MUNICIPAL SOLID WASTE INCINERATOR FLY ASH TO OBTAIN GEOPOLYMERS

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Abstract

Incinerator fly ash results in a heterogeneous mix of organic pollutants (dioxins, furans, etc.), volatile heavy metals and a variable part. These residues, which have an extremely fine grain size, have been successfully subjected to the stabilization/solidification (S/S) technology known as geopolymerization. The chemical stability of geopolymers obtained by alkali activation of metakaolin with Si/Al ratio of 1.8–1.9 and Na/Al ratio of 1.0, allowed the addition of 20 wt% of toxic fly ashes. Tested for leachability (accordingly to EN 12457 regulation), the proposed materials fall within limit values set by regulation for non-dangerous waste landfill disposal.

Introduction

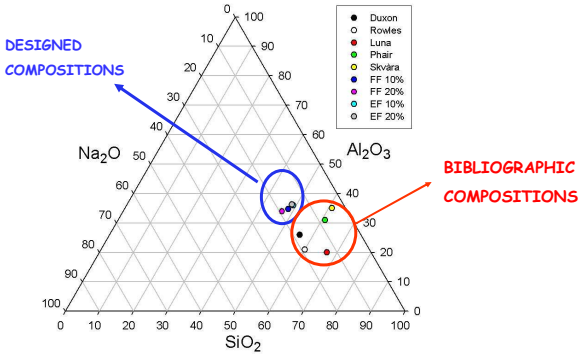
Considering the lack of landfill space and the contamination to environment, municipal solid waste is usually incinerated to reduce its volume and provide energy. The volatile metals (Pb, Cd...) are concentrated into the fly ash collected from the flue gas by the air pollution control devices (electrofilter EF and fabric filter FF). These residues, which are also characterized by a fine grain size, are potentially harmful to the environment due to the presence of leachable heavy metals (e.g. Cd, Cr, Mn, Pb), therefore they are classified as hazardous waste in Italy.

Geopolymerisation has recently received significant attention due to its low cost and flexibility, for instance, geopolymers have been used to immobilize and stabilize hazardous wastes.

Methods and Materials

The two kinds of fly ashes have been added to the metakaolin geopolymer matrix in percentage of 10 and 20 wt% (GPEF10, GPEF20 and GPFF10 e GPFF20, respectively) accordingly to the following steps: preparation of an alkaline solution by mixing, in a 1:1 ratio, concentrated (35 wt%) sodium hydroxide (NaOH) and sodium silicate, with 3.1 SiO_2/Na_2O molar ratio; dry mixing in a plastic container the mixture of metakaolin and fly ash in the desired proportion (10 and 20% wt); addition of the prepared alkaline solution to the dry powders in order to obtain a consistency of a paste to be poured into a greased container; setting stage with the maintenance of the paste at room temperature for 24 hours.

Results



Release values for the geopolymer matrix, GP, the geopolymer samples and as-received fly ashes, EF and FF (mg/l) (according to EN 12457) are reported in the table below.

SAMPLE	HEAVY METAL CONCENTRATION			
LAW LIMIT (for not dangerous dump)	Cr 1 ppm	Cd 0,02 ppm	Cu 5 ppm	Pb 1 ppm
EF	2,41	3,55	0,01	0,12
FF	2,31	3,22	2,63	3,94
GP	0,00	0,00	0,03	0,01
GP EF 20%	0,02 (1,57)	0,00 (0,84)	0,04 (3,80)	0,00 (4,03)
GP FF 20%	0,53 (0,60)	0,00 (1,60)	0,03 (3,99)	0,10 (11,5)
GP EF 40%	0,64 (2,92)	0,01 (1,56)	0,07 (7,05)	0,59 (7,48)
GP FF 40%	0,01 (1,12)	0,00 (2,99)	0,01 (7,47)	0,87 (21,5)

Ash-based geopolymers

Conclusions

The chemical efficiency, in the immobilisation of heavy metals, of the geopolymerization process has been evaluated by comparing the results of release test on the as-received fly ashes to the geopolimerized materials. From the values reported in the Table it is evident that the geopolymer materials present values at the inferior limit of detection of the ICP spectrometer. As comparison terms also geopolymer without ash is reported.

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