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APPENDIX

Table A.1 % Sorption Efficiency of ^{137}Cs on Titanium Dioxide as Effected by pH and Contact Time.

Contact Time \ pH	% Sorption Efficiency						
	1	3	5	7	9	11	13
5 mins.	37.51	45.27	45.39	48.50	48.85	45.46	29.17
10 mins.	39.95	51.50	59.50	62.83	48.58	51.50	29.00
20 mins.	42.13	52.57	59.25	69.91	51.00	52.78	28.87
30 mins.	38.48	55.41	58.59	68.18	51.89	57.96	29.35
1 hr	40.05	54.34	55.95	68.75	54.85	56.50	28.95
2 hrs.	42.42	52.96	57.53	69.02	54.18	57.57	27.08
4 hrs.	41.36	55.00	54.65	68.87	55.76	47.25	26.74
1 day.	41.50	56.30	51.50	67.10	54.73	54.45	29.95

Table A.2 % Sorption Efficiency of ^{137}Cs on Zeolite as Effected by pH and Contact Time.

Contact Time \ pH	% Sorption Efficiency						
	1	3	5	7	9	11	13
5 mins.	89.50	94.62	95.65	95.04	85.85	82.50	77.50
10 mins.	90.50	96.50	94.85	99.69	85.08	82.58	80.12
20 mins.	92.25	95.15	94.25	99.78	87.94	85.93	79.00
30 mins.	92.56	95.67	95.58	99.69	89.67	83.51	81.46
1 hr.	92.20	93.85	95.00	99.43	85.04	82.00	81.57
2 hrs.	91.95	94.15	94.05	99.50	84.15	83.35	82.14
4 hrs.	90.25	94.34	94.59	99.85	88.15	82.00	81.25
1 day.	92.20	97.54	95.25	99.43	88.94	82.93	81.29

Table A.3 % Sorption Efficiency of ^{137}Cs on Bentonite as Effected by pH and Contact Time.

Contact Time \ pH	% Sorption Efficiency						
	1	3	5	7	9	11	13
5 mins	54.50	52.75	55.34	61.00	51.24	53.52	54.41
10 mins	68.41	69.00	62.25	65.45	63.29	64.02	65.65
20 mins	75.95	78.54	76.68	79.35	72.95	67.45	68.58
30 mins	74.13	72.56	77.85	83.56	85.45	77.43	78.50
1 hr	78.54	77.63	75.15	85.95	86.58	78.57	78.85
2 hrs	80.84	81.35	80.48	83.52	85.59	83.35	80.35
4 hrs	79.52	82.50	83.00	83.50	86.08	82.65	80.74
1 day	80.00	82.00	82.65	85.74	85.65	82.15	80.84

Table A.4 % Sorption Efficiency of ^{137}Cs on Kaolinite as Effected by pH and Contact Time.

Contact Time \ pH	% Sorption Efficiency						
	1	3	5	7	9	11	13
5 mins	83.25	91.24	89.50	88.58	85.63	84.95	85.56
10 mins	87.70	92.74	95.41	98.35	94.59	92.12	91.58
20 mins	86.50	94.58	96.15	99.02	97.02	94.36	89.85
30 mins	85.36	94.89	97.76	99.12	96.55	93.63	89.55
1 mins	87.44	94.67	94.67	98.08	96.73	93.75	87.85
2 mins	87.54	95.54	95.44	99.04	96.98	92.98	83.78
4 mins	86.89	94.43	94.64	98.50	96.23	93.57	86.34
1 day	86.68	94.60	96.20	99.02	90.77	97.02	89.68

Table A.5 % Sorption Efficiency of ^{137}Cs on Sand as Effected by pH and Contact Time.

pH / Contact Time	% Sorption Efficiency						
	1	3	5	7	9	11	13
5 mins	57.12	50.86	56.65	51.53	58.25	53.00	51.04
10 mins	75.25	78.50	85.68	85.34	82.75	74.75	73.52
20 mins	77.19	82.50	90.68	90.58	88.50	77.35	82.15
30 mins	78.48	81.41	88.59	92.89	88.89	87.96	83.80
1 hr.	88.49	85.43	93.95	95.55	89.68	86.36	86.54
2 hrs.	86.57	85.81	95.57	94.75	90.47	87.50	86.05
4 hrs.	88.40	84.57	93.84	95.97	91.10	87.50	87.13
1 day.	87.59	84.90	94.57	93.58	89.95	85.80	85.59

Table A.6 % Sorption Efficiency of ^{137}Cs on Sanddy Soil as Effected by pH and Contact Time.

pH / Contact Time	% Sorption Efficiency						
	1	3	5	7	9	11	13
5 mins	55.20	55.27	50.68	58.32	57.48	51.00	51.39
10 mins	70.05	72.50	79.54	87.10	82.58	76.50	52.54
20 mins	75.13	76.57	84.25	92.73	83.50	82.78	58.87
30 mins	78.48	81.41	88.59	92.74	88.90	87.58	59.80
1 hr.	80.49	85.43	85.95	93.55	90.68	86.36	62.54
2 hrs.	80.57	86.81	87.57	94.75	91.47	87.50	63.05
4 hrs.	81.40	85.57	90.65	93.45	92.76	87.25	67.13
1 day.	81.59	86.90	91.57	94.58	92.35	88.80	69.95

Table A.7 % Sorption Efficiency of ^{137}Cs on HAP as Effected by pH and Contact Time.

Contact Time \ pH	% Sorption Efficiency						
	1	3	5	7	9	11	13
5 mins	55.44	61.27	60.68	61.00	37.55	41.14	32.64
10 mins	82.05	82.00	79.54	86.40	35.43	40.25	32.75
20 mins	85.48	86.74	85.25	88.73	39.45	41.78	34.47
30 mins	84.48	87.50	88.59	92.00	40.75	44.45	35.35
1 hr.	88.05	88.79	89.95	94.43	40.50	46.54	37.90
2 hrs.	88.42	89.96	87.53	96.50	41.18	45.64	34.15
4 hrs.	87.50	88.45	90.45	95.45	42.84	47.25	35.47
1 day.	87.50	89.75	92.14	96.80	42.45	45.00	34.50

Table A.8 % Sorption Efficiency of ^{137}Cs on Antimony Pentoxide as Effected by pH and Contact Time.

Contact Time \ pH	% Sorption Efficiency						
	1	3	5	7	9	11	13
5 mins	75.94	77.58	79.48	80.00	77.50	64.14	42.64
10 mins	88.55	88.76	89.52	87.40	85.43	66.50	42.75
20 mins	92.04	96.74	95.25	98.03	89.45	75.78	48.47
30 mins	95.50	97.50	98.59	99.50	88.75	76.14	49.35
1 hr.	98.05	98.65	99.45	98.00	90.52	76.54	47.94
2 hrs.	98.73	98.65	99.45	98.43	90.52	76.54	47.90
4 hrs.	97.50	98.45	98.47	98.45	92.84	77.50	43.13
1 day.	97.59	99.90	97.57	99.58	90.75	78.80	44.59

Table A.9 A Comparison of the Sorption Efficiency of ^{137}Cs by Various Exchangers. (pH 7, 25 °C, Various Contact Time)

Inorganic Ion-exchanger	% Sorption Efficiency of ^{137}Cs					
	5 mins	10 mins	20 mins	30 mins	1 hr	2 hrs
TiO_2	50.50	62.83	69.91	68.18	68.75	69.02
Zeolite	95.04	99.69	99.78	99.69	99.43	99.50
Bentonite	61.00	65.45	79.35	83.56	85.95	83.52
Kaolinite	88.58	98.35	99.02	99.12	98.08	99.04
Sand	71.53	85.34	90.58	92.89	95.55	94.75
Sandy Soil	82.32	87.10	92.73	92.74	93.55	94.75
HAP	81.00	86.40	88.73	92.00	94.43	96.50
Antimony-pentoxide	81.00	87.50	98.03	99.50	98.00	98.43

Table A.10 A Comparison of the Sorption Efficiency of ^{137}Cs at Various Temperatures (pH 7, 1 hr.Contact Time).

Ion-exchanger	% Sorption Efficiency			
	25 °C	30 °C	40 °C	50 °C
TiO_2	65.25	62.20	62.40	61.00
Zeolite	99.57	97.47	97.50	95.50
Bentonite	75.74	76.94	72.52	71.45
Kaolinite	98.02	97.41	96.54	96.05
Sand	90.50	88.45	89.50	88.00
Sandy Soil	95.00	93.25	92.55	92.74
HAP	94.62	95.00	93.14	92.54
Antimony-pentoxide	98.45	95.84	92.00	91.05

Table A.11 % Sorption Efficiency of ^{99}Tc on Titanium Dioxide as Effected by pH and Contact Time.

pH / Contact Time	% Sorption Efficiency						
	1	3	5	7	9	11	13
1 hr.	0.67	1.33	1.56	2.27	0.72	0.98	0.83
1 day.	4.73	5.83	4.48	6.60	2.61	3.76	4.36
5 days.	4.07	8.13	11.26	11.30	11.26	10.18	5.30
10 days.	3.85	7.88	9.46	11.04	11.43	10.37	4.88

Table A.12 % Sorption Efficiency of ^{99}Tc on Zeolite as Effected by pH and Contact Time.

Contact Time \ pH	% Sorption Efficiency						
	1	3	5	7	9	11	13
1 hr.	0.72	0.87	1.55	2.12	0.00	0.00	0.00
1 day.	1.46	3.82	3.49	5.91	0.45	0.00	0.00
5 days.	1.56	5.82	3.35	5.89	0.55	0.18	0.30
10 days.	1.71	4.46	3.12	5.59	0.05	0.10	0.18

Table A.13 % Sorption Efficiency of ^{99}Tc on Bentonite as Effected by pH and Contact Time.

Contact Time \ pH	% Sorption Efficiency						
	1	3	5	7	9	11	13
1 hr.	0.00	0.01	0.00	0.01	0.00	0.00	0.00
1 day.	0.03	0.02	0.08	0.01	0.00	0.00	0.00
5 days.	0.07	0.13	0.26	0.30	0.26	0.18	0.30
10 days.	0.05	0.08	0.06	0.04	0.13	0.37	0.18

Table A.14 % Sorption Efficiency of ^{99}Tc on Kaolinite as Effected by pH and Contact Time.

Contact Time \ pH	% Sorption Efficiency						
	1	3	5	7	9	11	13
1 hr.	0.46	1.07	0.53	0.07	0.00	0.00	0.00
1 day.	1.07	1.68	1.12	1.65	2.40	1.97	1.08
5 days.	1.06	2.42	1.09	4.13	4.05	1.17	1.65
10 days.	2.51	4.28	3.00	4.21	5.78	2.86	1.45

Table A.15 % Sorption Efficiency of ^{99}Tc on Sand as Effected by pH and Contact Time.

Contact Time \ pH	% Sorption Efficiency						
	1	3	5	7	9	11	13
1 hr.	0.00	0.00	0.00	0.00	0.02	0.03	0.00
1 day.	0.00	0.03	0.00	0.00	0.01	0.00	0.00
5 days.	0.00	0.00	0.00	0.00	0.00	0.00	0.00
10 days.	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Table A.16 % Sorption Efficiency of ^{99}Tc on Sandy Soil as Effected by pH and Contact Time.

pH / Contact Time	% Sorption Efficiency						
	1	3	5	7	9	11	13
1 hr.	0.00	0.03	0.00	0.00	0.02	0.00	0.03
1 day.	0.01	0.03	0.00	0.01	0.01	0.00	0.00
5 days.	0.00	0.00	0.00	0.00	0.01	0.00	0.00
10 days.	0.00	0.00	0.00	0.04	0.03	0.00	0.00

Table A.17 % Sorption Efficiency of ^{99}Tc on HAP as Effected by pH and Contact Time.

pH / Contact Time	% Sorption Efficiency						
	1	3	5	7	9	11	13
1 hr.	0.00	0.00	0.00	0.20	0.00	0.00	0.00
1 day.	0.00	0.00	0.00	0.30	0.00	0.00	0.00
5 days.	0.00	0.13	0.00	0.50	0.00	0.00	0.00
10 days.	0.00	0.20	0.00	0.54	0.03	0.17	0.00

Table A.18 % Sorption Efficiency of ^{99}Tc on Antimony pentoxide as Effected by pH and Contact Time.

Contact Time \ pH	% Sorption Efficiency						
	1	3	5	7	9	11	13
1 hr.	33.24	31.88	29.87	29.61	31.72	38.60	29.82
1 day.	50.64	38.60	48.64	33.69	40.90	35.54	53.54
5 days.	80.96	57.67	62.12	60.11	66.64	45.19	55.95
10 days.	95.81	87.63	79.10	81.98	81.53	56.87	56.95

Table A.19 A Comparison of the Sorption Efficiency of ^{99}Tc on Various Exchangers at Various Times.(at Optimum pH, 25°C.)

Inorganic Ion-exchanger	% Sorption Efficiency			
	1 hr.	1 day	5 days	10 days
TiO_2	2.27	6.60	11.30	11.04
Zeolite	2.12	5.91	5.89	5.59
Bentonite	0.01	0.01	0.30	0.04
Kaolinite	0.07	1.65	4.13	4.05
sand	0.00	0.00	0.00	0.00
Sandy Soil	0.00	0.01	0.01	0.04
HAP	0.20	0.30	0.50	0.54
Antimony-pentoxide	33.24	50.64	80.96	95.81

Table A.20 A Comparison of the Sorption Efficiency of ^{99}Tc at Various Temperatures(pH 7, 1 day Contact Time)

Ion-exchanger	% Sorption Efficiency			
	25 °C	30 °C	40 °C	50 °C
TiO_2	6.60	7.20	5.50	5.00
Zeolite	5.91	5.47	4.50	4.50
Bentonite	0.01	0.00	0.00	0.00
Kaolinite	2.46	2.50	1.54	1.05
Sand	0.00	0.00	0.00	0.00
Sandy Soil	0.00	0.00	0.00	0.00
HAP	0.62	0.50	0.54	0.54
Antimony-pentoxide	85.47	78.54	72.00	71.05

Table A.21 The Optimum Quantities of Inorganic Ion-exchangers for ^{137}Cs Sorption.

Inorganic Ion-exchanger	% Sorption Efficiency of ^{137}Cs			Contact Time (mins)
	0.3 g.	1 g.	3 g.	
Titanium dioxide	8.21	41.80	69.91	20
Zeolite	98.78	98.70	99.69	5
Bentonite	43.65	61.98	63.29	20
Kaolinite	96.50	96.80	98.35	10
Sand	22.51	88.32	90.58	20
Sandy Soil	3.50	72.46	92.73	20
HAP	41.72	86.40	86.40	30
Antimony pentoxide	56.23	95.15	98.03	20

Note : Volume of solution was 30 ml.

Table A.22 The Optimum Quantities of Inorganic Ion-exchangers for ^{99}Tc Sorption.

Inorganic Ion-exchanger	% Sorption Efficiency of ^{99}Tc			Contact Time
	0.3 g.	1 g.	3 g.	
Titanium dioxide	0.00	0.00	11.30	5 days
Zeolite	0.00	0.00	5.89	5 days
Bentonite	0.00	0.00	0.00	-
Kaolinite	0.00	0.80	5.05	5 days
Sand	0.00	0.00	0.00	-
Sandy Soil	0.00	0.00	0.00	-
HAP	0.00	0.00	0.50	-
Antimony pentoxide	6.50	15.00	80.96	5 days

Note : Volume of solution was 30 ml.

Table A.23 Density of Cemented Ion-Exchange Materials

Ion-Exchange Materials	Density (g/cm^3)
Titanium dioxide	0.7056
Zeolite	0.5976
Bentonite	0.7954
Kaolinite	0.9716
Sand	1.3667
Sandy Soil	1.2522
HAP	0.8392
Antimony pentoxide	1.6571
Portland Cement	1.3581

Table A.24 Weight Ratio of TiO_2 to Cement.

Ratio	Weight (g.)		
	TiO_2	Cement	Water
25 : 75	18.14	54.38	32.00
30 : 70	21.76	50.76	31.00
35 : 65	25.38	47.14	30.00
40 : 60	29.01	43.51	30.00
45 : 55	32.63	39.89	30.00
50 : 50	36.26	36.26	30.00

Table A.25 Weight Ratio of Zeolite to Cement.

Ratio	Weight (g.)		
	Zeolite	Cement	Water
25 : 75	18.22	54.64	30.00
30 : 70	21.86	51.00	32.00
35 : 65	25.50	47.36	34.00
40 : 60	29.14	43.72	36.00
45 : 55	32.79	40.07	38.00
50 : 50	36.43	36.43	40.00

Table A.26 Weight Ratio of Bentonite to Cement.

Ratio	Weight (g.)		
	Bentonite	Cement	Water
25 : 75	18.56	55.64	50.00
30 : 70	22.26	51.94	55.00
35 : 65	25.97	48.23	55.00
40 : 60	29.68	44.52	60.00
45 : 55	33.39	40.81	64.00
50 : 50	37.10	37.10	66.00

Table A.27 Weight Ratio of Kaolinite to Cement.

Ratio	Weight (g.)		
	Kaolinite	Cement	Water
25 : 75	19.67	59.02	30.00
30 : 70	23.61	55.08	30.00
35 : 65	27.54	51.15	33.00
40 : 60	31.48	47.21	35.00
45 : 55	35.41	43.28	38.00
50 : 50	39.34	39.34	40.00

Table A.28 Weight Ratio of Sand to Cement.

Ratio	Weight (g.)		
	Sand	Cement	Water
25 : 75	21.22	63.64	24.00
30 : 70	25.45	59.41	23.00
35 : 65	29.70	55.16	23.00
40 : 60	33.95	50.91	20.00
45 : 55	38.19	46.67	20.00
50 : 50	42.43	42.43	19.00

Table A.29 A Comparison of the Homogeneity of Cement Waste Forms.

Simulated Waste Forms	Homogeneity		
	good	fair	poor
TiO_2 - Cement	✓		
Zeolite-Cement	✓		
Bentonite-Cement			✓
Kaolinite-Cement		✓	
Sand-Cement	✓		

Table A.30 Density and Percentage of Weight-loss after Curing Time (28 days).

Specimens	% Weight-loss	Density (g/cm^3)	Note
Ti-25 %Wt	7.23	1.69	Ti: Titanium - dioxide
Ti-30 %Wt	8.50	1.69	
Ti-35 %Wt	7.61	1.68	
Ti-40 %Wt	9.87	1.67	
Ti-45 %Wt	13.84	1.59	
Ti-50 %Wt	15.50	1.59	
Z -25 %Wt	2.25	1.69	Z: Zeolite
Z -30 %Wt	5.12	1.60	
Z -35 %Wt	4.95	1.55	
B -25 %Wt	6.60	1.28	B: Bentonite
B -30 %Wt	6.82	1.33	
B -35 %Wt	7.30	1.29	
B -40 %Wt	12.43	1.14	
B -45 %Wt	13.28	1.12	
B -50 %Wt	19.90	1.00	
K -25 %Wt	3.73	1.58	K: Kaolinite
K -30 %Wt	5.11	1.51	
K -35 %Wt	5.84	1.49	
K -40 %Wt	6.54	1.45	
K -45 %Wt	10.97	1.31	
K -50 %Wt	11.71	1.30	
S -25 %Wt	5.52	1.95	S: Sand
S -30 %Wt	4.60	1.91	
S -35 %Wt	4.16	1.98	
S -40 %Wt	3.98	1.95	
S -45 %Wt	5.59	1.88	
S -50 %Wt	4.69	1.98	

Table A.31 Compressive Strength of TiO_2-Cement.

TiO_2 : Cement	Load* (kg)	Compressive strength* ($kg.cm^{-2}$)
25 : 75	3600 ± 0	304.86 ± 0
30 : 70	3433 ± 47.14	290.77 ± 3.99
35 : 65	2500 ±141.42	211.75 ± 11.98
40 : 60	2583 ±169.96	218.78 ± 14.40
45 : 55	1633 ±262.47	138.31 ± 22.23
50 : 50	1333 ± 94.28	112.90 ± 7.98

Table A.32 Compressive Strength of Zeolite-Cement.

Zeolite: Cement	Load* (kg)	Compressive strength* ($kg.cm^{-2}$)
25 : 75	2350 ±212.13	199.04 ± 17.97
30 : 70	1383 ±388.01	117.14 ± 32.86
35 : 65	583 ±117.85	49.40 ± 9.98

Note : Load* : average load (3 times replicated)

Compressive strength*: corrected by multiple correction factor shown in Appendix B Table B-1

Table A.33 Compressive Strength of Bentonite-Cement.

Bentonite:Cement	Load* (kg)	Compressive strength* (kg.cm^{-2})
25 : 75	1516 ± 271	128.40 ± 22.95
30 : 70	1273 ± 533	107.82 ± 45.14
35 : 65	1326 ± 142	112.31 ± 12.03
40 : 60	862 ± 151	73.01 ± 12.79
45 : 55	790 ± 81	66.91 ± 6.86
50 : 50	520 ± 14	44.05 ± 1.18

Table A.34 Compressive Strength of Kaolinite-Cement.

TiO_2 : Cement	Load* (kg)	Compressive strength* (kg.cm^{-2})
25 : 75	1650 ± 208	139.75 ± 17.62
30 : 70	1550 ± 168	131.25 ± 14.25
35 : 65	1237 ± 287	104.80 ± 24.29
40 : 60	1220 ± 439	103.30 ± 37.22
45 : 55	800 ± 147	67.75 ± 12.46
50 : 50	737 ± 83	62.46 ± 7.03

Table A.35 Compressive Strength of Sand-Cement.

TiO_2 : Cement	Load* (kg)	Compressive strength*($kg.cm^{-2}$)
25 : 75	4773 ± 383	404.22 ± 32.48
30 : 70	4450 ± 604	376.84 ± 51.16
35 : 65	3466 ± 645	293.56 ± 54.70
40 : 60	3883 ± 697	326.85 ± 59.10
45 : 55	2616 ± 102	221.59 ± 8.65
50 : 50	2340 ± 552	198.16 ± 46.74

Table A.36 Optimum Exchanger/Cement Ratio related to Compressive Strength by a Linear Regression Equation. (Optimum compressive strength is equal to 150 $kg/cm.^2$)

Type of Waste	Optimum Exchanger/cement ratio(% Weight)
Titanium dioxide	45.23 / 54.77
Zeolite	25.50 / 74.50
Bentonite	19.05 / 80.95
Kaolinite	24.42 / 75.58
Sand	54.14 / 45.86

Note : Calculation from the linear equation shown in Appendix B, Table B-2

Table A.37 Cesium-137 Leaching Data for Kaolinite/Cement Wasted-Forms

Leaching Time (days)	Activity (cps)			
	room temperature (25 C)		high temperature (50 C)	
	A_o^*	A_t^*	A_o^*	A_t^*
0.08	291	0.472	285	1.941
0.25	286	2.720	284	4.766
1	292	4.455	282	15.049
2	292	4.556	291	23.458
3	291	9.907	305	30.340
4	273	12.950	285	32.120
5	288	13.015	295	32.326
6	296	14.464	308	33.448
7	289	16.916	289	33.869
8	292	20.650	290	34.230
9	295	24.501	287	34.832
10	283	27.530	276	35.679
11	285	30.7785	286	41.705

<u>Remark</u> A_o^* : initail activities in cement samples (corrected with shielding factor = 1.565)

A_t^* , activities in leachants removed in time t (corrected with geometrical factor = 2.825)

Table A.38 The Leach Rate of Cesium-137 for Kaolinite/Cement Waste Forms

Leaching Time (days)	Leach rate x 10^{-3} ($g.cm^{-2}.d^{-1}$)			
	Room temperature (25°C)		Oven temperature (50°C)	
	IFL	CFL	IFL	CFL
0.08	11.40	11.40	50.00	50.00
0.25	20.00	31.40	36.00	86.00
1	9.00	40.40	30.00	116.00
2	2.50	42.90	23.00	139.00
3	6.33	80.63	18.70	157.70
4	6.75	87.38	16.00	173.70
5	5.20	92.58	12.40	186.10
6	4.66	97.24	10.00	196.10
7	4.71	101.95	9.43	205.53
8	5.00	106.95	8.38	213.91
9	5.22	112.17	7.67	221.58
10	5.50	117.67	7.30	228.88
11	6.00	123.67	7.45	236.33

<u>Remark</u> IFL: Incremental Fraction Leached

CFL: Cumulative Fraction Leached

Calculation of leach rate and the logarithmic cure fit shown in Appendix B. (Table B-3)

APPENDIX B

Calculations

Cementation Process

The weight of materials can be calculated as follows:

$$weight_{specimen} = volume \times density_{mix}$$

$density_{mix}$ =(ratio exchanger x density exchanger)+(ratio cement x density cement)

Example : ratio zeolite : cement = 25 % : 75 %

zeolite density = 0.5976 g/cm^3

cement density = 1.3581 "

volume of specimen = 62.38 cm^3

$$density_{mix} = (0.25 \times 0.5976) + (0.75 \times 1.3581)$$

$$= 1.1679$$

$$weight_{specimen} = 62.38 \times 1.1679 = 72.86 \text{ g.}$$

$$weight_{zeolite} = 0.25 \times 72.86 = 18.22 \text{ g.}$$

$$weight_{cement} = 0.75 \times 72.86 = 54.64 \text{ g.}$$

Calculation for Determination of Compressive Strength

$$\text{Compressive strength} = \frac{\text{maximum Load for specimen (kg.)}}{\text{cross-section area of specimen}(cm^2)}$$

If the specimen height is less than 2 times the diameter, the following correction factors must be used to determine the campressive strength.

Appendix Table B-1 Ratio of Height/Diameter with a Multiple Correction Factor for Compressive Strength.

Ratio of Height/ Diameter	Multiple Correction Factor
1.75	0.99
1.50	0.97
1.25	0.94
1.00	0.91

Calculation of multiple correction factor of height/diameter of a specimen by linear regression equation: $Y = a + b*X$

wher Y = multiple correction factor

X = hight/diameter ratio (for specimen of this study = 1.4473)

It was found that a = 0.804, b = 0.108 and the equation was:

$Y = 0.804 + 0.108*X$

Therefore, the multiple correction factor for this specimen is 0.9603.

Appendix Table B-2 Calculation of Exchanger/Cement related to Compressive Strength by the Linear Regression Equation.

$$Y = a + b*X$$

Y = Compressive strength (kg/cm^2)

X = % Weight of exchanger

Correct % Wt. = % Wt. at Compressive strength equal to 150 kg/cm^2

Type of Waste	a	b	r	Proper % Wt
Titanium dioxide	516.18	- 8.096	- 0.9518	45.23
Zeolite	275.00	- 4.902	- 0.9837	25.50
Bentonite	213.14	- 3.3134	- 0.9664	19.05
Kaolinite	237.55	- 3.5850	- 0.9851	24.42
Sand	653.06	- 9.2924	- 0.9936	54.14

Calculation for Determination of Leach Rate

$$\text{Leach rate},\ R = \frac{A_t . W_o}{A_o . S . t} \qquad g.cm^{-2}.d^{-1}$$

where A_t = amount of activity removed in time t

A_o = initial amount of activity in sample of weight W_o

S = surface area of sample (cm^2)

t = leach time (days)

In this study, S = 23.76 cm^2

W_o = 13.44 gm (average)

The results are shown in Table 4.38 (Appendix A).

Appendix Table B-3 Curve fit of Leach Rate related to the Logarithmic Regression Equation.

$$Y = a + b*\ln X$$

X = leaching times (days)

Y = leach rate ($g.cm^{-2}.d^{-1}$)

CFL	a	b	r^2
CFL (25 C)	0.06	0.02	0.90
CFL (50 C)	0.13	0.04	0.96

The coefficient of determination (r^2) indicates the quality of fit achieved by the regression. Values of r^2 close to 1.00 indicate a better fit than values close to zero.

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