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Application of Coating for Immobilization of Heavy Metals

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Abstract: *Many vital industries discharge toxic heavy metal sludges into their waste streams The traditional concept of dumping of the hazardous waste is no longer valid because of their possible return to the environment and entering in to the food chain. In this context fixation or immobilization of toxic waste in a solid crystalline or polymeric matrix is important so that the monolithic solid mass thus obtained can be safely handled, transported and disposed off using well established methods of land filling and burial. The use of man made materials of low permeability to line the waste storage disposal has been demonstrated to be feasible method of preventing leach ate and toxic components from seeping out of waste impoundment and polluting the ground. water. A great array of materials including fine grain soils, clays and polymeric material are potential candidates for use as coatings or liners.The present paper deals with leaching of heavy metals in solidified waste coated with polyurethane coating.*

Keywords : *LFAS sludge flyash*

1. Introduction

Development of new environmentally friendly technologies are required in order to improve the waste disposal of metallurgical waste. Solidification /stabilization of heavy metals using various bonding agents like cements, pozzolanic material is a common technique used for immobilization of heavy metals [1] . Million tones of fly ash is produced from thermal power stations. Fly ash itself is waste product with little commercial value. Use of this fly ash to consolidate another waste is often advantageous to the processor who can treat two waste streams at the same time. The present paper investigated the use of lime , fly ash .sand admixture for solidification and immobilization of heavy metals[5] The best combination which gave good compressive strength was used.

In first case 5cm 3cubes were prepared by mixing heavy metal sludge with lime fly ash admixture. In second case heavy metal sludge was encapsulated in lime fly ash sand admixture. In both the cases cubes were coated with polyurethane coating and subjected to leaching test.

2. Experimental Procedure

Fly ash was collected from “Koradi” thermal power plant near Nagpur [India]. The lime and standard Ennore sand was procured from local market.

3. Preparation of LFAS Cubes

Fly ash, lime and sand admixture in a proportion of 65: 25: 10 were mixed with a suitable quantity of metal hydroxide and water. The freshly mixed paste was then poured in to 5 cm3 moulds. Casting had been done by applying a load of 100 Kg/ cm2. The cubes were cured at an optimum pressure of 0.351 Kg /cm2 for 2.5 hours. The cubes were then subjected to leaching test.

4. Experimental Procedure for Immobilization of Heavy Metal Sludges by Pozzolanic Encapsulation

For encapsulation experiments 5cm 3 or 7.5cm3 moulds were filled with lime, fly ash and sand admixture of the composition 65:25:10 respectively. A cavity was made in the centre of the admixture filled in to the moulds. The cavity was filled with heavy metal sludge. [FIG 1]The mould with base plate removed is placed over the first mould. The upper mould was partially filled with the admixture.[Fig 2]The entire LFAS admixture in the mould is then compressed by applying a pressure of 100 kg/cm2.[FIG3]The sequential stages involved in encapsulation process are shown in fig 3

Fig1

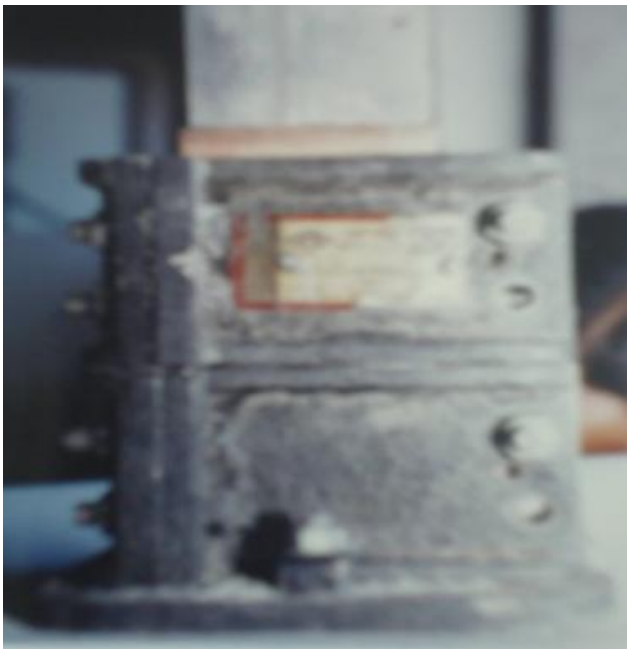

Fig2

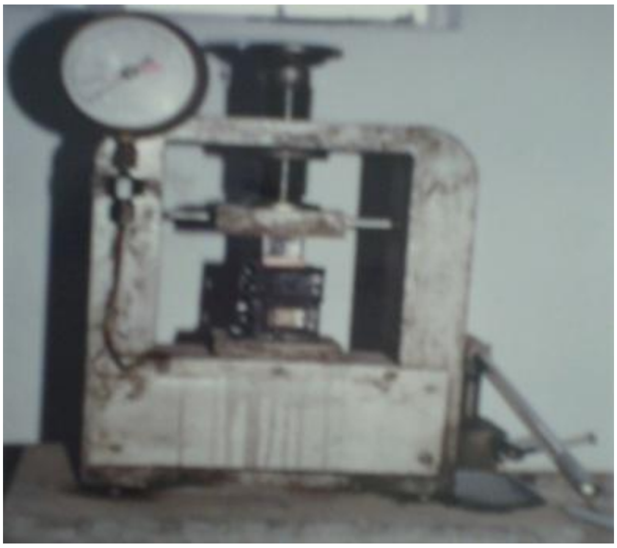

Fig 3

5. CURING PROCEDURE FOR LIME FLY ASH AND SAND CUBES.

The LFAS cubes were cured in autoclave cycromake vertical stainless steel autoclave at a steam pressure of 0.351 kg/cm2 for 3 hours. All the LFAS cubes were coated with white cement and polyurethane coating. Coated cubes after sufficient drying were subjected to leaching test.

6. LEACHING TEST FOR DETERMINIG THE EFFICIENCY IMMOBILIZATION OF TOXIC SLUGES

Leaching was done according to "Minnesota Pollution Control Agency (M P C A) test..Leaching medium is the buffer solution of sodium acetate and acetic acid of pH 4.9 to 5.2. The cubes were placed in a container containing acid buffered leaching solution maintaining solid to liquid ratio as 1:4. The container is shaken vigorously for a minute and is kept undisturbed. After a definite time interval pH of leachate medium is adjusted to 4.9 to 5.2and volume of solution is maintained constant by adding requisite quantity of the solution. Then 50 ml of leachate is withdrawn and is filtered through whatman 41filter paper and pH of this solution is adjusted to 2 by adding nitric acid.

7. ANALYSIS OF LEACHATE

Atomic absorption analysis for metal ion in solution was carried out on atomic absorption spectrophotometer (Model z -8000 with arrangement of data processor)

8. RESULT AND DISCUSSION

8.1 Efficiency of Immobilization of Heavy Metals by Fixation with LFAS Composite.

The table one represents the results of the various experiments conducted on fixation of heavy metals using lime fly ash sand composite .It has been observed that Nickel and copper are comparatively more immobilized as compared to other heavy metals.

8.2 Efficiency of immobilization of heavy metals when LFAS composite cubes are coated with white cement

Table 2 represents the results of leaching when LFAS cubes containing heavy metal are coated with white cement. The percentage of cadmium leached increases from O.224 % to 0. 5 % as the contact period increases from 3 days to twenty one days. The percentage of copper leached is only 0.23 % after the twenty one days contact period. The amount of zinc leached is much higher as compared to other heavy metals. 4.46% 0f Zinc was leached after 21 days contact period .The percentage of lead leached. into leaching medium increases from 0.26 to 4.2 as contact period increases from nine days to twenty one days.

9. USE OF POLYURETHANE COATING FOR IMMOBILIZATION OF HEAVY METALS

The amount of metal leached out from LFAS cubes into the leaching medium when it is coated with polyurethane is tabulated in table 5.3.The amount of metal leached for all metals is less than one ppm even after the continuous twenty one days contact period of acidic medium. The amount of heavy metal leached was only 0.086 ppm, 0.35 ppm and 0.07ppm for cadmium, Copper, Zinc, nickel, lead respectively. Thus it is clear from the results that excellent immobilization of heavy metals have been achieved by coating the cubes with polyurethane.

10. IMMOBILIZATION OF HEAVY METALS BY ENCAPSULATION AND POLYURETHANE COATING

3.3 g each of nickel, cadmium, copper, zinc were encapsulated separately in LFAS Cubes. The cubes were coated with polyurethane. The cubes were subjected to leaching test without adjusting the pH at different time intervals to create natural environment. Table 5.8 and 5.9 clearly indicates that no trace of metal was detected in to the leaching medium even after the twenty one days contact with leaching medium.

11. CONCLUSION

Immobilization of heavy metal sludges by fixation in Lime, Flyash, and Sand admixture could be improved by coating the LFAS cubes with materials of low permeability like polyurethane. The quantity of metal leached out from the polyurethane coated encapsulated pozzolanic cubes in to the leaching medium has been found to be in sub ppm level even after the contact time of 45 days.

This proves beyond doubt the use of polyurethane coating on encapsulated cubes can provide multiple barrier system for immobilizing the toxic heavy metal ions in a very effective manner and offers a reliable environmental protection.The hollow flyash bricks can be used for effective disposal of toxic waste.The LFAS matrix also provides suitable compressive strength.The method can be applicable for disposal of radioactive waste.However for ensuring full proof and long term safe disposal further elaborate study must be performed,which should include the long term interactions between hazardous waste constituent and component of LFAS composite and also the leaching boundry profiles of system under consideration.

Composition of Lfas Cube Flyash: Lime: Sand.-65:25:10 Amount of Metal Hydroxide = 3.3 G

Table 1: *Effect of White Cement Coating on Lfas Cubes*

Sr no	Metal studied	Contact period in days	Amount of metal leached in ppm	Percentage of metal leached
1	Cd	3	0.062	0.0024
		9	0.12	0.00474
		15	2.3	0.09
		21	14.6	0.57
2	Cu	3	0.041	0.0019
		9	0.06	0.00279
		15	0.41	0.019
		21	4.96	0.21
3	Zn	3	0.0056	0.000258
		9	0.01	0.00046
		15	12	0.55
		21	97	4.47
4	Pb	3	4.1	0.144
		9 15 21	7.65 14 120.48	0.269 0.49 4.24

Immobilization of Heavy Metals

Table 2: *Efficiency of fixation of heavy metal in uncoated lfas cubes*

Sr No	Metal	Composition Flyash:Lime:Sand:+ **Amount of metal**	Contact period in days	Contact period in days	Percentage of metal leached in ppm
1	Ni	65:25:10 + 8g Ni	7	3.6	0.071
			15	5.1	0.1
			21	10	0.197
2	Cu	65:25:10+8g Cu	7	0.56	0.010
			15	1	0.019
			21	4.25	0.081
3	Zn	65:25:10+9	7	124	2.09
			15	204	3.44
			21	245	4.1
4	Cd	65:25:10+9.9	7	50	0.65.
			15	127.5	1.67
			21	187.5	2.46
5	Pb	65:25:10+9.9g	7	77.5	0.910
			15	177.5	2.084
			21	235	2.75

Table 3: *Effect of Polyurethane Coating on Lfas Cubes for Immobilization of Heavy Metals*

S. no	Metal studied	Contact period in days	Amount of metal leached in ppm	Percentage of metal leached
1	Cd	3	0.001	0.0000394
		9	0.003	0.000184
		15	0.014	0.000552
		21	0.086	0.0039
2	Cu	3	0.042	0.001954
		9	0.08	0.00372
		15	0.09	0.00418
		21	0.18	0.00837
3	Zn	3	0.012	0.00052
		9	0.03	0.00138
		15	0.04	0.00184
		21	0.045	0.00207
4	Ni	3	0.11	0.00526
		9	0.078	0.00373
		15	0.21	0.0100
		21	0.35	0.016
5	Pb	3	Nd	
		9	0.01	0.000352
		15	0.04	0.00140
		21	0.09	0.00317

Table 4: *Efficiency of immobilization of heavy metals by pozzolanic encapsulation and polyurethane coatimg*

S.NO	Metal	Leaching time in days	Amount of metal leached in ppm
1	Nickel	7	Nd
		14	Nd
		21	Nd
2	Cd	7	Nd
		14	Nd
		21	Nd
3	Cu	7	Nd
		14	Nd
		21	Nd
4	Zn	7	Nd
		14	Nd
		21	Nd

Cube coated with Polyurethane

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