

Supplementary Materials: Immobilization of Heavy Metals in Contaminated Soils—Performance Assessment in Conditions Similar to a Real Scenario

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Table S1. Results of the individual adsorption tests – Adsorption of the heavy metals under study by the Soil, suspension of MWCNTs in water, and suspension of Soil with addition of MWCNTs (MWCNTs = 0.01%, w/w).

	Soil (reference)		MWCNTs		Soil + MWCNTs	
	Lead					
min	C (mg/l)	Adsorption (%)	C (mg/l)	Adsorption (%)	C (mg/l)	Adsorption (%)
0	105.3	0.0	105.3	0.0	105.3	0.0
5	5.8	94.5	20.5	80.5	2.9	97.3
20	5.7	94.5	27.4	74.0	2.7	97.5
60	4.6	95.6	26.4	74.9	3.0	97.1
240	4.5	95.7	24.9	76.4	3.0	97.2
1440	5.7	94.6	24.9	76.4	3.0	97.2
	Copper					
min	C (mg/l)	Adsorption (%)	C (mg/l)	Adsorption (%)	C (mg/l)	Adsorption (%)
0	41.0	0.0	41.0	0.0	40.95	0.0
5	10.3	74.9	35.2	14.0	0.3	99.2
20	7.9	80.6	34.6	15.4	0.3	99.3
60	8.5	79.2	40.3	-	0.3	99.3
240	7.4	82.0	32.6	20.4	0.3	99.3
1440	7.2	82.5	33.4	18.4	0.3	99.3
	Nickel					
min	C (mg/l)	Adsorption (%)	C (mg/l)	Adsorption (%)	C (mg/l)	Adsorption (%)
0	158.4	0.0	158.4	0.0	158.4	0.0
5	89.3	43.6	33.7	78.7	29.9	81.1
20	88.5	44.2	29.6	81.3	31.2	80.3
60	89.5	43.5	28.0	82.3	28.0	82.3
240	79.2	50.0	38.5	75.7	28.0	82.3
1440	100.2	36.7	32.5	79.5	28.4	82.1
	Zinc					
min	C (mg/l)	Adsorption (%)	C (mg/l)	Adsorption (%)	C (mg/l)	Adsorption (%)
0	106	0.0	106	0.0	106	0.0
5	88.2	16.8	83.8	20.9	82.4	22.3
20	85	19.8	85.9	19.0	88.8	16.2
60	86.6	18.3	87.3	17.6	90.5	14.6
240	83.6	21.1	83.6	21.1	70.2	-
1440	85.4	19.4	82.9	21.8	87.1	17.8

Table S2. Results of the individual adsorption tests – Adsorption of the heavy metals under study by a suspension of Montmorillonite in water and suspension of Soil with addition of Montmorillonite (montmorillonite = 0.01%, w/w) (results for soil alone as reference are given in Table S1).

Montmorillonite			Soil + Montmorillonite	
	Lead			
min	C (mg/l)	Adsorption (%)	C (mg/l)	Adsorption (%)
0	105.3	0.0	105.3	0.0
5	33.5	68.2	1.4	98.6
20	36.0	65.8	1.4	98.6
60	32.5	69.1	1.3	98.7
240	32.5	69.1	1.7	98.3
1440	34.2	67.5	0.1	99.9
	Copper			
min	C (mg/l)	Adsorption (%)	C (mg/l)	Adsorption (%)
0	40.9	0.0	40.9	0.0
5	40.7	0.6	5.0	87.6
20	39.7	3.1	4.7	88.4
60	40.8	0.3	4.4	89.2
240	35.6	13.1	-	-
1440	37.7	7.9	4.3	89.3
	Nickel			
min	C (mg/l)	Adsorption (%)	C (mg/l)	Adsorption (%)
0	158.4	0.0	158.4	0.0
5	140.9	11.0	58.7	62.9
20	139.9	11.6	66.6	57.9
60	138.5	12.5	76.5	51.7
240	134.9	14.8	59.8	62.2
1440	-	-	61.3	61.3
	Zinc			
min	C (mg/l)	Adsorption (%)	C (mg/l)	Adsorption (%)
0	106.0	0.0	106	0.0
5	91.2	13.9	83.4	21.3
20	89.2	15.8	82.9	21.7
60	88.8	16.2	81.4	23.2
240	90.4	14.7	85.9	18.9
1440	89.3	15.7	-	-

Table S3. Results of the percolation tests – adsorption of the heavy metals under study by soil with or without the addition of MWCNTs.

Heavy Metal	Adsorption (%)		
	Soil (reference)	Soil + MWCNTs (0.01%)	Soil + MWCNTs (0.05%)
Lead	99.73	99.85	-
Copper	99.81	99.88	-
Nickel	69.54	76.68	99.86
Zinc	59.11	76.89	97.06

Table S4. Results of the percolation tests – adsorption of the heavy metals under study by soil with or without the addition of Montmorillonite.

Heavy Metal	Adsorption (%)		
	Soil + Montmorillonite-Natural (25Kg/m ³)	Soil + Montmorillonite-Modified (0.01%)	Soil + Montmorillonite-Modified (1%)
Lead	99.98	-	-
Copper	99.99	-	-
Nickel	86.86	76.83	99.75
Zinc	93.04	72.17	97.68

Table S5. Results of the percolation tests – adsorption of the heavy metals under study by soil with the addition of Portland cement without or with addition of a second additive (MWCNTs or Montmorillonite).

Heavy Metal	Adsorption (%)		
	Soil + Binder	Soil + Binder + MWCNTs	Soil + Binder + Montmorillonite
Lead	99.99	99.99	99.99
Copper	99.99	99.99	99.93
Nickel	99.88	99.91	94.54
Zinc	99.91	99.99	92.77