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ENCAPSULATION OF INDUSTRIAL SOLID WASTE

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ABSTRACT

Local industries produce a large amount of sludge and solid waste from their production processes. This phenomenon created a disposal problem and managing of these waste materials become one of the major environmental and economical issues. The purpose of this study is to evaluate and develop a treatment method using these wastes to a useful product. The characteristic and constituent of some industrial wastes used in this study were analyzed before the treatment. Suitable ingredients such as magnesite material and proprietary additive (KH1 and KH2) were used to solidify the wastes and optimum ratios of the ingredients were determined to form a concrete-like mass. Strength and leachability tests were conducted on the treated wastes. The finding of this investigation revealed that the solidified waste could be recycled into a useful product using encapsulation technique.

Key words: *solidify, concrete-like mass, strength, leachability, encapsulation*

INTRODUCTION

Solid wastes come in the form of solid or semisolid materials that the producer no longer need or do not considers of sufficient value to retain. Hazardous wastes are generated by nearly every industry. These wastes must be disposed of in a safe manner in order to avoid adverse impacts on the environment and public health. Thus taking certain preventive measures will control excessive solid waste generated. Proper methods of waste disposal have to be done to ensure it does not affect the environment around the area or cause health hazards to the surrounded community. Solid waste management system is important in solving those problem where it is associated with the control of generation, storage, collection, transfer and transport, processing, and disposal of solid waste in a manner that it is in accord with the best principles of public health, economics, engineering, conservation, aesthetic, and other environmental considerations and that is also responsive to public attitudes (2). Typically, physical, chemical and biological treatments are used to improve the efficiency of solid waste management operation and system, to recover reusable and recyclable materials and to recover conversion products and energy. There are some limitations to be considered while selecting the best technique and process to be used; i.e. waste composition, reagent availability, moisture content and released of risk.

Inorganic and radioactive substances cannot be destroyed. However, they could be modified to make them less hazardous. Organic compounds can be destroyed but the cost and risk are sometimes too high. A safe sustainable way of dealing with toxic inorganic and many organic compounds is to encapsulate them with an inert matrix to produce concrete-like mass that can be safely returned to the earth's crust. Many attempts have been made to produce an effective matrix to solidify the wastes. However, most attempts have been either ineffective or uneconomical for the task required (3). Main objective of this is to develop an effective and economical binder matrix to encapsulate the variety of wastes. It is believed that encapsulation technology would be the best available and reproducible technology in providing a safe way in dealing with the unwanted materials. The solidified wastes will be undergoing strength and leachability test in order to determine the mechanical properties of the product and to predict whether any particular waste is likely to leach chemicals into groundwater when the waste is buried in a typical municipal landfill or use as a road base and pavement.

MATERIALS AND METHODS

Materials

Waste materials: The waste material used in this study was obtained from lens industry. Waste type, moisture content, type and concentration of contaminants were analyzed prior treatment.

Binder materials: Magnesium carbonate content, dolomite or magnesite materials, binder (KH1) and hardener (KH2).

Methods

Waste analysis: Waste types were determined by their consistency. The waste that contain less than 70% of water is classified as solid waste while waste that contain between 3 and 25% solid is classified as sludge (4). Moisture content and contamination concentration were analyzed based on the Standard Methods (APHA, 1985).

Binder preparation and treatment: Magnesite material was first finely crushed, calcined and proprietary additives (KH1 and KH2) were added. The resultant of the prepared binder can be chemically bonded with the waste and produced a solidified waste in the presence of water. The freshly mix concrete (binder and waste filler) were poured in a mould and compress with a specific mass. In order to get a chemically and physically stable solid end product, proportions of the materials were determined through field of optimization process depending on the type of waste, moisture content, type and concentration of contaminants (1).

Control specimen preparation: The control specimen was prepared using conventional cement-based concrete.

Leachate test: Toxicity Characteristic Leaching Procedure test (TCLP) was conducted on the encapsulated waste to determine the leaching of the contaminant after treatment. The method used for TCLP is in accordance with EPA SW-846-1311.

Strength test: A compression test, ASTM C39-86 standard, will be conducted to control specimen and concrete composites. The entire prepared specimens were cured for 28 days to reach the maximum required strength.

RESULTS AND DISCUSSION

Table 1 indicates the TCLP results on content of the waste before and after treatment. The results show the encapsulation technique has the ability to encapsulate the solid toxic waste. This technique using magnesium and calcium-chemical based as a binder system for micro-encapsulation, i.e. single particles such as heavy metals ions and other wastes are individually trapped in a matrix while organic components of the waste are chemically and physically bounded to the active magnesium. Therefore, it significantly reduces the leachability of the contaminant into the environment even if the treated waste is crushed.

The waste to binder ratio varies according to the waste being treated. Typically the mix ratio of 4:1 of waste to binder was used, whereas cement based solidification applied a ratio of 1:4 of waste to cement. Bulking factor comparison shown in Figure 1. The early setting time of this special concrete was much lower compared to that of cement concrete. The end result is a substantially lower volume and weight increased of the solidified waste. There were no introduced odors from the encapsulation process. Low quality of water also used in the mixing process.

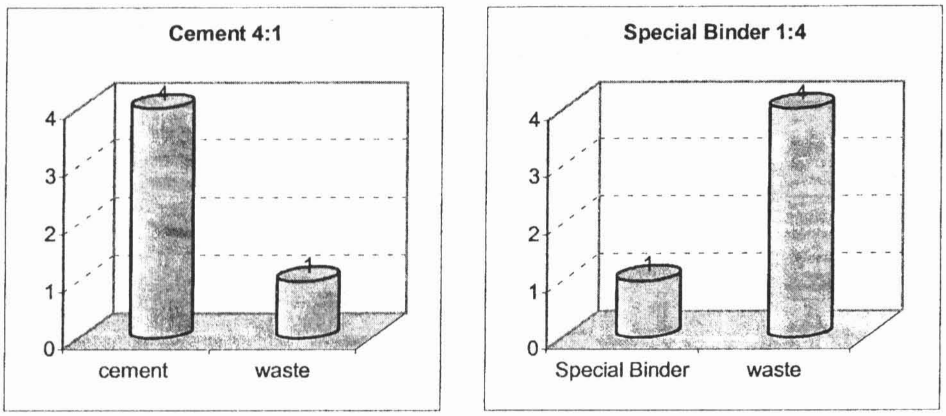

Figure 1. Bulking factor comparison between cement-based binder and special prepared binder

Table 1. Waste from lens industry, analysed before and after encapsulation

Waste contaminant	Content before treatment of waste (mg/L)	TCLP content after encapsulation of waste (mg/L)
Aluminum	13209	2.82
Barium	7372.53	1.42
Cadmium	5.53	< 0.01
Indium	4300.64	0.63
Strontium	2150.32	< 0.01
Zinc	2150.32	< 0.01
Copper	291.83	< 0.01
Manganese	168.95	< 0.01

CONCLUSION

Treating solid waste with encapsulation technology using the binder could produce many environmental benefits. Firstly, there were no introducing odors from the encapsulation process. The low TCLP of the treated waste allow disposal at lower classification waste sites. It is also cost benefits, where a low ratio of binder to waste was used in treatment and low quality water used in the mixing waste. Finally, some of the treated waste can also be recycled as road based or pavement.

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