

## Stabilization of Cadmium & Zinc metals on Cooler cake waste using lime and cement

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**ABSTRACT:** The research publication of the study is to test the effectiveness of leaching cadmium and zinc metals with cooler cake hazardous waste to prevent heavy metals from being dissolved. After conducting toxicity characteristic leaching procedure (TCLP) and Water Leachate Test (WLT) stabilization trials five times each was lower than permissible limits as per regulatory guidelines. Each trial is cured properly and checked frequently for 4, 8, 12, 16, 20 & 24 hours for the fixation time of heavy metals. In this trial using statistics optimized the best combination through ANOVA significance results.

**KEY WORDS:** Cooler Cake, Lime, Cement, Stabilization, Cadmium and Zinc

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### I. INTRODUCTION

1.1 Solidification/ stabilization (S/S) is a widely used process to treat toxic wastes. (Effa Affiana Ishak et al 2020). This technology is potentially useful for reducing the physical and chemical properties of hazardous waste. This process is a cost-effective method. The end product of the project has safety and environmental impact as per USEPA (2002). Stabilization means to minimize the toxic behavior of the waste by means of chemical reactions. Solidification means to produce a monolithic solid with a structural behavior (Conner UR et.al). A comparative study of solidification and stabilization of Hazardous waste from the Tannery industry done by R. Jayashankar (2018). The solidification and stabilization are evaluated by the following ways 1. Leaching behavior, 2. Curing fixation time 3. Cost-effective. Comparison of two leaching tests to assess the effectiveness of Cement-based Hazardous Waste Solidification/Stabilization done by Olcay YILMAZ (2002).

#### 1.2 Problem Statement

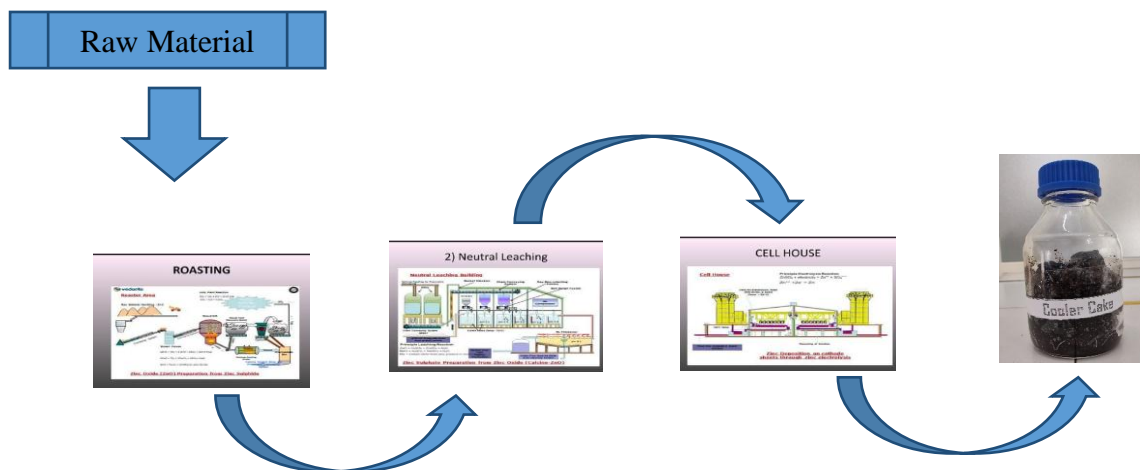
Cooler cake is not suited for direct landfill disposal based on the afore mentioned observations. In this waste main problem low pH and Heavy metals present Cadmium & Zinc in Water leachate & Zinc in Toxicity Characteristic Leachate Test it is very highly toxic in environment and health effects. Before disposal properly treat with using lime and cement quantities very less effectively stabilized then check disposal environmental friendly manner. Using statistics one way Analysis of Variance significantly pass with 95% confidence interval.

### II. MATERIAL AND METHODS

In this research work, the S/S process has been applied to the zinc industry waste. The Cooler cake waste samples generated from the zinc industry were considered in the study M/S Hindustan Zinc Limited, Rajasthan. The raw cake samples were collected with the assistance of the RESL unit at Udaipur location, Rajasthan. The cake was analyzed by means of the TCLP test, Water leachate test for both sludge with hydrated lime mixed matrix (F series) and OPC mixed matrix (C series) and the test results were compared with the standard specified by USEPA 1311 & 2008. The optimum quantity of lime that is suitable for the stabilization

process is calculated by adding lime 1 %, 2 %, 3 %, 4 % and 5 % by total weight. The selection of the optimum quantity of lime which is added to the cake, the minimum lime attains the maximum stabilization of hazardous waste. In our study, we chose 4 % of lime is added to the cake for stabilization. In this investigation, we analyze the physical and chemical properties such as pH, moisture content, bulk density, Cd, Pb, Zn, Ni, Cu, and Cr.

**Figure 1: Process flow for Cooler Cake**



### 2.1 Hydrated Lime

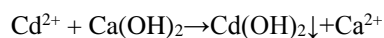
Heavy metal ions (e.g.,  $Zn^{2+}$ ,  $Cd^{2+}$ ,  $Cu^{2+}$ ) in aqueous solutions can react with calcium hydroxide to form insoluble hydroxides. For example,  $Zn^{2+}$  ions can precipitate as zinc hydroxide ( $Zn(OH)_2$ ), which is insoluble and therefore less likely to leach into the environment. Jiang et al (2004) studied heavy metal stabilization in municipal solid waste incineration fly ash using heavy metal chelating agents in TCLP leachate. Heavy metals can adsorb onto the surface of lime particles. This adsorption can occur through electrostatic attraction or chemical bonding between the metal ions and the hydroxyl groups present on the surface of calcium hydroxide. Lime increases the pH of the surrounding environment (typically above 12), which can influence the speciation and solubility of heavy metals. Many heavy metals form less soluble hydroxides or carbonates under alkaline conditions, reducing their mobility and bioavailability. Lime can form complexes with heavy metal ions, altering their chemical properties and reducing their toxicity. These complexes are typically less mobile and less likely to interact with biological systems. Once heavy metals are immobilized or complexed with lime, they are generally stable over time and less prone to leaching into groundwater or being taken up by plants. Andres et al (1995) using industry byproduct Calcium sulphate are using as a binder in the stabilization process for treating heavy metals.

### 2.2 Ordinary Portland Cement

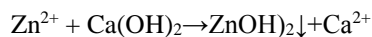
Cementitious materials such as Portland cement contain calcium hydroxide ( $Ca(OH)_2$ ) and other minerals that can adsorb heavy metal ions (e.g.,  $Zn^{2+}$ ,  $Cd^{2+}$ ,  $Cu^{2+}$ ) from aqueous solutions. These ions may also undergo precipitation reactions within the cement matrix. Ganjidoust et al (2009) said that cement based stabilization of heavy metal contaminated soil focused high compressed strength of final matrix with effective leachate (TCLP). Heavy metal ions can replace calcium ions in the crystal lattice of hydrated cement phases (e.g., calcium silicate hydrate, C-S-H). This process can occur due to similarities in charge and ionic radius between calcium and the heavy metal ions. Heavy metal ions can react with components of cement to form insoluble complexes or compounds that are less mobile and less toxic. For example, metals may form hydroxides, carbonates, or silicates that are less soluble and therefore less likely to leach out into the environment. The high pH environment created by cement (typically pH 12-13) can passivate certain heavy metals by forming a protective layer on their surface, reducing their reactivity and mobility. Once immobilized or stabilized within the cement matrix, heavy metals are less likely to be released into the environment, even under changing conditions such as varying pH or temperature. Paul Bishop (1988) using cement, silicates, fly ash other pozzolon material in liquid hazardous waste and sludge's on stabilization focused only TCLP.

### 2.3 Mechanism:

**2.3.1 Cadmium:** In the presence of water, Portland cement hydrates to form calcium silicate hydrate (C-S-H) gel and calcium hydroxide (Ca(OH)<sub>2</sub>). Heavy metal ions such as Cd<sup>2+</sup> in solution can undergo ion exchange with calcium ions (Ca<sup>2+</sup>) present in the cement matrix:



**2.3.2 Zinc:** In the presence of water, Portland cement hydrates to form calcium silicate hydrate (C-S-H) gel and calcium hydroxide (Ca(OH)<sub>2</sub>). Heavy metal ions such as Zn<sup>2+</sup> in solution can undergo ion exchange with calcium ions (Ca<sup>2+</sup>) present in the cement matrix:



## III. ANALYTICAL METHODS

### 3.1 pH (USEPA 9045D)

Take 20 g of Waste in a 50 mL beaker, add 20 mL of reagent water and continuously stir the suspension for 5 min. Additional dilutions up to 100 ml. Let the waste suspension stand for about 1 hr to allow most of the suspended waste to settle out from the suspension or filter or centrifuge off the aqueous phase for pH measurement. Check the pH using pH meter.

### 3.2 Total Metals (USEPA 3051A)

This method is used for the preparation of sludge's, sediments, soils and oils for total recoverable metal determinations by FLAA, GFAA, ICP-OES or ICP-MS. Initially weigh the dried sample followed by nitric acid and hydrochloric acid are added to the representative sample in a fluorocarbon digestion vessel and heated in a microwave unit prior to metals determination. Analyzed all heavy metals Cd, Cu, Pb, Zn, Cr & Ni using Atomic Absorption Spectrophotometer.



**Figure 2 : Atomic Absorption Spectrophotometer**

### 3.3 Toxicity Characteristic Leaching Procedure (USEPA 1311)

Weigh out a dry sample of the waste (100 grams minimum) and record the weight in 1000 ml vessel. Slowly add this amount of appropriate extraction fluid (Buffer based on the pH) to the extractor vessel. Close the extractor bottle tightly (it is recommended that Teflon tape be used to ensure a tight seal), secure in rotary agitation device, and rotate at 30 + 2 rpm for 18 + 2 hours. Separate the material in the extractor vessel into its component liquid and solid phases by filtering through a new glass fiber filter. TCLP extracts to be analyzed for metals shall be acid digested except in those instances where digestion causes loss of metallic analytes. If an analysis of the undigested extract shows that the concentration of any regulated metallic analyte exceeds the regulatory level, then the waste is hazardous and digestion of the extract is not necessary. Analyzed all heavy metals Cd, Cu, Pb, Zn, Cr & Ni in TCLP extract using Atomic absorption spectrophotometer.

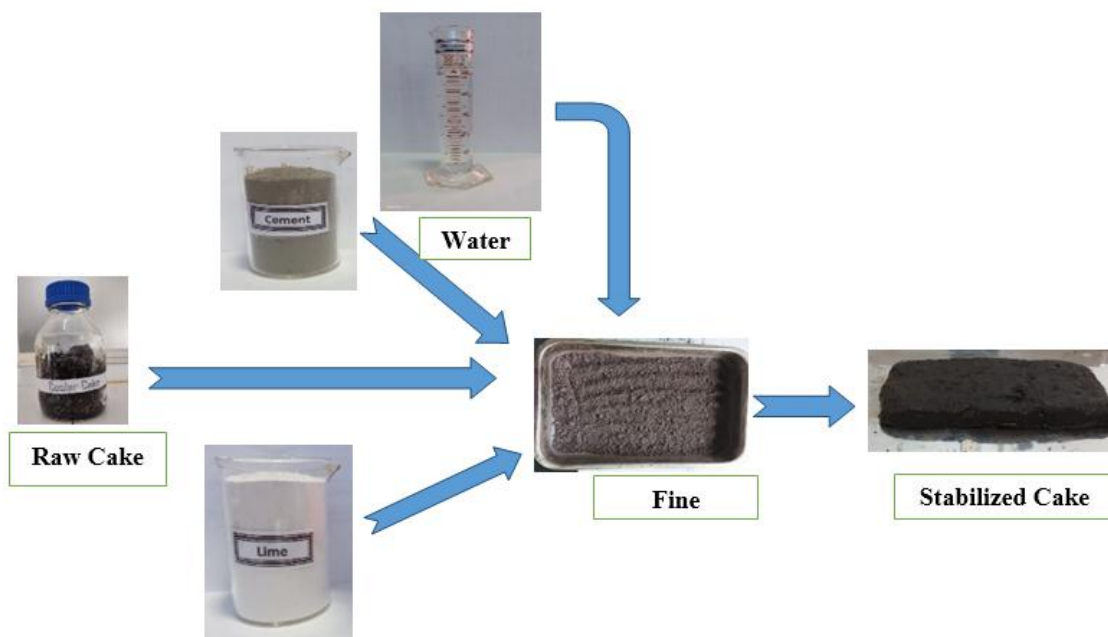


Figure 2 : Flow diagram of Stabilization Process of Cooler Cake

### 3.4 Water Leachate Test (CPCB Protocol)

Water leachate test to be mandatory as per CPCB Protocol (Refer HAZWAMS 2010-11). Take dried sample 100 gm of waste and filling up to 1 liter with distilled water, stirring or shaking for 24 hrs, filtering the solids and analyzing the filtrate all heavy metal Cd, Cu, Pb, Zn, Cr & Ni using Atomic absorption spectrophotometer as per APHA method. Evagelina et al (2019) studied a mixed separation-immobilization method for soluble salts removal and stabilization heavy metals in municipal solid waste incineration fly ash using as reagent solution of sodium carbonate concentrate heavy metals in water leachate as per guidelines.

### 4. Design of Stabilization

SET-A: Initially weigh (A1) 100 g Cooler Cake waste add sufficient water for homogeneity like slurry then add 4 g of Lime mixing with slurry finally add 4 g Cement keep it for some time for complete curing and hardening of blocks. Parallel to continue the same combination mix in separate beakers A2, A3, A4 and A5 kept few hours. Once stabilization mixing completed analyze all six metals (Cd, Cu, Cr, Pb, Ni & Zn) both Water Leachate and TCLP tests as per method CPCB & USEPA.

Similarly followed as per design trails conducting SET-B, SET-C, SET-D & SET-E each set five trails 4% Lime is fixed but cement quantity varies 8%, 12%, 16%, 20% and 24% separately with five times for statistically check the repeatability of measurements using statistics.

## IV. RESULTS AND DISCUSSIONS

Table I: COOLER CAKE ANALYSIS (UNTREATED)

Parameter	Units	Method	Results (Mean ± SD)	CPCB & Schedule II (Permissible Limits)
Color	-	USEPA, SW846	Black	Not specified
State	-	USEPA, SW846	Solid	Not specified
pH	-	APHA 23 <sup>rd</sup>	<b>1.94 ± 0.0071</b>	<b>4 – 12</b>
Moisture	%	APHA 23 <sup>rd</sup>	18.91 ± 0.1026	Not specified
Bulk Density	g/cc	ASTM D057	1.282 ± 0.0005	Not specified
<b>Total Metals</b>				
Cadmium	mg/Kg	USEPA, SW846	7.534 ± 0.108	Not specified
Chromium	mg/Kg	USEPA, SW846	43.042 ± 4.27	Not specified
Copper	mg/Kg	USEPA, SW846	3.938 ± 0.044	Not specified
Lead	mg/Kg	USEPA, SW846	23.739 ± 2.665	Not specified
Nickel	mg/Kg	USEPA, SW846	3.925 ± 0.295	Not specified
Zinc	mg/Kg	USEPA, SW846	37431 ± 1094	Not specified
<b>Metals in TCLP</b>				
Cadmium	mg/L	USEPA, SW846	0.904 ± 0.001	< 1

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Chromium	mg/L	USEPA, SW846	1.949 ± 0.085	< 5
Copper	mg/L	USEPA, SW846	0.531 ± 0.009	< 25
Lead	mg/L	USEPA, SW846	0.582 ± 0.008	< 5
Nickel	mg/L	USEPA, SW846	0.491 ± 0.006	< 20
Zinc	mg/L	USEPA, SW846	<b>28680 ± 903</b>	<b>&lt; 250</b>
<b>Metals in WLT</b>				
Cadmium	mg/L	USEPA, SW846	<b>0.849 ± 0.008</b>	<b>&lt; 0.2</b>
Chromium	mg/L	USEPA, SW846	1.745 ± 0.133	Not applicable
Copper	mg/L	USEPA, SW846	0.368 ± 0.013	< 10
Lead	mg/L	USEPA, SW846	0.466 ± 0.013	< 2
Nickel	mg/L	USEPA, SW846	0.429 ± 0.008	< 3
Zinc	mg/L	USEPA, SW846	<b>22983 ± 449</b>	<b>&lt; 10</b>

**4.1 Stabilization Fixation Time:**

I have checked the stabilization fixation time, taken one trial from SET-A. After stabilization process one trail selected & checked at frequent interval conducted both water leachate and TCLP (as per Method) after 4 Hours, 8 Hours, 12 Hours, 16 Hours, 20 Hours and 24 Hours separately. Each interval all metals concentration levels measured on Atomic absorption spectrophotometer. Cerbo et al (2016) studied stabilization of fly ash from incinerator reagens as cement additives concentrate in TCLP metals only in their experiments. Its take stabilization fixation time more than 7 days not hours.

These results are tabulated as per below:

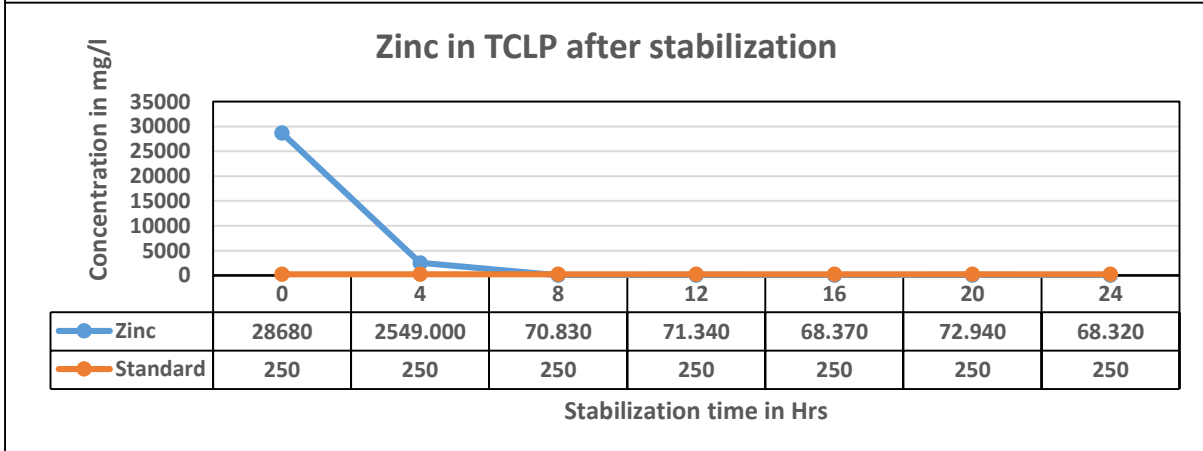
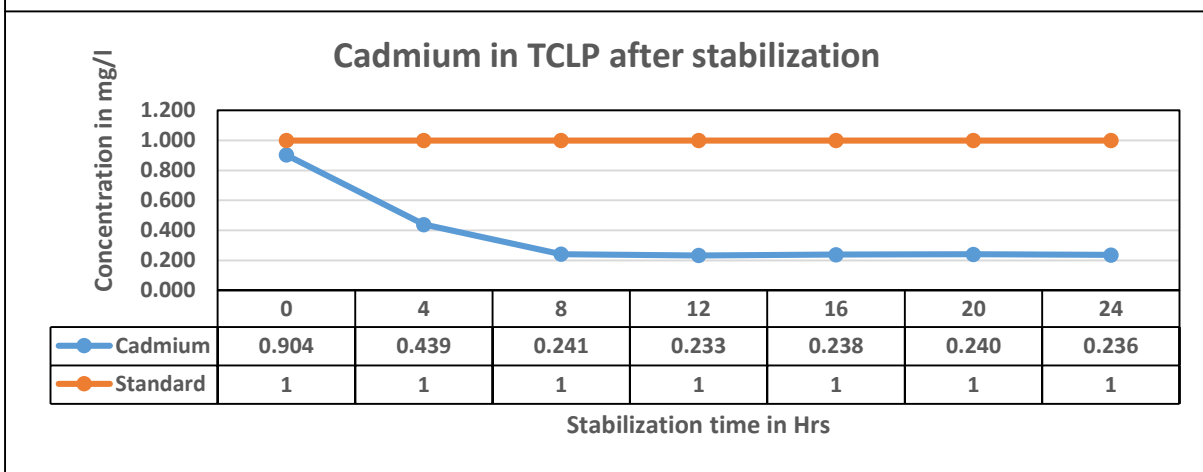
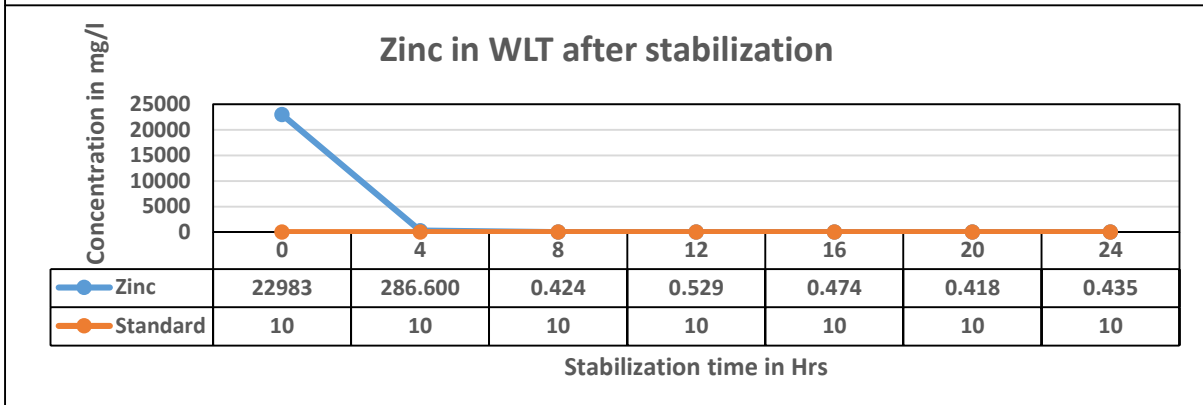
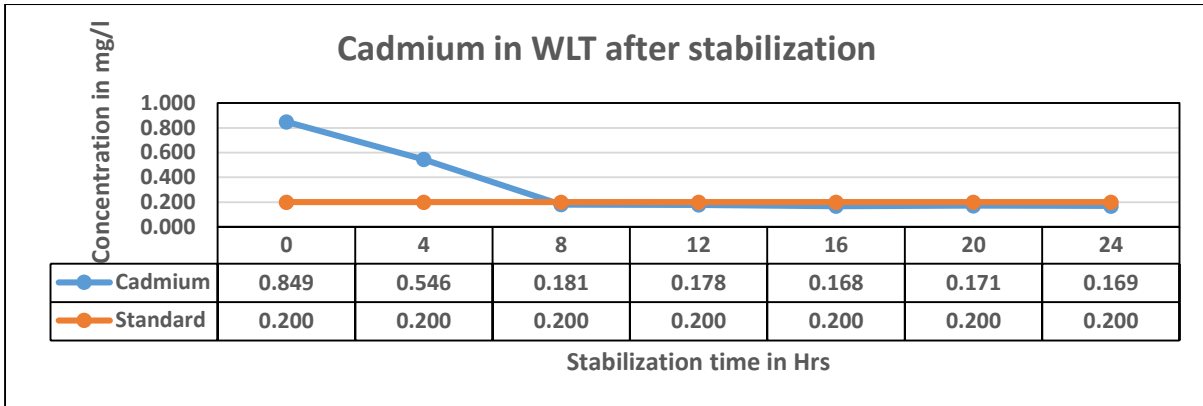
**Table II : Cooler Cake (Water Leachate Test) Trial:**

Heavy Metal	After Stabilization in Cooler Cake (Duration in Hours) in mg/L							Std. Limit
	0	4	8	12	16	20	24	
<b>Cadmium</b>	0.849	0.546	0.181	0.178	0.168	0.171	0.169	< 0.2
<b>Copper</b>	0.368	0.187	0.004	0.003	0.004	0.004	0.004	< 10
<b>Chromium</b>	1.745	0.894	0.237	0.242	0.233	0.238	0.236	NA
<b>Lead</b>	0.466	0.287	0.065	0.058	0.061	0.062	0.066	< 2
<b>Nickel</b>	0.429	0.229	0.075	0.081	0.078	0.071	0.069	< 3
<b>Zinc</b>	22983	286.600	0.424	0.529	0.474	0.418	0.435	< 10

**Table III : Cooler Cake (TCLP Test) Trial:**

Heavy Metal	After Stabilization in Cooler Cake (Duration in Hours) in mg/L							Std. Limit
	0	4	8	12	16	20	24	
<b>Cadmium</b>	0.904	0.439	0.241	0.233	0.238	0.240	0.236	< 1
<b>Copper</b>	0.531	0.254	0.008	0.008	0.007	0.008	0.007	< 25
<b>Chromium</b>	1.949	1.121	0.187	0.179	0.183	0.184	0.181	< 5
<b>Lead</b>	0.582	0.314	0.056	0.057	0.052	0.056	0.051	< 5
<b>Nickel</b>	0.491	0.265	0.063	0.067	0.062	0.055	0.059	< 20
<b>Zinc</b>	28680	2549.000	70.830	71.340	68.370	72.940	68.320	< 250

As per the above observation concluded the metals concentration levels from 4 Hours to 24 Hours are slowly reduced. I have observed most of the metals in both leachate reduced at after 8 Hours. I have fixed the curing time of the stabilization process optimized at 8 Hours each trials. Standard limits taken as per Hazardous Waste Management Series: HAZWAMS/CPCB/2010-11, May 24, 2010.



#### 4.2 Stabilization Process (After Treatment)

Figure 2 shows a flow diagram of the stabilization process using lime initially optimized before add sufficient water for homogeneously mixing with waste followed by addition of cement complete hardening of all heavy metals. Waste (50 g) was taken in a beaker add water slowly like slurry for perfect mixing completed add lime 1%, 2%, 3%, 4% and 5% individually stirring with the help of glass rod. Once the task completed lime process check the pH each experiment results noted. Initially waste pH observed acidic condition as per regulatory requirement pH should be in between 4 to 8. As my observation at 4% lime level pH is good and sufficient as per limit if more than add expensive cost is more. Now conclude the 4% lime optimized the stabilization of cooler cake. Jayasankar & Dr S Mohan (2018) studied stabilization of heavy metal containing hazardous waste from tannery industry using as a reagent fly ash and fly ash with cement.

A two level factorial design of experiment (Montgomery, 2001) was performed to study and optimize the use of sodium carbonate as stabilizing agent of FA. Solid/liquid mass ratio and the excess of stabilizing agent were chosen as experimental factors. In my experiment design once optimized with 4% lime followed by OPC used as total five Sets A, B, C, D & E. Each Set again same trail five times done for consistency results out come to see the statistically calculated over all mean, standard deviation.

In my observations untreated of cooler cake both Water Leachate Test and Toxicity Characteristic Leaching Procedure metals are all acceptable except cadmium and zinc. Now, I am concentrating of Cadmium and Zinc metal properly studied using lime and cement combination where it is optimized results as per criterial of landfill. Each Set I have conducted five trails in same recipe from that calculated mean each metal in both WLT and TCLP. Actual landfill limits as per CPCB guidelines Cadmium < 0.2 ppm and Zinc <10 ppm in WLT same like that Zinc < 250 ppm in TCLP. Jesse et al (2011) studies stabilization of hazardous waste using cluan coal technology products on TCLP of metals.

Optimization of recipe from SET-A to SET-E the results Cadmium concentration meet at SET-E (4% Lime & 20% Cement), but Zinc concentration meet at SET-C (4% Lime & 12 % Cement). Remaining metals are all acceptable limits from initially without treatment.

#### 4.3 Water Leachate Test (Cadmium & Zinc)

**Table IV : SET-A (Cadmium in CC-WLT) 4% Lime & 4% Cement**

Cadmium	A1	A2	A3	A4	A5
Mean (5 replicates)	0.4405	0.4513	0.4438	0.4426	0.4479
Std. Dev (5 replicates)	0.0017	0.0008	0.0015	0.0009	0.0035

**Table V : SET-B (Cadmium in CC-WLT) 4% Lime & 8% Cement**

Cadmium	B1	B2	B3	B4	B5
Mean (5 replicates)	0.3828	0.3814	0.3805	0.3812	0.3810
Std. Dev (5 replicate)	0.0039	0.0034	0.0043	0.0032	0.0053

**Table VI : SET-C (Cadmium in CC-WLT) 4% Lime & 12% Cement**

Cadmium	C1	C2	C3	C4	C5
Mean (5 replicates)	0.3224	0.3314	0.3256	0.3222	0.3271
Std. Dev (5 replicates)	0.0013	0.0021	0.0017	0.0014	0.0014

**Table VII : SET-D (Cadmium in CC-WLT) 4% Lime & 16% Cement**

Cadmium	D1	D2	D3	D4	D5
Mean (5 replicates)	0.2330	0.2390	0.2301	0.2355	0.2293
Std. Dev (5 replicates)	0.0012	0.0009	0.0013	0.0012	0.0008

**TableVIII : SET – E (cadmium in CC-WLT) 4% Lime & 20% Cement**

Cadmium	E1	E2	E3	E4	E5
Mean (5 replicates)	0.1809	0.1792	0.1826	0.1785	0.1793
Std. Dev (5 replicates)	0.0008	0.0010	0.0005	0.0005	0.0009

**Table IX : SET-A (Zinc in CC-WLT) 4% Lime & 4% Cement**

Zinc (ppm)	A1	A2	A3	A4	A5
Mean (5 replicates)	18.5260	19.0160	18.7250	18.8630	18.4120
Std. Dev (5 replicates)	0.0042	0.0096	0.0079	0.0091	0.0104

**Table X : SET-B (Zinc in CC-WLT) 4% Lime & 8% Cement**

Zinc (ppm)	B1	B2	B3	B4	B5
Mean (5 replicates)	10.3300	9.8680	11.0250	10.9220	10.2770
Std. Dev (5 replicates)	0.0079	0.0110	0.0137	0.0057	0.0057

**Table XI : SET-C (Zinc in CC-WLT) 4% Lime & 12% Cement**

Zinc (ppm)	C1	C2	C3	C4	C5
Mean (5 replicates)	6.1250	6.8670	6.2610	6.3710	6.5750
Std. Dev (5 replicates)	0.0117	0.0097	0.0096	0.0129	0.0137

**Table XII : SET-D (Zinc in CC-WLT) 4% Lime & 16% Cement**

Zinc (ppm)	D1	D2	D3	D4	D5
Mean (5 replicates)	2.0810	1.9570	2.1220	2.0670	1.9690
Std. Dev (5 replicates)	0.0089	0.0084	0.0084	0.0172	0.0089

**Table XIII : SET-E (Zinc in CC-WLT) 4% Lime & 20% Cement**

Zinc (ppm)	E1	E2	E3	E4	E5
Mean (5 replicates)	0.4103	0.3783	0.4804	0.4203	0.4403
Std. Dev (5 replicates)	0.0002	0.0181	0.0002	0.0001	0.0002

#### 4.4 Toxicity Characteristic Leaching Procedure (Zinc)

**Table XIV : SET-A (Zinc in CC-TCLP) 4% Lime & 4% Cement**

Zinc (ppm)	A1	A2	A3	A4	A5
Mean (5 replicates)	425.21	430.16	434.20	426.71	428.70
Std. Dev (5 replicates)	0.1194	0.1475	2.3203	0.1294	0.0935

**Table XV : SET-B (Zinc in CC-TCLP) 4% Lime & 8% Cement**

Zinc (ppm)	B1	B2	B3	B4	B5
Mean (5 replicates)	298.7200	297.6600	289.70	303.2500	297.6400
Std. Dev (5 replicates)	0.1204	0.0962	0.0447	0.1061	0.1194

**Table XVI : SET-C (Zinc in CC-TCLP) 4% Lime & 12% Cement**

Zinc (ppm)	C1	C2	C3	C4	C5
Mean (5 replicates)	205.7500	227.8600	210.2800	208.1500	207.7500
Std. Dev (5 replicates)	0.1061	40.0772	0.0908	0.1369	0.1118

**Table XVII : SET-D (Zinc in CC-TCLP) 4% Lime & 16% Cement**

Zinc (ppm)	D1	D2	D3	D4	D5
Mean (5 replicates)	159.7300	161.7600	158.2800	162.6400	158.7500
Std. Dev (5 replicates)	0.0758	0.0962	0.1255	0.0742	0.0791



**Table XVIII : SET-E (Zinc in CC-TCLP) 4% Lime & 20% Cement**

Zinc (ppm)	E1	E2	E3	E4	E5
Mean (5 replicates)	72.5340	69.6300	70.4360	72.3560	69.4400
Std. Dev (5 replicates)	0.4458	0.0158	0.0230	0.0241	0.0158

#### 4.5 ANOVA

An analysis of variance (ANOVA) was performed to check the significance of the effects of each factor and their interaction (Montgomery, 2001). The statistical test was based on the total error criteria with a confidence level of 95%. After optimization of our trails check the cadmium and zinc significance criteria with a confidence level of 95% using statistical techniques.

**Table XIX : One Way ANOVA test, using F distribution df (4, 20) - Cadmium in WLT**

Source	DF	Sum of Square	Mean Square	F Statistic	P-value
Groups (between)	4	0.2306	0.05789	5156.8778	0
Error (Within)	20	0.0002245	0.00001123		
Total	24	0.2318	0.009658		

**Table XX : One Way ANOVA test, using F distribution df (4, 20) – Zinc in WLT**

Source	DF	Sum of Square	Mean Square	F Statistic	P-value
Groups (between)	4	1076.8956	269.2239	3490.6595	0
Error (Within)	20	1.5425	0.07713		
Total	24	1078.4381	44.9349		

**Table XXI : One Way ANOVA test, using F distribution df (4, 20) – Zinc in TCLP**

Source	DF	Sum of Square	Mean Square	F Statistic	P-value
Groups (between)	4	372890.7187	93222.6797	3781.5487	0
Error (Within)	20	493.0397	24.652		
Total	24	373383.7584	15557.6566		

As per ANOVA, p-value is less than F Statistic, H0 rejected. The difference between sample averages of same groups is to be statistically significant. P-value equal to 0, It means that the chance of type I error is small. All cadmium and zinc observation of F statistic vale is more than p-vale, which is 95% confidence acceptance level. In Tukey HSD test the means of pairs are significantly different.

**Table XXII : Permissible Limits Table of Heavy metals (BIS and WHO)**

Name of the Metal	BIS (mg/L)	WHO (mg/L)
	IS-10500 : 2012	Water Quality 4 <sup>th</sup> Edition 2017
Arsenic	0.01	0.01
Cadmium	0.01	0.003
Chromium	0.05	0.05
Lead	0.01	0.01
Mercury	0.001	0.006
Nickel	0.02	0.02
Selenium	0.01	0.01
Antimony	0.01	0.02
Thallium	0.002	0.001
Copper	2	2
Zinc	5	3

## V. CONCLUSIONS AND RECOMMENDATIONS

The type of cooler cake waste will affect the quality of the final product of stabilization process. The effect of inorganic heavy metal substances on the quality of the stabilization product seen based on the final concentration of water leachate and TCLP test. Once stabilized with lime the waste pH also neutral its not effect or react with other substances in environmental. In optimization SET-E after stabilization indicate the

concentration both cadmium and zinc in water and TCLP well within the limits as per criteria. In this design we are using fixation time of stabilization curing are also very less i.e., after 8 hours easily cured got the result within the limits. Cost of reagents for this process very cheaper also use less quantities in waste mechanism even zinc value very high before treatment.

In this stabilization process use sufficient of water for homogeneously mixing waste with lime and cement vital role of this mechanism. Once fix the design like brick shape you can use (brick replacement) final product of stabilization block based on the shape. Use environmentally friendly walls, garden area, etc., Finally monitor the metals in ground water or surface water or soil at landfill surrounding area for environmental pollutants. Disposal of landfill after stabilized waste strictly followed as per Hazardous Waste Management guidelines 2016.

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