

**SOLIDIFICATION/STABILISATION OF HEAVY
METAL SLUDGE FOR ENVIRONMENTALLY
SAFE DISPOSAL : *LEACHING BEHAVIOUR
OF HEAVY METAL SALT STABILISED IN
POLYMERIC MATRIX***

ARTI BHATT

Department of Chemical Engineering

Submitted

in fulfillment of the requirements of the degree of Doctor of Philosophy

to the



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CERTIFICATE

This is to certify that the thesis entitled “ **Solidification/Stabilisation of Heavy Metal Sludge for Environmentally Safe Disposal: *Leaching behaviour of heavy metal salt stabilised in polymeric matrix***” the Studies, presented by Arti Bhatt, is worthy of consideration for the award of the degree of Doctor of Philosophy and is a record of the original bonafide research work carried out by her under our guidance and supervision and that the results contained in it have not been submitted in part or in full to any other University or Institute for award of any Degree.



Chitra Rajagopal

Head

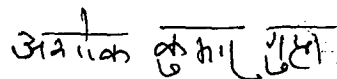
Explosive Safety Group

Centre for Fire, Explosive and

Environment Safety

Brig. S.K. Mazumdar Marg, Timarpur

Delhi 110054 (India)



Ashok Kumar Gupta

Professor

Department of Chemical Engineering

Indian Institute of Technology, Delhi

New Delhi 110016 (India)

Dedicated to my Husband, Yogesh

&

Daughter Kritika

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Gurur Brahma Gurur Vishnu

Gurur Devo Maheshvarah

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Tasmai Sri Guruve Namah

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(ARTI BHATT)

ABSTRACT

The present work originated from the research problem entitled "Development of treatment and disposal techniques for hazardous heavy metal wastes". Exploratory studies were carried out for solidification/stabilisation of chromium bearing sludge using Portland cement as the immobilizing material. But the deficiencies like high porosity, low compressive strength, and adverse impact on the stabilised waste form under acidic and alkaline environment, deterioration of the waste form with the passage of time due to interference of the salts with the basic hydration reactions of Portland cement etc. lead to the study of epoxy resins as immobilising materials. The advantages of this material are its strength and toughness, excellent resistance to chemical attack and moisture, absence of volatiles on curing and negligible shrinkage on setting, higher waste loadings than those achievable with cements.

Since the stabilised waste has to be buried in a landfill ultimately, it is desirable to understand the leaching behaviour of S/S inorganic waste. Inorganic salts being highly water-soluble represent the "worst case scenario" for a given composition. The behaviour will also reflect the transport mechanism of heavy metal from the polymeric matrix to the leachant; irrespective of the source of the metal.

The present work is focused on studying the leaching of heavy metal salts (viz., potassium dichromate, lead nitrate, mercury chloride, zinc nitrate, nickel nitrate and manganese chloride) stabilised in polymeric

matrices. The experimental work involved preparation of polymeric matrices and subjecting them to water absorption and leaching experiments.

The results of the studies show that water absorption by polymeric matrices is not an instantaneous phenomenon. Water absorption was empirically correlated and the limiting amount of water estimated. Penetration depth of water (due to water up take) and exposure time could also be correlated.

The numerical results show that even after an exposure time of 2160 h (i.e., 90 days), the leachant would have penetrated up to about 44% of radial distance inwards from the surface and an unexposed fractional volume of about 16% may still exist. Based on the observations of water absorption studies, a method was developed to estimate the total leachable salt from the entire matrix.

Leaching tests are integral for assessing the efficacy of the S/S waste form. The ANSI/ANS16.1- 1986 leach test method was followed to study the effect of different parameters viz., type of filler, salt loading, pH of leachant, size of matrix (surface/volume ratio) and effect of loading ground /ungrounded salt.

The leaching data were subjected to mathematical analysis for developing the leach model specific to polymeric matrices. The methodology followed included description of the physical picture envisaged followed by building up the proposed concept of three regions in a leached matrix. Region I comprises of dissolved salt and its thickness indicates the leaching depth. Region II comprises of both

dissolved and undissolved grains of salt and region II comprises of the unexposed portion of the matrix. The movement of these regions with time indicates the leaching behaviour. Diffusion of salt outwards from region I governs the salt leaching behaviour. Salt leached could be correlated with leaching time. Cumulative amount leached over the 90 days test period was found to be proportional to the square root of cumulative leaching time.

Effective diffusivity (D) reflects the ease with which the salt diffuses out of the matrix.

Leaching depth was found to be a function of effective diffusivity and the type of salt.

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