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APPENDICES

APENDIX A

Table A-1 Free lime content at different burning temperatures

temp.(°C)	% of free lime				Standard deviation
	No.1	No.2	No.3	Average	
1300	6.384	6.44	6.272	6.365	0.085
1400	2.352	2.52	2.52	2.464	0.096
1450	2.02	2.07	2.02	2.03	0.028

Table A-2 Free lime content at different burning times

time(min.)	% of free lime				Standard deviation
	No.1	No.2	No.3	Average	
15	7.76	7.56	7.84	7.72	0.144
30	4.31	4.28	4.33	4.31	0.025
60	2.02	2.07	2.02	2.03	0.028
90	1.23	1.23	1.18	1.21	0.028

Table A-3 Free lime content of clinker doped with chromium

Sample	Initial concentration, wt. %	No.	% Free lime			Average	Standard deviation
			Sample 1	Sample 2	Sample 3		
Chromium	0.10%	1	1.29%	1.34%	1.40%	1.360%	0.055
		2	1.34%	1.40%	1.40%		0.034
	0.50%	1	1.23%	1.18%	1.23%	1.34%	0.028
		2	1.29%	1.40%	1.34%		0.055
	1%	1	1.29%	1.34%	1.29%	1.31%	0.028
		2	1.34%	1.29%	1.29%		0.028
	2%	1	4.03%	3.98%	4.03%	4.005%	0.028
		2	3.98%	4.03%	3.98%		0.028

Table A-4 Free lime content of clinker doped with nickel

Sample	Initial concentration, wt. %	No.	% Free lime			Average	Standard deviation
			Sample 1	Sample 2	Sample 3		
Nickel	0.10%	1	1.46%	1.51%	1.46%	1.48%	0.028
		2	1.51%	1.46%	1.46%		0.028
	0.50%	1	1.40%	1.40%	1.46%	1.44%	0.034
		2	1.46%	1.51%	1.40%		0.055
	1%	1	1.12%	1.12%	1.12%	1.14%	0
		2	1.18%	1.18%	1.12%		0.034
	2%	1	0.67%	0.67%	0.62%	0.64%	0.028
		2	0.62%	0.62%	0.62%		0

Table A-5 Free lime of clinker doped with zinc

Sample	Initial concentration, wt. %	No.	% Free lime			Average	Standard deviation
			Sample 1	Sample 2	Sample 3		
Zinc	0.10%	1	1.46%	1.51%	1.40%	1.46%	0.055
		2	1.46%	1.46%	1.46%		0
	0.50%	1	1.18%	1.18%	1.18%	1.10%	0
		2	1.01%	1.01%	1.01%		0
	1%	1	0.56%	0.62%	0.62%	0.60%	0.034
		2	0.62%	0.56%	0.62%		0.034
	2%	1	0.34%	0.34%	0.39%	0.365%	0.028
		2	0.34%	0.39%	0.39%		0.028

Table A-6 Extracted concentration of chromium from M3051A

Sample	Initial concentration, wt.%	extracted concentration (mg/kg)				Standard deviation
		Sample 1	Sample 2	Sample 3	Average	
Chromium	0	0	0	0	0	0
	0.1	310	324	318	317.3	7.02
	0.5	1487	1568	1539	1531.3	41.04
	1	3565	3547	3542	3551.33	12.09
	2	6135	6274	6217	6208.67	69.87

Table A-7 Extracted concentration of nickel from M3051A

Sample	Initial concentration, wt.%	extracted concentration (mg/kg)				Standard deviation
		Sample 1	Sample 2	Sample 3	Average	
Nickel	0	0	0	0	0	0
	0.1	241	212	224	225.67	14.57
	0.5	900	880	800	860	52.91
	1	2410	2520	2360	2430	81.85
	2	4860	4060	4500	4473.33	400.66

Table A-8 Extracted concentration of zinc from M3051A

Sample	Initial concentration, wt.%	extracted concentration (mg/kg)				Standard deviation
		Sample 1	Sample 2	Sample 3	Average	
Zinc	0	0	0	0	0	0
	0.1	274	251	260	261.67	11.59
	0.5	2120	1830	1860	1936.67	159.47
	1	4360	4370	3920	4216.67	256.96
	2	9204	8940	9327	9157	197.73

Table A-9 Extracted concentration of chromium from M3052

Sample	Initial concentration, wt. %	extracted concentration (mg/kg)				Standard deviation
		Sample 1	Sample 2	Sample 3	Average	
Chromium	0	0	0	0	0	0
	0.1	363	347	352	354	8.18
	0.5	1764	1759	1737	1753.33	14.36
	1	3921	3929	3937	3929	8
	2	6461	6438	6427	6442	17.34

Table A-10 Extracted concentration of nickel from M3052

Sample	Initial concentration, wt. %	extracted concentration (mg/kg)				Standard deviation
		Sample 1	Sample 2	Sample 3	Average	
Nickel	0	0	0	0	0	0
	0.1	247	258	242	249	8.18
	0.5	986	1103	1145	1078	82.39
	1	2485	2513	2439	2479	37.36
	2	4574	4613	4602	4596.3	20.10

Table A-11 Extracted concentration of zinc from M3052

Sample	Initial concentration, wt. %	extracted concentration (mg/kg)				Standard deviation
		Sample 1	Sample 2	Sample 3	Average	
Zinc	0	0	0	0	0	0
	0.1	293	274	287	284.7	9.71
	0.5	2076	2085	2089	2083.3	6.65
	1	4435	4428	4452	4438.3	12.34
	2	9665	9676	9671	9670.7	5.5

Table A-12 Leached concentration of chromium from AVL T

Sample	Initial concentration, wt. %	leached concentration (mg/kg)				Standard deviation
		Sample 1	Sample 2	Sample 3	Average	
Chromium	0	0	0	0	0	0
	0.1	270	280	252	267.4	14.18
	0.5	1376	1362	1368	1368.66	7.02
	1	3294	3145	3278	3239	81.79
	2	5256	5408	5230	5298	96.14

Table A-13 Leached concentration of nickel from AVL T

Sample	Initial concentration, wt. %	leached concentration (mg/kg)				Standard deviation
		Sample 1	Sample 2	Sample 3	Average	
Nickel	0	0	0	0	0	0
	0.1	3.62	9.52	6.84	6.66	2.95
	0.5	26	88	48	61	31.43
	1	44	130	92	146.7	43.09
	2	64	166	128	311.5	51.54

Table A-14 Leached concentration of zinc from AVL T

Sample	Initial concentration, wt. %	leached concentration (mg/kg)				Standard deviation
		Sample 1	Sample 2	Sample 3	Average	
Zinc	0	0	0	0	0	0
	0.1	206	220	296	240.66	48.42
	0.5	1478	1660	1798	1645.33	160.5
	1	3643	3488	3752	3627.67	132.66
	2	8280	8314	8788	8460.66	283.98

Table A-15 Leached concentration of chromium from TCLP

Sample	Initial concentration, wt. %	leached concentration (mg/l)				Standard deviation
		Sample 1	Sample 2	Sample 3	Average	
Chromium	0	0	0	0	0	0
	0.1	5.76	5.61	5.66	5.67	0.076
	0.5	25.9	25.98	27.16	26.34	0.7
	1	45.67	46.44	47.88	46.66	1.21
	2	102.5	106.84	107.1	105.48	2.58

Table A-16 Leached concentration of nickel from TCLP

Sample	Initial concentration, wt. %	leached concentration (mg/l)				Standard deviation
		Sample 1	Sample 2	Sample 3	Average	
Nickel	0	0	0	0	0	0
	0.1	ND	ND	ND	ND	-
	0.5	ND	ND	ND	ND	-
	1	ND	ND	ND	ND	-
	2	ND	ND	ND	ND	-

Remark: ND = Not detected

Table A-17 Leached concentration of zinc from TCLP

Sample	Initial concentration, wt. %	leached concentration (mg/l)				Standard deviation
		Sample 1	Sample 2	Sample 3	Average	
Zinc	0	0	0	0	0	0
	0.1	ND	ND	ND	ND	-
	0.5	ND	ND	ND	ND	-
	1	ND	ND	ND	ND	-
	2	0.137	0.142	0.135	0.138	0.003

Table A-18 Leached concentration of chromium from NFMI

Sample	Initial concentration, wt. %	leached concentration (mg/l)				Standard deviation
		Sample 1	Sample 2	Sample 3	Average	
Chromium	0	0	0	0	0	0
	0.1	5.47	5.09	5.21	5.26	0.19
	0.5	16.85	17.06	17.14	17.02	0.15
	1	28.37	28.45	27.71	28.18	0.41
	2	40.23	41.04	39.57	40.28	0.73

Table A-19 Leached concentration of nickel from NFMI

Sample	Initial concentration, wt. %	leached concentration (mg/l)				Standard deviation
		Sample 1	Sample 2	Sample 3	Average	
Nickel	0	0	0	0	0	0
	0.1	0.034	0.018	0.015	0.022	0.01
	0.5	0.024	0.027	0.025	0.025	0.001
	1	0.029	0.023	0.025	0.026	0.003
	2	0.032	0.034	0.028	0.031	0.003

Table A-20 Leached concentration of zinc from NFMI

Sample	Initial concentration, wt. %	leached concentration (mg/l)				Standard deviation
		Sample 1	Sample 2	Sample 3	Average	
Zinc	0	0	0	0	0	0
	0.1	0.051	0.045	0.044	0.047	0.003
	0.5	0.218	0.23	0.215	0.221	0.007
	1	0.258	0.251	0.256	0.255	0.003
	2	0.272	0.257	0.259	0.263	0.008

APENDIX B

Table B-1 The allowable value of heavy metals in leachate according to U.S. EPA

Metal	Concentration (mg/l)
Arsenic	5
Barium	100
Cadmium	1
Chromium	5
Lead	5
Mercury	0.2
Selenium	1
Silver	5

Table B-2 The allowable value of heavy metals in leachate according to Notification of Ministry of Industry No.6 B.E. 2540

Metal	Concentration (mg/l)
Arsenic	5
Barium	100
Cadmium	1
Chromium	5
Lead	5
Mercury	0.2
Selenium	1
Silver	5

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