

Appendix-A Different Values and Parameters Evaluated in the Research Work

Table A1 Batch leaching test details for FA-1 and FA-2 through TCLP and ASTM D 3987

S. N.	Sample no.	Weight of sample	Extraction fluid (100 ml)	L/S ratio	Procedure followed	pH of the leachates
1	FA-1	20 grams	Distilled Water	5	-	7.54
2	FA-1	10 grams	Distilled Water	10	-	7.44
3	FA-1	5 grams	Distilled Water	20	ASTM	7.38
4	FA-1	2 grams	Distilled Water	50	-	7.36
5	FA-1	20 grams	Acetic Acid	5	-	3.77
6	FA-1	10 grams	Acetic Acid	10	-	3.60
7	FA-1	5 grams	Acetic Acid	20	TCLP	3.44
8	FA-1	2 grams	Acetic Acid	50	-	3.23
9	FA-2	20 grams	Distilled Water	5	-	6.98
10	FA-2	10 grams	Distilled Water	10	-	6.92
11	FA-2	5 grams	Distilled Water	20	ASTM	6.60
12	FA-2	2 grams	Distilled Water	50	-	6.36
13	FA-2	20 grams	Acetic Acid	5	-	3.86
14	FA-2	10 grams	Acetic Acid	10	-	3.65
15	FA-2	5 grams	Acetic Acid	20	TCLP	3.48
16	FA-2	2 grams	Acetic Acid	50	-	3.30

Table A2 TCLP Batch leaching test details

TCLP Batch test (FA & CT)					
S. N.	Sample no	FA (in gm)	CT (in gm)	Vol of acetic acid (0.1M, pH 2.88)	pH of leachate
1	1-A	0.5	4.5	100	3.82
2	1-B	0.5	4.5	100	3.82
3	1-C	0.5	4.5	100	3.7
4	2-A	1	4	100	3.78
5	2-B	1	4	100	3.77
6	2-C	1	4	100	3.8
7	3-A	1.5	3.5	100	3.74
8	3-B	1.5	3.5	100	3.72
9	3-C	1.5	3.5	100	3.65
10	4-A	2	3	100	3.69
11	4-B	2	3	100	3.8
12	4-C	2	3	100	3.74
13	5-A	2.5	2.5	100	3.62
14	5-B	2.5	2.5	100	3.74
15	5-C	2.5	2.5	100	3.79
16	6-A	3	2	100	3.69
17	6-B	3	2	100	3.69
18	6-C	3	2	100	3.7
19	7-A	3.5	1.5	100	3.62
20	7-B	3.5	1.5	100	3.62
21	7-C	3.5	1.5	100	3.66
22	8-A	4	1	100	3.55
23	8-B	4	1	100	3.54
24	8-C	4	1	100	3.59
25	9-A	4.5	0.5	100	3.41
26	9-B	4.5	0.5	100	3.46
27	9-C	4.5	0.5	100	3.44

Table A3 ASTM D 3987 Batch leaching test details

S. No.	Sample No	FA (in gm)	CT (in gm)	Distilled water Vol (ml)	pH of leachate
1	1-A	0.5	4.5	100	8.18
2	1-B	0.5	4.5	100	8.26
3	1-C	0.5	4.5	100	8.28
4	2-A	1	4	100	8.2
5	2-B	1	4	100	8.11
6	2-C	1	4	100	8.05
7	3-A	1.5	3.5	100	8.03
8	3-B	1.5	3.5	100	8.01
9	3-C	1.5	3.5	100	7.93
10	4-A	2	3	100	7.82
11	4-B	2	3	100	7.6
12	4-C	2	3	100	7.63
13	5-A	2.5	2.5	100	7.57
14	5-B	2.5	2.5	100	7.54
15	5-C	2.5	2.5	100	7.4
16	6-A	3	2	100	7.82
17	6-B	3	2	100	7.81
18	6-C	3	2	100	7.98
19	7-A	3.5	1.5	100	7.84
20	7-B	3.5	1.5	100	7.88
21	7-C	3.5	1.5	100	7.87
22	8-A	4	1	100	7.91
23	8-B	4	1	100	7.85
24	8-C	4	1	100	7.81
25	9-A	4.5	0.5	100	7.91
26	9-B	4.5	0.5	100	7.86
27	9-C	4.5	0.5	100	7.74

Table A4 Rate of materials taken for the cost calculation from the schedule of rates followed in district Gwalior, Madhya Pradesh, India for the year 2018

S. No.	Material	Rate (in INR)	Cost of each kg of material (in INR)
1	Cement	335/ bag of 50kg	6.70
2	Fine aggregate	19100/ 14.16 m ³	0.49
3	Coarse Aggregate	700/ton	0.70
4	Fly Ash (loading, unloading transportation)	32000/ 15 tons	2.13
5	Copper tailings (loading, unloading transportation)	35000/ 15 tons	2.34
6	Super Plasticizer	41/kg	41.00

Appendix-B Different Guidelines Values used in the Research Work

Table B1 Drinking water guidelines for different elements as per IS 10500:2012 (IS 10500, 2012)

S. No.	Characteristic	Requirement (acceptable limit)	Permissible limit (in the absence of alternate source)
1	Aluminium (as Al), mg/l, max	0.03	0.2
2	Ammonia (as total ammonia N) mg/l, max	0.5	No relaxation
3	Anionic detergents (as MBAS) mg/l, max	0.2	1.0
4	Barium (as Ba), mg/l, max	0.7	No relaxation
5	Boron (as B), mg/l, max	0.5	1.0
6	Calcium (as Ca), mg/l, max	75	200
7	Chloramines (as Cl ₂), mg/l, max	4.0	No relaxation
8	Chloride (as Cl), mg/l, max	250	1000
9	Copper (as Cu), mg/l, max	0.05	1.5
10	Fluoride (as F) mg/l, max	1.0	1.5
11	Free residual chlorine, mg/l, Min	0.2	1
12	Iron (as Fe), mg/l, Max	0.3	No relaxation
13	Magnesium (as Mg), mg/l, Max	30	100
14	Manganese (as Mn), mg/l, Max	0.1	0.3
15	Mineral oil, mg/l, Max	0.5	No relaxation
16	Nitrate (as NO ₃), mg/l, Max	45	No relaxation
17	Phenolic compounds (as C ₆ H ₅ OH), mg/l, Max	0.001	0.002
18	Selenium (as Se), mg/l, Max	0.01	No relaxation
19	Silver (as Ag), mg/l, Max	0.1	No relaxation
20	Sulphate (as SO ₄) mg/l, Max	200	400
21	Sulphide (as H ₂ S), mg/l, Max	0.05	No relaxation
22	Total alkalinity as calcium carbonate, mg/l, Max	200	600
24	Total hardness (as CaCO ₃), mg/l, Max	200	600
25	Zinc (as Zn), mg/l, Max	5	15

Table B1 Drinking water guidelines for different elements as per IS 10500:2012 (Cont....)

S. No.	Characteristic	Requirement (acceptable limit)	Permissible limit (in the absence of alternate source)
25	Cadmium (as Cd), mg/l, Max	0.003	No relaxation
26	Cyanide (as CN), mg/l, Max	0.05	No relaxation
27	Lead (as Pb), mg/l, Max	0.01	No relaxation
28	Mercury (as Hg), mg/l, Max	0.001	No relaxation
29	Molybdenum (as Mo), mg/l, Max	0.07	No relaxation
30	Nickel (as Ni), mg/l, Max	0.02	No relaxation
32	Polychlorinated biphenyls, mg/l, Max	0.000 5	No relaxation
33	Polynuclear aromatic hydrocarbons (as PAH), mg/l, Max	0.0001	No relaxation
34	Iron (as Fe), mg/l, Max	0.3	No relaxation
35	Magnesium (as Mg), mg/l, Max	30	100
36	Total arsenic (as As), mg/l, Max	0.01	0.05
37	Total chromium (as Cr), mg/l, Max	0.05	No relaxation
38	Total arsenic (as As), mg/l, Max	0.01	0.05
39	Total chromium (as Cr), mg/l, Max	0.05	No relaxation

Table B2 Other drinking water parameters as per IS 10500:2012

S. No.	Characteristic	Requirement (acceptable limit)	Permissible limit (in the absence of alternate source)
1	Color, Hazen units, Max	5	15
2	Odour	Agreeable	Agreeable
3	pH value	6.5-8.5	No relaxation
4	Taste	Agreeable	Agreeable
5	Turbidity, NTU, Max	1	5
6	Total dissolved solids, mg/l, Max	500	2000

Table B3 WHO drinking water guidelines for different constituents (GDWQ, 2017)

S. No.	Parameter	Unit	Latest WHO 4th edition (2011) Guideline Value
1	Acrylamide	µg/L	0.5
2	Alachlor	µg/L	20
3	Aldicarb	µg/L	10
4	Aldrin and Dieldrin	µg/L	0.03
5	Antimony	mg/L	0.02
6	Arsenic	mg/L	0.01
7	Atrazine and its chloro- s-triazine metabolites	µg/L	100
8	Barium	mg/L	0.7
9	Benzene	µg/L	10
10	Benzo[a]pyrene	µg/L	0.7
11	Boron	mg/L	2.4
12	Bromate	µg/L	10
13	Bromodichloromethane	µg/L	60
14	Bromoform	µg/L	100
15	Cadmium	mg/L	0.003
16	Carbofuran	µg/L	7
17	Carbon tetrachloride	µg/L	4
18	Chlorate	µg/L	700
19	Chlordane	µg/L	0.2
20	Chlorine	mg/L	5
21	Chlorite	µg/L	700
22	Chloroform	µg/L	300
23	Chlorotoluron	µg/L	30
24	Chlorpyrifos	µg/L	30
25	Chromium	mg/L	0.05
26	Copper	mg/L	2
27	Cyanazine	µg/L	0.6
28	Cyanazine	µg/L	0.6
29	Cyanide	mg/L	0.07
30	Cyanogen chloride	mg/L	0.07
31	2,4-D (2,4- dichlorophenoxyacetic acid)	µg/L	30
32	2,4-DB (2,4-dichlorophenoxybutyric acid)	µg/L	90
33	DDT (Dichlorodiphenyltrichlor ethane) and metabolites	µg/L	1
34	Di(2-ethylhexyl) phthalate	µg/L	8
35	Dibromoacetonitrile	µg/L	70

Table B3 WHO (4th edition) drinking water guidelines for different constituents (Cont..)

S. No.	Parameter	Unit	Latest WHO 4th edition (2011) Guideline Value
36	Dibromochloromethane	µg/L	100
37	1,2-Dibromo-3- chloropropane	µg/L	1
38	1,2-Dibromoethane	µg/L	0.4
39	Dichloroacetate	µg/L	50
40	Dichloroacetonitrile	µg/L	20
41	1,2-Dichlorobenzene	µg/L	1000
42	1,4-Dichlorobenzene	µg/L	300
43	1,2-Dichloroethane	µg/L	30
44	1,2-Dichloroethene	µg/L	50
45	Dichloromethane	µg/L	20
46	1,2-Dichloropropane	µg/L	40
47	1,3-Dichloropropene	µg/L	20
48	Dichlorprop	µg/L	100
49	Dimethoate	µg/L	6
50	1,4-Dioxane	µg/L	50
51	Edetic acid	µg/L	600
52	Endrin	µg/L	0.6
53	Epichlorohydrin	µg/L	0.4
54	Ethylbenzene	µg/L	300
55	Fenoprop	µg/L	9
56	Fluoride	mg/L	1.5
57	Hexachlorobutadiene	µg/L	0.6
58	Hydroxyatrazine	µg/L	200
59	Isoproturon	µg/L	9
60	Lead	mg/L	0.01
61	Lindane	µg/L	2
62	MCPA (4-(2-Methyl-4-chlorophenoxy) acetic acid)	µg/L	2
63	Mecoprop	µg/L	10
64	Mercury	mg/L	0.006
65	Methoxychlor	µg/L	20
66	Metolachlor	µg/L	10
67	Microcystin-LR	µg/L	1
68	Molinate	µg/L	6
69	Monochloramine	mg/L	3
70	Monochloroacetate	µg/L	20

Table B3 WHO drinking water guidelines for different constituents (Cont..)

S. No.	Parameter	Unit	Latest WHO 4th edition (2011) Guideline Value
71	Nickel	mg/L	0.07
72	Nitrate (as NO ₃ ⁻)	mg/L	50
73	Nitritotriacetic acid	µg/L	200
74	Nitrite (as NO ₂ ⁻)	mg/L	3
75	N-Nitrosodimethylamine	µg/L	0.1
76	Pendimethalin	µg/L	20
77	Pentachlorophenol	µg/L	9
78	-	-	-
79	-	-	-
80	Selenium	mg/L	0.04
81	Simazine	µg/L	2
82	Sodium dichloroisocyanurate (as cyanuric acid)	mg/L	40
83	Styrene	µg/L	20
84	2,4,5-T (2,4,5-trichlorophenoxy acetic acid)	µg/L	9
85	Terbutylazine	µg/L	7
86	Tetrachloroethene	µg/L	40
87	Toluene	µg/L	700
88	Trichloroacetate	µg/L	200
89	Trichloroethene	µg/L	20
90	2,4,6-Trichlorophenol	µg/L	200
91	Trifluralin	µg/L	20
92	Trihalomethanes		The sum of the ratio of the concentration of each to its respective guideline value should not exceed 1
93	Uranium	mg/L	0.03 (P)
94	Vinyl chloride	µg/L	0.3
95	Xylenes	µg/L	500

Table B4 Other WHO drinking water guidelines (GDWQ, 2017)

S. No.	Parameters	Value
1	pH at 25°C	8.2 – 8.8
2	Colour	Not exceeding 5 Hazen units
3	Turbidity	Not exceeding 1.0 NTU, and not exceeding 0.3 NTU in 95% of daily samples in any month
4	Iron as Fe	Not exceeding 0.1 mg/L
5	Manganese as Mn	Not exceeding 0.05 mg/L
6	Aluminium as Al	Not exceeding 0.10 mg/L
7	Free residual chlorine	0.5 - 1.5 mg/L
8	Fluoride as F	± 10% of nominal level (0.5 mg/L)
9	Taste and odour	Unobjectionable
10	Total Coliforms & E. coli (no./100mL)	Absent
11	Cryptosporidium	4-log (99.99%) reduction or inactivation
12	Giardia	4-log (99.99%) reduction or inactivation
13	Viruses	4-log (99.99%) reduction or inactivation

Table B5 Total concentration and leachability limits for Class A and Class B landfills (MFENZG, 2004)

Inorganic contaminants	Class A landfills		Class B landfills	
	Screening criteria ² (mg/kg)	Concentration in leachate (mg/L)	Screening criteria ² (mg/kg)	Concentration in leachate (mg/L)
Aluminium	800	40	80	4
Antimony	12	0.6	1.2	0.06
Arsenic	100	5	10	0.5
Barium	2000	100	200	10
Beryllium	200	10	20	1
Boron	400	20	40	2
Cadmium	20	1	2	0.1
Chromium (VI)	100	5	10	0.5
Copper	100	5	10	0.5
Fluoride	4000	200	400	20
Lead	100	5	10	0.5
Lithium	400	20	40	2
Mercury	4	0.2	0.4	0.02
Molybdenum	200	10	20	1
Nickel	200	10	20	1
Selenium	200	1	20	0.11
Silver	200	5	20	0.5
Tin	20000	1000	2,000	100
Vanadium	40	2	4	0.2
Zinc	200	10	20	1
Aromatic hydrocarbons				
Aniline	4	0.2	0.4	0.02
Styrene	120	6	12	0.6
Polynuclear aromatic hydrocarbons				
Naphthalene	200	10	20	1
Other halogenated aromatic hydrocarbons				
1,2 Dichlorobenzene	4	0.2	0.4	0.02
1,3 Dichlorobenzene	1000	50	100	5
1,2,3 Trichlorobenzene	1000	50	100	5
1,2,4 Trichlorobenzene	800	40	80	4
BTEX				
Benzene	10	0.5	1	0.05
Toluene	2000	100	200	10
Ethyl benzene	1000	50	100	5
Xylene (m,o,p)	2000	100	200	10