15	1,23						
Na^+ %								1,79		
SB me/100	26,87	27,32	25,60	24,09						
T me/100	29,00	29,33	26,75	25,32				31,76		
V %	92,65	93,04	95,41	95,14						
soluble salts mg/100g	106,1	95,5	159,1	100,8	116,9	106,1	132,6	190,9	79,6	106,1

Table3. Heavy metals content (ppm) of soil samples from the area surrounding the ash dump of CETimişoara (1997)

The plots	A 519		A 524		A 614		PS 614		A 615	
depth cm	0-10	-40	0-20	-40	0-10	-40	0-10	-40	0-20	-40
copper	35,0	42,5	42,5	45,0	37,5	40,0	50,0	51,0	37,5	45,0
zinc	80	55	55	85	55	45	30	55	80	85
mangan	575	475	900	975	775	850	1175	1225	950	900
cobalt	62,5**	67,5**	50,5**	62,5**	25,0	30,0*	42,5*	35,0*	62,5**	72,5**
chrome	56,1	52,3	40,2	55,5	61,8	72,1	56,6	63,2	55,5	55,1
nickel	16	25	5	5	21	20	23	21	16	5
lead	30	22,5	105**	4	30	22,5	62,5*	70*	10	40
cadmium	1,5	1,3	1,4	1,3	1,1	1,4	1,4	1,3	1,5	0,9

Table 4. Heavy metals content (ppm) of soil samples from the area surrounding the ash dump of CETimişoara (2008)

The plots	A 519		A 524		A 614		PS 614		A 615	
depth cm	0-10	-40	0-20	-40	0-10	-40	0-10	-40	0-20	-40
copper	34,4	21,6	19,0	22,8	30,1	27,7	20,0	24,7	19,5	19,0
zinc	30,2	28,5	28,8	30,5	32,5	30,8	26,8	29,1	28,8	32,9
mangan	122,1	119,8	125,7	124,7	125,1	126,4	172,2	127,7	127,9	127,9
cobalt	50,0*	50,4*	42,3*	45,6*	21,4	24,2	40,0*	31,3*	48,8*	43,5*
chrome	43,0	36,5	38,1	46,9	50,1	56,7	48,4	51,4	42,6	40,7
nickel	49,7	22,6	22,8	2,7	30,2	33,5	23,9	26,0	25,5	25,5
lead	13,7	11,2	15,9	12,3	20,0	17,0	16,8	16,1	15,3	26,6
cadmium	1,3	1,2								

Table 5. Analytical data of samples of plants from the area surrounding the ash dump of CET- Sânmihaiu Român

Place and date chemical indicators		A 519 spontaneous flora		A 519 cultivated flora		A 614 plants		PS 614 plants	
		7.05.97	18.08.97	7.05.97	18.08.97	7.05.97	18.08.97	7.05.97	18.08.97
nitrogen	%	1,68	1,95	3,56	3,52	2,25	2,38	3,54	3,68
phosphorus	%	0,17	0,18	0,49	0,48	0,23	0,18	0,45	0,26
potassium	%	1,71	1,96	1,80	1,80	0,91	1,51	1,86	1,35
heavy metals									
cobalt	ppm	5,0	2,5	12,5*	1,88	6,25	7,5	10,0*	5,0
copper	ppm	10, 0	22,25**	18, 5*	1,25	15,5*	10,25	10,0	21,25**
Mangan	ppm	107,5	61, 0	82,5	45,0	325	110,5	75,0	102, 5
zinc	ppm	62,5	92,5	37,5	72,5	37,5	72,5	32,5	93,7
cadmium	ppm	0,2	0,2	0,3	0,2	0,3	0,2	0,3	0,2
nickel	ppm	10, 0	<5	7	<5	13	<5	10	<5
magnesium	ppm	3075	65	3100	5065	2700	7065	3000	1815
lead	ppm	2,5	2,8	2,5	2,6	2,5	2,8	2,5	2,8
iron	ppm	788**	550**	1150**	312*	4075**	412*	1250**	9750**

* - critical concentration

** - toxic concentration

This is due to the ash dust deposition on plants and even reduction of radiation by atmospheric contamination.

- The emergence of heavy metal concentrations toxic to plants, respectively iron and copper;
- The existence of critical concentrations of cobalt and manganese.

Therefore, it can be concluded that there are changes in the vegetation, but analysis is needed for a greater number of plants and maybe animals.

The main negative effects of the dump, respectively contamination of surface water, groundwater, soil and vegetation, but also sealing of large areas can be mitigated or eliminated by acting on the following main areas:

- Use ash from burning coal;
- Fixing the ash dump;
- Direct recultivation of ash dump;
- Dump stabilization through dense fluid method.

a). The main directions of using ash from power plants are:

- The manufacture of filler cements clinker grinding to a rate of up to 15%;
- The production of autoclaved aerated concrete;
- The construction of embankments and roads (using ash in road construction is limited to a radius of 15-20 km from the ash deposit to fit in terms of economic efficiency, so far have only used for earthworks the county roads, utilities and technology located in the ash deposits area);
- The construction of dams of deposits formed hydraulic near the coal thermal power plants;
- As a replacement part cement to manufacture for hydrotechnical concrete;
- In the manufacture of some types of products made from concrete without cement;
- In the manufacture of various ceramic materials of construction;
- The manufacture of alumina;
- As additive in mixture of sand for foundry core;
- In preparation of products for cleaning metal surfaces;
- Paper-making;
- In the manufacture of rubber;
- As a filler in the manufacture of plastics;
- In the manufacture of paints and matches;
- For cementing oil wells.

In agriculture has tried to use ash as amendment and directly recultivation of ash dumps. It is estimated that the ash produced in Romania can be used more than 30% in industry.

From the analysis of data on the use of ash from power plants for different purposes following main conclusions can be drawn:

- Predominant use of coal ash, and concerns of expanding the use of lignite ash;

- Are used in most cases captured freshly dry ash, ash from dump has a low use;

- The largest quantities of ash are consumed in civil, industrial, hydrotechnical and road constructions and building materials industry;

- Ash production is growing due to the extension of power plants coal, which will require finding new storage areas and fixing and recultivation of ash dumps surfaces.

b). Fixing ash dumps is done by the following methods:

- Fix using an emulsion polymer, a method that is used on abandoned dumps a period of 0.3 to 2 years;

- Fix using an emulsion polymer and sowing dump, in which the polymer must be chosen such that the crust made to be resistant to water and wind, permeable to water and non-toxic to vegetation;

- Fix by applying sprinkler watering; this method is usually used on dumps that are inactive for a short period of time;

- Fix using organic mulch and sowing dump;

- Fixation with a soil cover with thickness 3-5 cm and sowing perennial plants (legumes and grasses selected according to geographical area where it is located dump);

- Fix using seeded textile carpets.

c). Cover ash dumps is particularly made with soil.

In addition to soil for recover is recommended settling sludge (from rivers, lakes) peat, sapropel (mud of ponds) and other organic fertilizers.

The best results were obtained by recultivation of ash dumps by using a cover of 20 cm of soil and organic fertilizers and NPK fertilization.

Thus, the 200 species tested on dump were selected 19 species, which gave the best results as: Bromus inermis, Frestuca pratensis, Melilotus albus, Salcola kali, Betula, Salix, Pinus, Artemisia leesingiana etc. Vegetation maintenance on dump needed to return each year with fertilizers, prohibiting animals on the dump and leaving to self-sown plants.

d). Direct recultivation dump

The research concluded that the limiting factor of production on the ash dump is moisture deficit and lack of nutrients. Paying due attention dissipation where water is provided can be used successfully mineral fertilizers without the need for cover with soil or peat. For protection against dissipation, at young plants will be applied frequent watering, so always be moistened ash surface. Will be sowing the optimal time and will be fertilized with organic fertilizers. It was found that graminaceae are more sensitive than the legumes at the insufficient content of nutrients elements in the substrate, but legumes largely disappear in the insufficient humidity conditions.

By cultivating dumps obtains an increase in microbial life in the dump. Higher plants take part indirectly to increase microbial life, through the enrichment of substrate in organically substance and through more species of microorganisms.

A potential source of phytotoxicity, to cultivate the plants on ash dumps, is the high content of ash in Cu, Ar, B, Al. Their solubility depends on the pH dump. Root growth was reduced by half when the aluminum concentration in solution increased to 2.0 mg/l, in boron to 90 mg/l, in arsenic at 1.6 mg/l, in copper to 0.3 mg/l and in soluble sulphates at 100 mg/l.

Large amounts of aluminum and iron in the dump set phosphorus, which makes only a small part is accessible for plants.

4. CONCLUSIONS

Ash dump owned CET Timisoara, occupying an area of about 50 hectares of agricultural land and is located east of the village Sânmihaiu Român, suffer wind erosion, is a risk factor for adjacent area of about 10 km radius and has the effect of pollution and environmental degradation.

Impact assessment was based on analysis of water, soil and vegetation, performing physical and chemical analysis, including determination of heavy metals content (such as cadmium, cobalt, lead) that have serious effects on the body.

Main conclusions on impact are:

a). There are phenomena of contamination of surface water and groundwater (NH_4, NO_3, NO_2, heavy metals);

b). Changes occurred in the composition of wild and cultivated flora;

c). There have been changes in the first 40 cm of soil cover, such as increase of sand content, pH change, toxic concentrations of heavy metals.

This calls for urgent measures to the use of technology to stop environmental pollution phenomena.

REFERENCES

[1] Borza *I.,* Improvement and soil protection, Mirton Publishing House, Timişoara, 1997.

[2] *Coste I.,* The natural vegetation of Banat and Crisana, Public. SNRSS, Conf. Timişoara, vol.1, Bucharest, 2004.

[3] *Dumitru M.,* Overview of monitoring soil quality Public. SNRSS, Conf. Timişoara, vol.1, Bucharest, 2004.

[4] *Florea N.,* Degradation, protecting and improving soil and land, Estfalia Publishing House, Bucharest, 2003.

*** ICPA, Elaboration Methodology of Soil Studies, vol. I, II, III, Bucharest, 2003

*** ICPA, Monitoring soil quality status in Romania, vol. I, II, III, Bucharest, 2002.