STUDY OF LEACHING CHARACTERISTICS OF STAINLESS STEEL PICKLING SLUDGE & ITS UTILIZATION WITH CONCRETE USING TAGUCHI METHODOLOGY

Thesis submitted in partial fulfillment of the requirements for the degree of

Master of Technology

in

Environmental Engineering

by

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July, 2014

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CERTIFICATE

This is to certify that **Sakshi Garg (2K12/ENE/11)** has submitted the thesis titled "**Study of leaching characteristics of stainless steel pickling sludge & its utilization with concrete using Taguchi methodology**" to the Department of Environmental Engineering, Delhi Technological University, is a bonafide research carried out by her under our guidance and supervision. The matter contained in the thesis has not been submitted to any other University or Institution for the award of degree or diploma.

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Dedicated

To

My Parents, My brother

&

Environment

Acknowledgements

Acknowledgement is a word that undermines my respect and feelings towards those connected with the successful completion of my work. I hereby express my sincere gratitude from the depth of my heart to those without whom this work might not have taken shape.

First and foremost, I would like to than**my beloved parents and my brother** who are my ultimate pillar of strength, for giving me the confidence to face a task of this magnitude and for always being there with immense belief in me.

I take this opportunity to express my profound gratitude and deep regards to my supervisors **Dr. S.K. Singh**, Professor and H.O.D. of Department of Environmental Engineering, Delhi Technological University, Delhi and **Dr. H.V.C. Chary Guntupalli**, PhD. IIT Delhi, Scientist C, Central Pollution Control Board, New Delhi for their exemplary guidance, for keeping me in right direction and for constant encouragement throughout the course of my work.

I also express my sincere thanks to **Dr. Anil Kumar Haritash**, Assistant Professor, Dept. of Environmental Engineering, DTU for his continuous guidance, motivation and support. Also, I would like to thank **Sh. H.V. Gurudutt** (Scientist D), Central Pollution Control Board, **Mr. Amit Kr. Shrivastava,** Assistant Prof**.** & **Mr. Alok Verma**, Associate Prof., Dept. of Civil Engineering, DTU for their valuable guidance.

I would like to extend my extreme gratitude towards **Mr. Sunil Tirki**, **Ms. Namita, Mr. Hukum chand & Mr. Sunil,** laboratory staff of the Environmental Engineering Laboratory and **Mr. Manoj Hodda, Mr. Miraj, Mr. Keval Singh & Mr. Mahesh,** staff members of the Concrete Technology Laboratory, DTU, for the valuable cooperation and help they have provided during my study, which greatly helped me at every step of my project.

I would also like to thank Dept. of Applied Physics (DTU), Dept. of Chemistry (IIT Delhi), Dept. of Chemical Engineering (IIT Delhi) for letting me use the laboratory facilities and I would also like to express my thanks to the Pickling Industry in Wazirpur Industrial Area, New Delhi for providing me with the process details and hazardous sludge generated on which my study is based.

I would also like to acknowledge the contribution of my friends **Preeti, Dushyant, Navneet**, **Deepika** and **Sanjan** for unceasing support.

Sakshi Garg

Abstract

Steel finishing operations such as pickling, galvanizing, plating, etc., involve a process of removing scale, rust and dust from the surface of stainless steel. In this, sheets of steel are immersed in hot acidic solution resulting in waste liquor which contains heavy metals like Fe, Cr, Ni, etc. When treated with lime, these heavy metals get settled as metal hydroxides in form of sludge. As per the Act of Hazardous Waste (Management and Handling) Rules, 1989, the disposal of lime treated spent pickling sludge should be done with consideration and is not easy. In normal practice, this sludge is being stored in leak proof bags and no proper disposal technique is being employed by small and medium industries.

An attempt has therefore been made to utilize the lime treated pickling sludge in cement concrete mix in the presence of fly-ash as a binder agent. The main objective is to immobilize heavy metals in the concrete matrix and studying its leaching characteristics and compressive strength. Sludge is characterized for the heavy metal content using AAS, EDX and XRD. Other physical and chemical properties are also analysed. Test cubes of nominal mix M20 were prepared and these were tested for its 7 and 28 days compressive strength. Toxicity characteristics leaching procedure (TCLP) test as per USEPA was carried out on these cubes to study the extent of immobilization and stabilization of heavy metals in the concrete matrix.

For this, Four factors were varied on three levels i.e. Percentage of cement replaced by sludge (5%, 7.5% & 10%) and Percentage of fly-ash (0%, 15% & 20%), type of cement used and particle size grading of sludge, to assess the effect of these factors on compressive strength and heavy metal concentrations in leachate. Taguchi methodology (L9 orthogonal array) was used for optimizing the design of experiments and for further analysis.

Experimental results show that the lime treated pickling sludge can be utilized with cement/concrete with some binding materials like fly-ash. By Analysis of Mean (ANOM) method, it was found that 7.5% addition of sludge and 20% fly-ash as partial replacement of cement with 43 grade OPC and sludge particle size ranging between 0.3 to 2.36mm produced the optimal performance for compressive strength and heavy metal immobilization values of the cement-sludge-flyash concrete cubes. By Analysis of Variance (ANOVA) method, it was found that particle size grading of sludge and percent of sludge added as cement replacement contributed 46% and 41% respectively to the optimal performance. Formation of C_2H, C_3H and gypsum (C-S-H gel) may be contributing in the better performance of concrete.

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AAS	Atomic Absorption Spectroscopy
ANOM	Analysis of Mean
ANOVA	Analysis of variance
APHA	American Public Health Association
BIS	Bureau of Indian Standards
CPCB	Central Pollution Control Board
C2S	Di Calcium Silicates
C3S	Tri Calcium Silicates
DOE	Design of Experiments
DPCC	Delhi Pollution Control Committee
EDX	Energy Dispersive X-Ray spectroscopy
ETP	Effluent Treatment Plant
HW	Hazardous Waste
LOI	Loss on Ignition
MT	Million Ton
S/N	Sound/ Noise
S/S	Solidification/ Stabilization
SEM	Scanning Emission Microscope
SS	Stainless Steel
TCLP	Toxicity Characteristic Leaching Procedure
TPA	Tons per Annum
USEPA	United states Environment Protection agency
XRD:	X- Ray Diffractometer
µm	Micro meters