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Evolution of Heavy Metals Concentration when Using Electro Screened Ash in Building Materials

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Abstract: In the paper, the possibility of dense slurry reuse is studied, from COLTERM S.A. of Timisoara Thermal Plant, by embedding them into various building materials and by observing the heavy metal concentration evolution, contained originally by the slurry. The dense slurry usually had density of 1.36 kg/dm^3, results as mixture of fly ash (resulted from burning the lignite coal) and the same quantity of water into the thermal plant; this operation is made with special devices. The building materials, poured in cube shape, were compacted manually, by shaking and keept in air until when were mechanical tested (compression strength). Migration of heavy metals, (Cr, Cu, Ni, Zn, Pb, Cd, Sr), from these materials into the soil, was analyzed by immersing the hardened cubs into ultrapure water (Millipore), simulating conditions of repeated torrential rainfalls. Determining the exact concentration, was made using novAA 400 G atomic absorption spectrophotometer, equipped with MP60 autosampler, graphite oven, specialized software, WinAAS, for continuous data processing and predefined methods (CookBook).

Keywords: dense slurry, fly ash, dumps ash, concentration, methods.

1. Introduction

The dense slurry is obtained in a special device by mixing fly ash (as results from lignite combustion) with water in 1:1 mass proportion an it is transported through pipes to the dump (Utvin county). Possible utilizations of the dense slurry, fly ash and dump ash produced by COLTERM S.A Thermal Station in Timisoara are the productions of new building materials (for base layer and secondary roads, materials for masonry etc.).

2. Experimental researches

The samples resulted by mixing the following materials: dense slurry, lime (L) CL90 type, cement (C) CEM I 42.5R type, river sand 0-4 mm sort, fly ash (CT) and water. The mixing was mechanical for a period of 2 minutes. In the mud from the plant were introduced during mixing: lime, cement, sand, fly ash and water. The mixture was poured in forms (cubes of 10 cm length). Compactuses was assured manually, by gentle shaking the forms.

Compositions were established with the formula:
% ∑ mixed binders = % ∑ (classical binders + CT) =100%
Where CT= fly (electro filter) ash and dump ash.

The ash played also a role as micro aggregate.

Various percentages of classic mineral binders were established and the ash resulted from the relation:

% CT= 100% - % ∑ classic binders

In order to study the less of heavy metals the cubes were dipped in equal volumes of ultra pure (millipore) water (2 liters) having pH = 4.6 and conductivity of 3.5 µS.

The heavy metals concentration were periodically determined using a nov AA 400G atomic absorption spectrometer equipped with Analytic Jena graphite furnace and MP 60 Auto sampler and provided with Cookbook for all elements and Win AAS specialized soft for the collection, work-up and storage of data.

The surface of the cubes, after drying was studied with a L 2020 microscope (Reflected and Transmitted Light Microscope) equipped with an uEye digital camera

3. Results and discussions

The experiments were made in order to evaluate the toxicity degree of fly ash and dense slurry or dump ash (dead ash) that results in winter periods at COLTERM S.A. Thermal Station and which or stocked at the ash dump.

Composition of the working samples is shows in tables 1 and 2.

TABEL 1. Composition of tested cubes

Ash type	Sample code	Water %	Lime %	Cement %	Ash %	Sand %
Fly ash	C11	25	2	5	30	38
	C22	25	2	10	30	33
	C33	25	2	15	30	28
Dump ash	C44	20	2	20	20	38
	C55	20	2	25	20	33

TABLE 2. Composition of tested cubes with slurry content

Sample	Mixture composition					Water / binder
	Dense slurry %	Lime %	Cement %	Ash %	Sand %	
1	82,36	8,82	8,82	-	-	
2	88,88	5,56	5,56	-	-	
9	88,88	8,34	2,78			
10	85,72	8,56	5,72	-	-	
11	85,72	11,42	2,86	-	-	
12	78,80	12,12	9,08	-	-	
14	37,80	2,7	2,65	-	54,1	0,80
17	54,80	3,9	7,80	10,1	23,4	0,56

The concentrations of following heavy metals were monitored: Cr, Cu, Pb, Ni, Zn, Sr.

The recorded results are presented in tables 3-6 and figures 1-4.

The appearance of the immersion liquid modifies in time and becomes yellowish in case of probes with ash from C44, C55 batches (dump ash). The pH variations during the tests in not significant. Alkaline values ware registered accordingly with colloidal deposits (hydroxides-oxyhidroxides) observed on bottom and walls of containers, after the 60 day immersion period.

The microscopic appearance of cubes surface after 60 days immersing in water and drying is shows in charts from figures 5, 6, 7, 8.

TABEL 3. Determination of chromium from the immersion water

No.	Sample	Cr, ppb				
		6 days	13 days	23 days	42 days	60 days
1.	C 11	5.668	8.633	12.032	-	-
2.	C 22	45.27	24.84	25.736	28.36	-
3.	C 33	105.37	98.608	111.77	147.95	-
4.	C 44	19.24	10.70	4.493	0	-
5.	C 55	27.46	16.13	16.28	16.77	-
6.	1	115.26	124.50	138.41	130.10	-
7.	2	15.60	6.90	2.79	-	-
8.	9	20.86	10.30	0	-	-
9.	10	9.27	5.06	1.63	-	-
10.	11	7.27	11.08	15.44	-	-
11.	12	352.2	448.4	556	500.21	-
12.	14	16.2	19.35	23.50	-	-
13.	17	17.40	8.15	7.80	7.53	-

TABLE 4. Determination of strontium from the immersion water

No.	Sample	Sr, ppb				
		6 days	13 days	23 days	42 days	60 days
1.	C 11	225.24	604.14	130.48	407.59	1462.06
2.	C 22	204.36	417.67	207.27	438.42	1292.12
3.	C 33	169.24	359.06	331.93	307.01	1087.13
4.	C 44	328.08	471.67	252.49	580.57	500.1
5.	C 55	166.94	422.08	137.11	451.10	1186.13
6.	1	130.81	373.39	91.01	377.19	1337.36
7.	2	229.16	686.50	673.30	425.42	1195.07
8.	9	194.75	572.46	146.45	508.74	1493.87
9.	10	291.13	655.48	615.48	306.78	1224.35
10.	11	113.63	399.47	355.40	388.84	902.83
11.	12	141.84	359.60	100.34	418.2	1262.6
12.	14	67.35	258.74	237.48	208.50	814.35
13.	17	983.46	948.97	491.96	380.47	-

TABLE 5. Determination of nichel from the immersion water

No.	Sample	Ni, ppb				
		6 days	13 days	23 days	42 days	60 days
1.	C 11	2.93	6.40	-	-	-
2.	C 22	7.82	41.62	-		-
3.	C 33	48.95	23.53	-	-	-
4.	C 44	47.08	128.33	22.16	0.1	-
5.	C 55	7.77	-	-		-
6.	1	-	6.49	-	-	-
7.	2	214.12	787.38	176.47	9.81	-
8.	9	72.36	158.49	22.55	-	-
9.	10	48.56	213.60	20.68	-	-
10.	11	-	-	-	-	-
11.	12	21.11	191.4	40.26	-	-
12.	14	-	-	-	-	-
13.	17	389.45	496.38	158.74	3.05	-

TABEL 6. Determination of zinc from the imersion water

No.	Sample	Zn, ppb				
		6 days	13 days	23 days	42 days	60 days
1.	C 11	-	912.96	2477.24	1008.68	1663.4
2.	C 22	597.09	510.42	556.36	806.78	1520.1
3.	C 33	389.82	466.90	628.07	719.77	1464.3
4.	C 44	273.44	-	-	-	-
5.	C 55	26.87	91.23	-	-	19.48
6.	1	210.56	980.99	2758.67	1558.84	2525.6
7.	2	412.31	1277.44	3755.67	1394.48	2983.25
8.	9	568.22	1241.61	3527.64	2144.72	2820.10
9.	10	581.32	1242.43	3069.56	1648.34	2526.96
10.	11	365.21	936.99	2980.53	1800.18	2607.07
11.	12	452.96	1147.60	2576.0	1609.20	2666.01
12.	14	165.23	420.20	1138.60	669.50	1191.36
13.	17	698.90	767.56	1933.85	1009.76	895.87

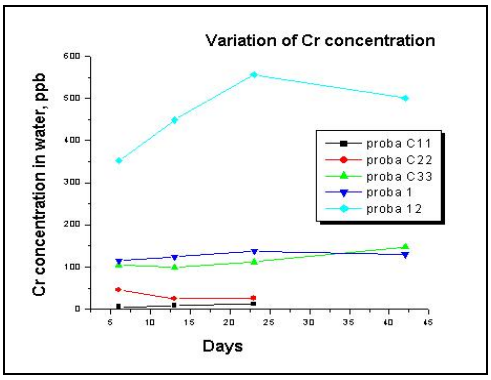

Figure 1. Variation in time of chromium concentration in immersion water

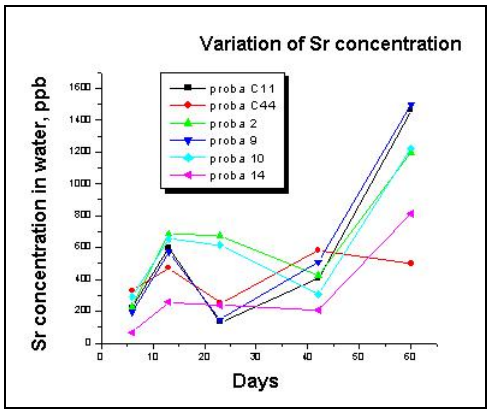

Figure 2. Variation in time of zinc concentration in immersion water

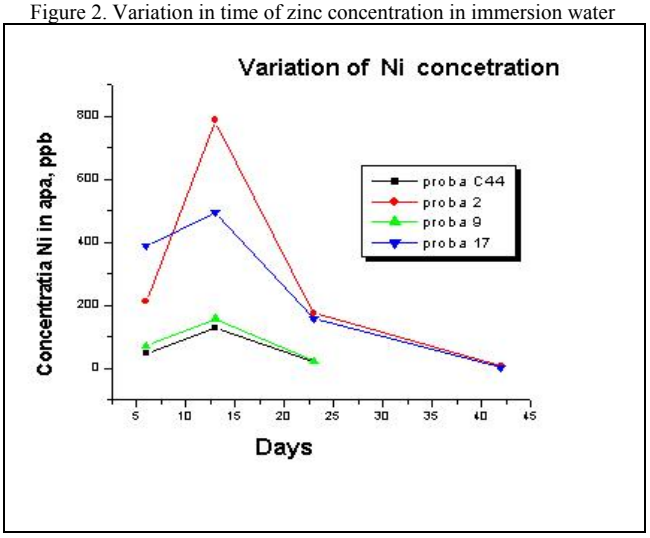

Figure 3. Variation in time of nichel concentration in immersion water

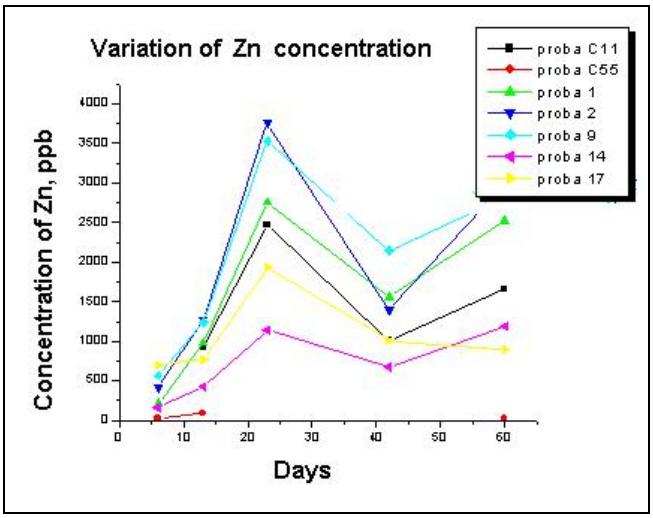

Figure 4. Variation in time of nichel concentration in immersion water

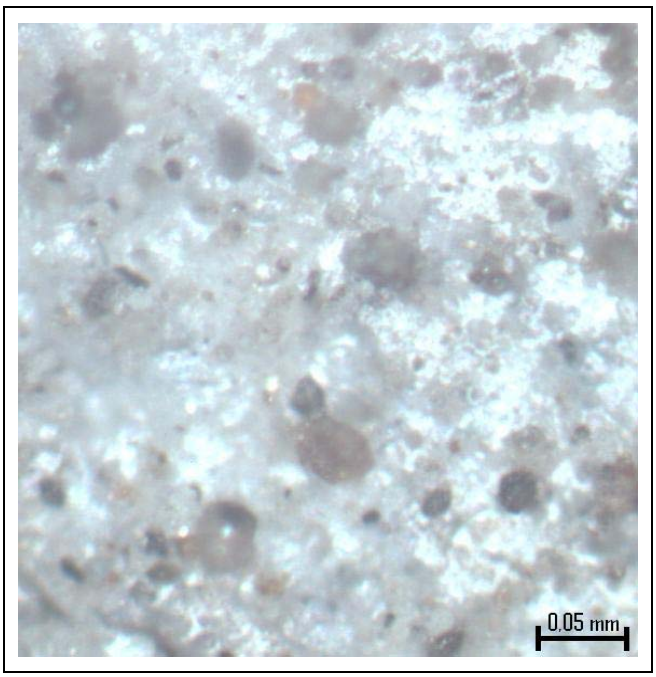

Figure 5. Microscopic apparence of surface portion taken from sample 2; front view.

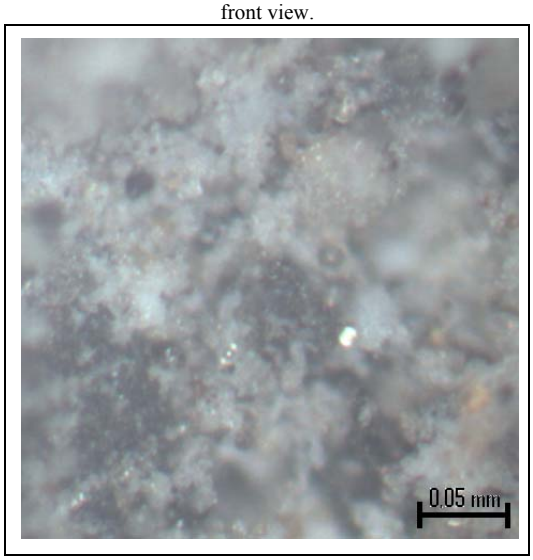

Figure 6. Microscopic apparence of surface portion taken from sample 2; bottom view.

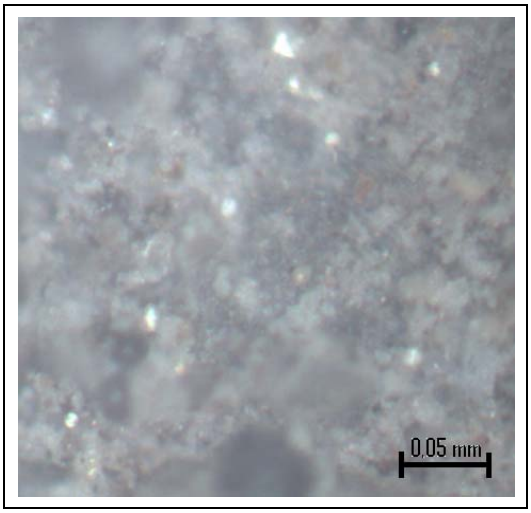

Figure 7. Microscopic apparence of surface portion taken from sample 2; front view.

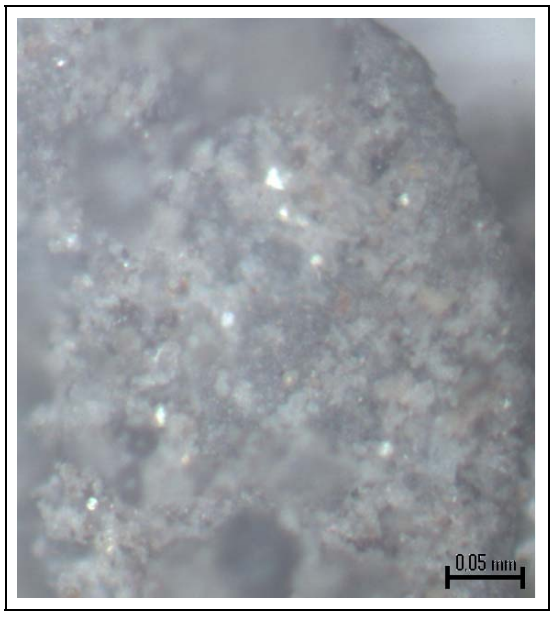

Figure 8. Microscopic apparence of surface portion taken from sample C11; bottom view.

4. Conclusions

In can be observed that in the case of use of dump ash, the heavy metals content is smaller, probably due to the rains that have washed and transported the heavy metals in soil. In the case of test cubes 1-17 containing dense slurry greater amounts of Cr, Sr and Zn can be observed.

In the batches C11 – C55 a greater amount of heavy metals in water is observed for cubes C11 - C33 which contain greater amounts of ash (up to 30%).

The very high concentration of Sr is allowing. The use of these wastes is to be thoroughly analyzed. They could be used to produce materials for the isolation or plating waste dumps that are not placed in proximity of cultures of residences.

From mechanical properties point of view, new building materials based on dense slurry with fly ash are the same with ceramic bricks and lightweight concrete, Which are materials used for masonry.

The use of industrial waste like fly ash, dump ash and dense slurry represent a positive position regarding the conservation and the protection of the environment.

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