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(54) Title: INERTIZATION OF WASTE MATERIAL CONTAMINATED WITH HEAVY METALS

(57) Abstract

Method for treating waste material contaminated with heavy metals so as to make it inert, characterized in that the material to be made inert, optionally at least in part neutralized, is subjected to the following operations, optionally under stirring: addition of a concentrate aqueous solution of orthophosphoric acid and of an alkaline or alkaline earth salt thereof in a molar ratio ranging from 1:5 to 5:1; optionally addition of water to give the homogeneous paste thus obtained a sufficient moisture content; addition of calcium hydroxide and/or calcium oxide; the resulting homogeneous paste being placed in the open air to help it dry out. The material thus obtained is fit to be disposed according to local environmental legislation.

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INERTIZATION OF WASTE MATERIAL CONTAMINATED WITH HEAVY METALS

DESCRIPTION

The present invention relates to a method for treating waste material contaminated with heavy metals so as to make it inert, the treatment involving the use of calcium hydroxide and/or calcium oxide and a concentrated aqueous solution of orthophosphoric acid and of a salt thereof with an alkaline or alkaline earth metal.

As is known, special and/or toxic harmful waste material from various sources containing heavy metals, such as arsenic, cadmium, chromium, mercury, lead, selenium and tellurium, which is liable to give in transfer tests an eluate that does not comply with the established acceptability limits, needs to be disposed of in secured landfills for hazardous toxic wastes.

The prior art in this specific area records many techniques which allow metals to be immobilized in stable matrices, thereby making them acquire characteristics of chemical inertness capable of preventing their leaching and of thereby allowing these types of waste material to be disposed under less severe condition (leaching tests within limits imposed by national and international legislation).

Very often, these types of waste material have a composition which requires, for sufficient stabilization, the use of large amount of reagents, such as for example cement, or the use of expensive products, accompanied by long maturation times. Other solidification techniques make use of additives, such as slag, triturated bricks, pebble gravel, and sand mixed with bentonite, which results in excessive increases in the final weight and volume, accompanied by modest results in limiting the leaching of the metals.

In order to lower the binder component for example in the case of ash from mining flue gases, the

interfering ions (chlorine ions) are washed with water.

A number of systems recently applied use aqueous solutions of chemical products that are particularly expensive, as a result of which not enough is known about the physical and physicochemical conditions required for the various types of waste material, or about the amounts to be used in order to ensure the desired results.

There is thus a need, in this specific field, to have available a versatile method which does not require particular pre-treatments and which uses readily available and low-cost reagents, to be added in modest amounts in order to minimize the variations of the final weight.

The present invention makes it possible to satisfy the abovementioned requirements by also offering other advantages which will become apparent hereinbelow.

The subject of the present invention is thus a method for treating waste material contaminated with heavy metals so as to make it inert, characterized in that the material to be made inert, optionally at least in part neutralized, is subjected to the following operations, optionally under stirring:

- addition of a concentrate aqueous solution of orthophosphoric acid and of an alkaline or an alkaline earth salt thereof in a molar ratio ranging from 1:5 to 5:1;
- optionally, addition of water to give the homogeneous paste thus obtained a sufficient moisture content, the resulting homogeneous paste being placed in the open air to help it dry out;
- addition of calcium hydroxide and/or calcium oxide.

The calcium hydroxide and/or calcyum oxide, can be added in powder form, in an amount of between 10 and 350 kg per ton of the waste material to be made inert. Good results have been obtained with powder for construction use.

The concentrated aqueous solution of orthophosphoric acid and of an alkaline salt thereof can be the "Fissa Met", i.e. an inertizing solution which comprises orthophosphoric acid and at least one member selected from the group comprising mono, di, tri sodium phosphate (NaH_2PO_4, Na_2HPO_4, Na_3PO_4) anhydrous or hydrate, mono, di, tri potassium phosphate (KH_2PO_4, K_2HPO_4, K_3PO_4) anhydrous or hydrate, and mono, di, tri calcium phosphate ($CaHPO_4$, $Ca(H_2PO_4)_2$, $Ca_3(PO_4)_2$) anhydrous or hydrate which is added in an amount of between 1 and 200 litres, preferably 5 to 150 litres, per ton of material to be made inert.

The method according to the present invention is very versatile and can be applied to waste materials from various sources, such as metal slag, non-ferrous metallurgical waste, demolition residues, ash from plants for the incineration of solid urban, special, hospital, industrial and inorganic chemical sludge waste.

A description of the general nature of the present invention has been given hereinabove. A detailed description of a specific embodiment thereof, intended to allow the objects, features, advantages and operating modes of this invention to be better understood, will now be provided with the aid of the annexed example.

EXAMPLE

The inertization method according to the invention is applied to fly ash from the incineration of hospital waste. This material is introduced into a mixer. In parallel, calcium hydroxide is pneumatically added from suitable hoppers, in an amount of 90 kg per ton of waste, 50 litres of the "Fissa Met", i.e. an inertizing solution, which in the present example consists of a concentrated aqueous solution of orthophosphoric acid and of the hydrogen disodium salt thereof (disodium monohydrogen phosphate (Na_2HPO_4)), is added from another tank, together with just enough water to enhance the intimate contact of the mixture. The mixture needs to maintain a stirrable consistency and to be kept stirring for a few minutes.

At the end of this operation, the wet mixture is emptied out onto a suitable surface to help it to dry out completely, or is dried directly in a stream of hot air (whenever heat recovery is possible).

When subjected to eluate tests, the material resulting from the treatment revealed a release of lead, cadmium, copper and selenium which was within the acceptability limits for direct dumping (without additional treatment) in a secured landfill.

The original values of the metal concentrations in the eluate with a 0.5 M solution of acetic acid before and after the treatment are given for comparative purposes in Tables 1 and 2.

TABLE 1

METAL	BEFORE THE TREATMENT ELUATE (mg/l)	AFTER THE TREATMENT ELUATE (mg/l)	ACCEPTED LIMITS
Lead	10.500	0.200	0.200
Cadmium	6.400	0.020	0.020
Copper	0.600	0.100	0.100
Selenium	0.030	0.030	0.030

TABLE 2

	FLY ASHES FROM MUNICIPAL WASTE INCINERATOR			METALLURGIC SLAGS			METALLURGIC FLY ASHES			VARIOUS MATERIALS		
TESTS	C.M.* (mg/l)	eluate (mg/l)	eluate inert. (mg/l)	C.M.* (mg/l)	eluate (mg/l)	eluate inert. (mg/l)	C.M.* (mg/l)	eluate (mg/l)	eluate inert. (mg/l)	C.M.* (mg/l)	eluate (mg/l)	eluate inert. (mg/l)
Lead	1400	8.00	<0.02	87000	10.00	0.20	30000	250	0.20	12 .500	100	0.20
Cadmium	400	<0.02	<0.02	160	0.12	0.01	525	15	<0.02	25	0.40	0.02
Copper	75	<0.10	<0.10	...	...	...	1650	10	<0.10	0.10	15	0.10

*C.M. stands for "Crude Waste Material to be treated"

CLAIMS

1. Method for treating waste material contaminated with heavy metals so as to make it inert, characterized in that the material to be made inert, optionally at least in part neutralized, is subjected to the following operations, optionally under stirring:

- addition of a concentrate aqueous solution of orthophosphoric acid and of an alkaline or alkaline earth salt thereof;
- optionally addition of water to give the homogeneus paste thus obtained a sufficient moisture content;
- addition of calcium hydroxide and/or calcium oxide;

the resulting homogeneous paste being placed in the open air to help it dry out, before it is sent to a dumping site.

2. Method for treating waste material contaminated with heavy metals so as to make it inert according to claim 1, in which the neutralizing agent is selected from the group comprising NaOH, KOH and $Ca(OH)_2$.

3. Method for treating waste material contaminated with heavy metals so as to make it inert, according to claim 1 or 2, in which the calcium hydroxide or the calcium oxide is added in powder form, in an amount of between 10 and 350 kg, per ton of material to be made inert.

4. Method for treating waste material contaminated with heavy metals so as to make it inert, according to claim 3, in which the calcium hydroxide or the calcium oxide is added in the form of powder for construction use.

5. Method for treating waste material contaminated with heavy metals so as to make it inert, according to any one of the preceding claims, in which the concentrated aqueous solution of orthophosphoric acid and of an alkaline salt thereof is an inertizing solution which comprises orthophosphoric acid and at least one member selected from the group comprising mono, di, tri sodium phosphate (NaH_2PO_4, Na_2HPO_4, Na_3PO_4) anhydrous or hydrate, mono, di, tri potassium phosphate (KH_2PO_4, K_2HPO_4, K_3PO_4)

anhydrous or hydrate and mono, di, tri calcium phosphate ($CaHPO_4$, $Ca(H_2PO_4)_2$, $Ca_3(PO_4)_2$) anhydrous or hydrate which is added in an amount of between 1 and 200 litres per ton of material to be made inert.

6. Method for treating waste material contaminated with heavy metals so as to make it inert according to claim 5, in which the concentrated aqueous solution is added in an amount of between 5 and 150 litres per ton of material to be made inert.

7. Method for treating waste material contaminated with heavy metals so as to make it inert, as described, exemplified and claimed above.

INTERNATIONAL SEARCH REPORT

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PCT/IT 98/00046

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 A62D3/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 A62D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2 277 515 A (SEVENSON ENVIRONMENTAL SERVICE) 2 November 1994 see page 5, line 14-24; claims	
A	EP 0 568 903 A (SAMAG MASCHINENFABRIK SANGERSH) 10 November 1993	
A	US 4 737 356 A (O'HARA MARK J ET AL) 12 April 1988	
A	WO 97 31874 A (SOLVAY ;DERIE RENE (BE)) 4 September 1997	

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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INTERNATIONAL SEARCH REPORT

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