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ASHES AS AN AGENT FOR CEMENT-LIME BASED SOLIDIFICATION/ STABILIZATION OF THE HAZARDOUS WASTE

PEPEO KAO SREDSTVO NA CEMENTNO-VAPNENOJ OSNOVI ZA SOLIDIFICIRANJE/STABILIZIRANJE OPASNOG OTPADA

BARBORA LYČKOVÁ[1], VLADIMÍR HŮDA[2]

[1]VŠB-TU Ostrava, HGF – IEI, 17. listopadu 15/2172, 708 33 Ostrava-Poruba
[2]GESTA a.s. Rynoltice, Rynoltice 149, 463 55 Rynoltice

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Abstract

One of the common treatment methods for the hazardous waste is the cement and cement-lime based solidification/stabilization (S/S). This article deals with the possibility of currently used recipe modification using fluidized bed heating plant ashes as an agent.

Sažetak

Jedan od uobičajenih postupaka obrade opasnih otpada je primjena cementa i solidificiranje/stabiliziranje (C/S) na cementno vapnenoj osnovi. Rad obrađuje mogućnost modifikacije, trenutno često korištene metode upotrebe pepela iz toplana kao agensa u fluidiziranom sloju.

Introduction

GESTAB is a two-stage stabilization technology. The waste is processed as a liquid, before processing the waste is turned into liquid state, suitable for pumping. Technology combines following processes: pH change, change of chemical composition, coagulation, neutralization, solidification and encapsulation. The basic currently used agents are Portland cement, hydrated lime (calcium hydroxide), neutralization agents and reduction/ oxidation agents.

The first stage of the GESTAB technology is „primary stabilization“. During this process amount of approximately 100 cubic meters of the waste (or of mixture of various sorts wastes) is slowly mixed for 4-12 hours. During the second stage, waste is homogenized with agents in a high-speed homogenization device. The amount of the agents, which are added, differs according to the recipe. Preprocessed product (unmatured material) is then pumped into pools and spread there in thin layers. It matures in the pools from 3 to 6 moths. The advantage of this method is a high level homogenization of the waste and the fact that solid, semisolid and liquid waste can be processed with this technology.

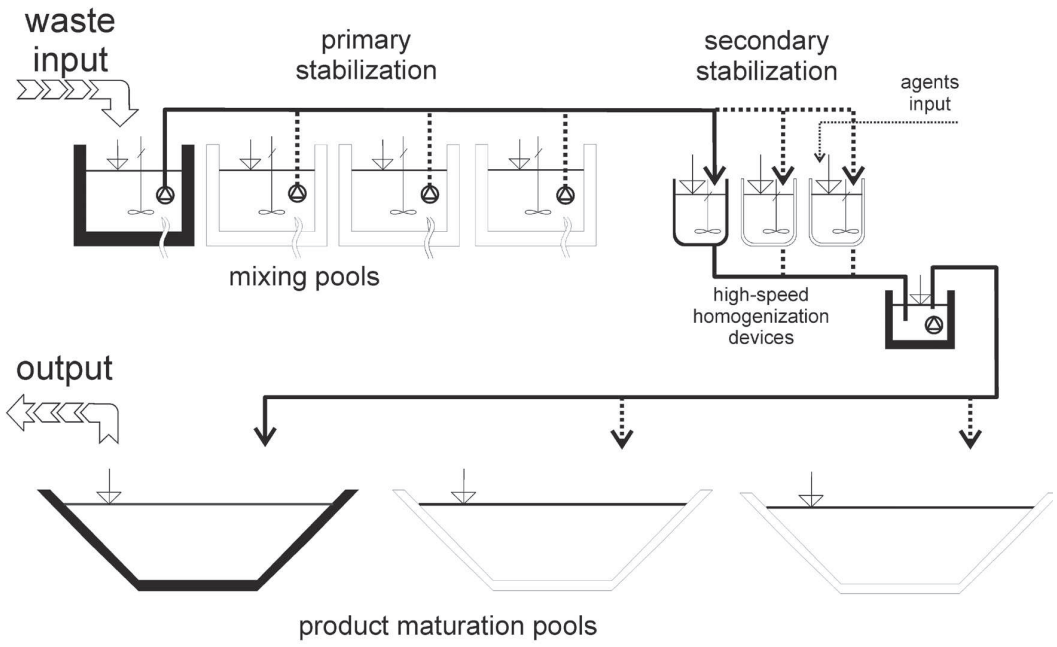

Figure 1 GESTAB technology diagram
Slika 1. *Dijagram tehnološkog postupka GESTAB*

The aim of the recipe modification

A new recipe aim is improving cost effectiveness of waste processing while maintaining the high reliability of the GESTAB technology.

The main focus in the S/S process is paid to the immobilization of metalic ionts and compounds as well as organic matters (Hlavatá, 2004). For that reason among the most suitable agents shall be those that positively affect the amount of pollution in water leach.

Among the agents, which have the ability to absorb heavy metals and organic compounds, ashes are the cheapest and available in large amounts (Fečko et al., 2003). They also sets and harden after being mixed with water similarly to cement. Clays (especially bentonites) also have some of these features (Bhatty et al., 1999).

The following agents were selected for the experiment:

- Portland cement (class CEM III – A 32,5 N)
- fluidized bed hating plant brown coal ashes
- bentonite (Obrnice plant, Keramost a.s.)

At the beginning there were five different recipes, each of which was based on adding from 15 to 20% of the agents to the waste. The samples were marked ZK-1 to ZK-5. The detailed recipes are shown in overview below:

Table 1 The recipes used in tests
Tablica 1. *Mješavine sredstava primijenjenih tijekom ispitivanja*

	ZK1	ZK2	ZK3	ZK4	ZK5
cement	15,0 %	10,0 %	0,0 %	15,0 %	7,5 %
ashes	0,0 %	5,0 %	20,0 %	0,0 %	10,0 %
bentonite	0,0 %	0,0 %	0,0 %	3,0 %	3,0 %

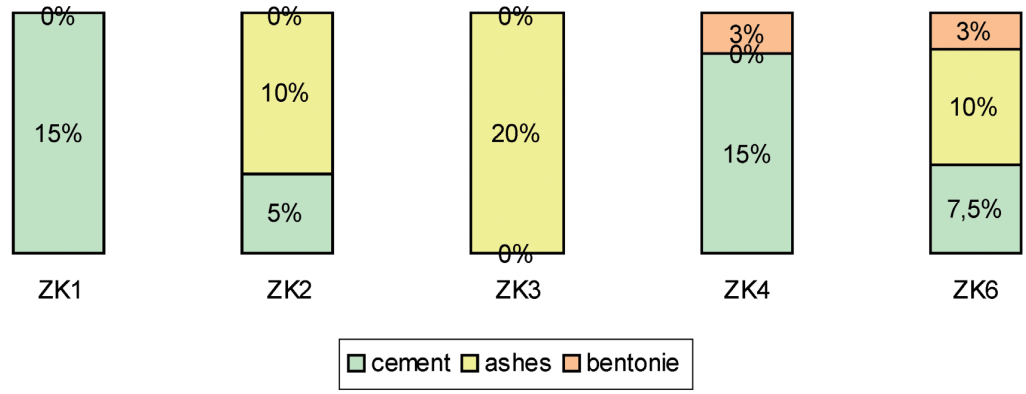

Figure 2 *The recipes used in test*
Slika 2. *Mješavine sredstava primijenjenih tijekom ispitivanja*

The selection of quality indicators

For the evaluation of the experiment results it was important to select proper indicators that can show how a given recipe affected the amount of pollutants in water leach. DOC (diluted organic carbon) was selected to show the effectivitiy of every given recipe to stabilize organic contaminants, inorganic ones were represented by Zn and Cr. This selection was made with respect to:

- the fact that DOC monitoring in water leached from waste is a relatively new important requirement;
- the experience-based knowledge that Zn as a very frequent metal in industrial waste, mostly present in the form of oxides;
- the fact, that Cr (especially Cr^{6+}) regularly causes toxicity of the waste;
- the need to evaluate effectiveness of the stabilization method with special attention to heavy metal immobilization;
- the requirement to monitor DOC, as the important indicator of the organic pollution.

The experiment

Mixture of the waste after the primary stabilization stage was used as a tested material. A sample was taken randomly from the first stage mixing pool. The experiment then continued in the laboratory.

Table 2 The content of the test material
Tablica 2. *Sastav ispitivanih materijala*

waste or group of waste	fraction
sediments from industrial waste water cleaning plant	20%
solid waste from gas purification containing hazardous matter	10%
cast processes solid waste (casting frames and cores)	7%
glass grinding and polishing waste	25%
acid or alkali solution	25%
metal grinding waste	4%
solid waste from drainage fat traps and sand traps	4%
other organic and inorganic waste	up to 100%

The composition of the waste shown above reflects the same composition of waste processed with GESTAB technology. The mixture of the waste was "preprocessed" before the experiment, which means that pH was changed to neutral and the waste was homogenized.

Samples weighing 1000g were inserted into glass container. They were marked ZK-1 to ZK5 (for different stabilization recipes) and ZK-6 as reference sample. Each sample was mixed with agents according to recipes with a glass stick for 5 minutes. After mixing the samples were inserted into an oven and left there for 48 hour at the temperature of 35°C. Then random samples weighing 500 g were taken from each container and put into sealed transport container. All samples were sent to laboratory for analyses.

The evaluation of the results

Only standard testing methods were used for samples analyses. The water leach was prepared in compliance to ČSN EN standards. The test reports and related documents (samples collection plan, samples collection report) are stored in the company's archives.

The content of Cr was near or under the detecting methods sensitivity threshold and we did not evaluate this parameter.

The content of the DOC in water leach was determined in compliance with *ČSN EN 1484 - determination of total organic carbon (TOC) and dissolved organic carbon (DOC)*. Zn and Cr concentrations in the water leach were determined with the atom mass spectrometry method.

The results are shown below:

Table 3 The indicators values
Tablica 3. *Vrijednosti pokazatelja*

test sample		stabilized waste					reference sample
		ZK1	ZK2	ZK3	ZK4	ZK5	ZK6
indicators	DOC	570	55	400	530	180	920
	Cr(total)	0,02	0,02	0,02	0,02	0,03	0,02
	Zn(total)	0,18	73,00	130,00	0,47	0,57	230,00

The numbers means mass in $mg.l^{-1}$ of water leach

Data interpretation

If we look at the data we can see some interesting patterns. In general we can see, that cement-ashes based S/S is less effective for the immobilization of organic compounds in comparison to of metals immobilization. It is not surprising considering the basic principles of S/S methods (Conner et al., 1997). Because of this fact, the waste with high level of organic pollutants is not suitable for stabilization. On the other hand, it is possible to process inorganic waste together with the waste which contains low content of some organic pollutants

Content of fluidized bed ashes remarkably improves the quality of water leach and this effect is further boosted by the addition of even small amounts of bentonite or Portland cement. Ashes have larger grains, which results in worse absorption of contaminants (Hlaváč, 1981). This property can be improved dramatically by the addition of cement and bentonite. From the economical point of view the fact that ashes are cheap and available in sufficient amount is very important. Under such circumstances the costs are lower even if the percentage of agent is slightly higher.

Sample ZK-5 showed that the recipe used for its preparation was most successful. It only contained one half of the amount of cement currently used which was replaced by 10% of ashes and 3% of bentonite.

Conclusion

The data we have collected show that fluidized bed ashes are prospective agent in cement or cement based hazardous waste stabilization/solidification. Large

amounts of cement can be effectively replaced with ashes. The replacement can save energy and costs. The recipe using cement-ashes-bentonite in 7,5-10-3 ratio turn out to be most effective for pollutant immobilization while being also the most cost effective.

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