RESIDUAL WASTES OF BARIUM INDUSTRIES, ITS MANAGEMENT AND RECLAMATION

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Abstract: Waste generation is inexorable in industries, it can be controlled but cannot be abolished totally. The aim of the investigation was reclamation of industrial wastes to eliminate heavy metal toxic ions such as barium ions from industrial wastes dumping sites, and it exemplifies very productive, easy and low cost utilisation of barium industrial wastes.

Present paper is about the ill effects of barium/barium chemicals and the development of waste management technology by using industrial wastes of barium industries, which helps us to formulate the approach for mitigating the harmful effects of barium ions present in industrial wastes. In this paper the author tried to achieve the goal of waste minimization through simple but effective way. The outcomes are quite promising. Results revealed that within experimental limitations, water insoluble contents of powdered black ash mixed with lime forms a hydraulic mortar which has better strength than the mortar with lime.

Key Words: Black Ash, Hydraulic Mortar, Industrial Waste, Cementitious.

Introduction: Uncontrolled and hasty industrialization/urbanisation is one of the major cause of rapid environmental degradation. Emitted industrial pollution has done a drastic damage to the environment. The Indian industrial sector generated an estimated 100 million tons/year of non-hazardous solid waste and 8 million tons/year of hazardous solid waste [1]. However no data is available to estimate the amount of industrial waste for reclamation or agricultural purpose.

Industrial wastes especially the metallurgical wastes (highly pulverised and rich in heavy metal contents) affects the environment gravely and are hazardous for human/animal health. Thus efforts are to be made to control pollution arising due to waste disposal, by conversion of these unwanted wastes into utilizable raw materials. India ranks second in the production of barite in the world and is one of the important barite exporters to the world market [2]. Barium industries produces wastes of different types which includes unreacted barite i.e. barium sulphate, barium sulphide i.e. black ash filtration sludge, dust etc. Most of the solids wastes are of RCRA characteristic hazardous waste, carrying waste code D005 (EPA).

Without realizing the hazardous effects these untreated wastes are usually stored in an open area ultimately which sways the environment and posed serious threats on human, plants, etc. as a whole.

Once barium (in any form) enters in human body it may cause gastrointestinal disturbance, muscular weakness, hypertension, baritosis (physical irritation and benign pneumoioniosis) etc. [3]-[8]. Therefore there is an urgent need of proper use and disposal of the barium wastes in order to contribute more towards sustainable production.

Sensitized by this malpractice author has done some experimental investigations with wastes of Barium industries, cement and lime in order to reclaim the industrial waste. The outcomes are fairly supportive.

Materials and Methods:

Residual Waste (Powdered Form): After the extraction of barium sulphide (water soluble) from the black ash [9] the residue thus obtained is the main raw material along with residue of carbothermaly reduced barite, broken earthen pots, etc. Barium sulphide which is also known as black ash (used to prepare barium sulphide extract) was prepared by the author in lab by carbothermal reduction of barite.

Lime: Lime (mainly composed of calcite) was procured from local market of Jaisalmer (Rajasthan) act as a basic binding material.

Cement: Used cement was Ultra Tech cement of OPC-43 Grade as defined in IS 8112:1989.

Experimental Procedures:

Preparation of blocks: Two types of blocks were prepared. One set is of lime with residual wastes and another set of lime with sand. Residual waste of black ash was thoroughly mixed with fine powder of lime in 2:1 ratio (weight of residual waste of black ash is 3 parts). After mixing, the above trial mixture was gauged with minimum amount of water just sufficient to obtain a plastic wet mix of workable consistency. Two sets of three standard blocks of 70.6mm (70.6×10^{-3} m) cubic size were prepared as per the standard procedure.

Similarly two sets of 3 standard blocks of 70.6mm cubic size were prepared by mixing sand and lime in 2:1 ratio. The above prepared cubes were placed at 27 ± 3^0 (for about 21 days) under water, after 24 hrs of air curing.

Once curing was done under identical conditions these cubes were subjected to compression in a compressive strength testing machine by using Universal Testing Machine model no.UTM40, Yama Engineers Kolhapur make. The crushing loads were noted at the interval of 7 days and 30 days. Average strength of three trial cubes was used to tell the compressive strength of the blocks (unit-kg/cm^2).

Results and Discussions: Corresponding findings of compressive strength of the blocks of lime vs residual wastes, lime vs sand, are recorded in Table 1.

Table 1: Compressive strengths of the blocks of lime – insoluble black ash residue Vs lime – sand mortars. Surface area: 50cm^2

S. No.	Composition of Block	Approx. ratio	Compressive strength in kg/cm^2	
			After 7 days	after 30 days
1.	Residual wastes/Lime	2:1	4.75	1. 6.40
2.	Sand/Lime	2:1	broken even without	
			application of load	2.80

Table 1 reveals the compressive strength of the blocks of residual waste material - lime mortars and sand - lime mortars prepared as per the standard procedures. Results shown are average of three blocks (one set of 3 blocks was used after 7 days and one set of 3 blocks was used after 30 days respectively for both compositions). It is clear from Table 1 that water insoluble part of black ash shows excellent binding characteristics with lime. It is far better than sand – lime mortars with respect to its compressive strength taken either 7 or 30 days.

Black ash is comprised of water soluble and water insoluble contents. They react with lime in a faster and better way because of their amorphous character then compared to the weathered gravel which is of crystalline texture. At ordinary temperature, black ash contents react with lime to form calcium silicate, calcium aluminate, calcium aluminosilicate etc. At ordinary temperature, the latter materials react with lime to form calcium silicate, calcium aluminate, calcium aluminosilicate etc. [10]-[12]. Thus higher compressive strength of the water insoluble black ash and lime mortar is expected.

Proposed reactions are as follows:

$$CaO + H_2O \rightarrow Ca(OH)_2 \quad \text{-------- (1)}$$

$$Ca(OH)_2 + \text{Silica} \rightarrow \text{Calcium silicates (Insoluble)} \quad \text{--------- (2)}$$

Conclusions: Water insoluble black ash residue in powdered form is better substitute of gravel in mortars based on hydraulic lime. Within the experimental limitations water insoluble contents of black ash in powdered form, forms hydraulic mortar with lime of better strength than that.

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