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Assay	Temperature (°C)	BW content (% -w.w <sup>-1</sup> )	Solid/liquid ratio (% -w.w <sup>-1</sup> )	Contaminant removal yields (%)				
				As	Cr	Cu	PCP	PCDDF
1	75	1.5	20	64	50	47	57	64
2	75	1.5	40	52	36	38	64	68
3	50	3.0	30	64	47	46	67	65
4	75	3.0	30	32	27	41	60	69
5	50	3.0	20	47	46	42	62	64
6	25	1.5	20	49	45	46	65	63
7	25	1.5	40	51	47	46	67	61
8	25	3.0	30	52	42	45	58	64
9	50	1.5	30	60	52	45	63	61
10	50	1.5	30	55	50	42	65	60
11	50	1.5	30	62	46	36	62	61
12	50	1.5	30	54	48	44	65	61
13	50	1.5	30	51	46	42	67	60
14	50	0.0	20	56	40	43	52	43
15	25	0.0	30	55	44	39	40	48
16	50	0.0	40	65	49	45	54	46
17	75	0.0	30	57	46	40	43	50

**Table 5** Variance analysis (ANOVA) for quadratic models established to predict PCP and PCDDF removals from the 1 – 4 mm contaminated soil fraction by attrition

Contaminant	Source	Sum of square	Degree of freedom	Mean square	F value	p-value Prob > F	Conclusion	
<b>PCP</b>	Model	996	6	166	21.3	< 0.0001	Significant	
	A-Temperature	3.38	1	3.38	0.43	0.5253		
	B-Surfactant	429	1	429	55.0	< 0.0001		
	C- Pulp density	35	1	35	4.52	0.0594		
	A <sup>2</sup>	98.9	1	98.9	12.7	0.0052		
	B <sup>2</sup>	371.8	1	372	47.7	< 0.0001		
	C <sup>2</sup>	57.7	1	57.7	7.40	0.0216		
	Residual	78.0	10	7.80				
	Lack of fit	59.8	6	10.0	2.20	0.2327		Not Significant
	Pure error	18.1	4	4.5				
<b>PCDDF</b>	Model	970	8	121	173	< 0.0001	Significant	
	A-Temperature	33.6	1	33.6	47.9	<0.0001		
	B-Surfactant	720	1	720	1 027	< 0.0001		
	C- Pulp density	5.28	1	5.28	7.53	0.0253		
	AB	2.72	1	2.72	3.88	0.0843		
	AC	11.2	1	11.2	16.0	0.0039		
	A <sup>2</sup>	41.6	1	41.6	59.4	< 0.0001		
	B <sup>2</sup>	163	1	163	233	< 0.0001		
	C <sup>2</sup>	0.002	1	0.002	0.002	0.9621		
	Residual	5.61	8	0.70				
	Lack of fit	4.30	4	1.07	3.28	0.1385		Not Significant
	Pure error	1.31	4	0.33				

PCP :  $R^2 = 0.92$ ; adjusted  $R^2 = 0.88$ ; adequation precision = 14.5; CV = 4.7%

PCDDF :  $R^2 = 0.99$ ; adjusted  $R^2 = 0.99$ ; adequation precision = 42.3; CV = 1.4%

**Table 6** Variance analysis (ANOVA) for significant quadratic models established for the removals of 11 PCDDF from the 1 – 4 mm contaminated soil fraction by attrition (A: Temperature – B: Surfactant – C: Pulp density)

	1,2,3,7,8 PCDD	1,2,3,4,7,8 HCDF	1,2,3,7,8,9 HCDF	1,2,3,6,7,8 HCDD	1,2,3,7,8,9 HCDD	2,3,4,6,7,8 HCDF	1,2,3,4,6,7,8 HPCDD	1,2,3,4,7,8,9 HPCDF	1,2,3,4,6,7,8 HPCDF	OCDD	OCDF
Source	Prob > F	Prob > F	Prob > F	Prob > F	Prob > F	Prob > F	Prob > F	Prob > F	Prob > F	Prob > F	Prob > F
Model	< 0.0001*	0.0005	0.0314	<0.0001	<0.0001	0.0155	0.0001	0.0003	0.0279	< 0.0001	< 0.0001
A	0.3328	0.0011	0.1853	0.0028	0.0008	0.2705	0.0002	0.0018	0.7455	0.5144	0.0134
B	< 0.0001	0.0001	0.0089	< 0.0001	< 0.0001	0.0033	0.0004	0.0006	0.0037	< 0.0001	< 0.0001
C	0.7590	0.5138	0.2392	0.8514	0.3729	0.6568	0.0130	0.4843	0.6566	0.9588	0.7943
AB	-	0.0485	-	0.0948	-	-	-	0.0826	-	-	-
AC	-	-	-	-	-	-	-	0.2371	-	-	-
BC	-	0.1369	-	-	-	-	-	-	-	0.0724	-
A^2	0.1123	0.0133	-	0.0144	-	-	-	<0.0001	-	0.0197	-
B^2	< 0.0001	0.0054	-	0.0013	-	-	-	0.6019	-	< 0.0001	0.0070
C^2	0.9125	0.0688	-	-	-	-	-	-	-	0.0516	0.0413
Lack of fit	0.7646	0.9889	0.0171	0.9541	0.7131	0.2570	0.9166	0.78845	0.7834	0.6295	0.3781
Conclusion for the Lack of fit	Not Significant	Not Significant	Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant	Not Significant

\* Significant models and parameters were highlighted in grey



**Table 7 Solutions suggested by the Design-Expert 8.0 software to maximize the PCP and PCDDF removal efficiencies from the fraction 1-4 mm of the soil S3 by attrition**

Solution number	Temperature (°C)	Surfactant (%)	Pulp density (%)	Predicted removal yields (%)		Desirability function
				PCP	PCDDF	
1	25.0	2.30	40.0	67.2	63.8	0.923
2	25.0	2.31	40.0	67.1	63.8	0.923
3	25.0	2.27	40.0	67.2	63.7	0.923
4	25.0	2.40	40.0	66.9	63.9	0.922
5	25.0	2.19	40.0	67.3	63.6	0.922
6	25.0	2.42	40.0	66.9	63.9	0.922
7	25.4	2.31	40.0	67.3	63.7	0.922
8	25.9	2.38	40.0	67.3	63.8	0.920
9	26.1	2.41	40.0	67.3	63.8	0.918
10	25.0	1.87	40.0	67.2	62.7	0.907
11	25.0	2.23	37.5	65.1	63.9	0.901
12	25.0	2.27	20.0	63.0	65.4	0.897
13	25.0	2.29	20.0	63.0	65.5	0.897
14	25.0	2.31	20.0	62.9	65.5	0.897
15	25.0	2.33	20.0	62.9	65.5	0.897
16	25.1	2.17	20.0	63.2	65.2	0.896
17	25.0	2.21	20.2	63.0	65.3	0.895
18	25.6	2.29	20.0	63.2	65.3	0.895
19	25.6	2.20	20.0	63.3	65.2	0.894
20	26.0	2.51	20.0	62.8	65.4	0.888
21	25.0	2.42	35.6	63.4	64.2	0.886
22	26.9	2.04	20.0	63.8	64.5	0.883
23	25.0	2.33	31.4	61.6	64.5	0.867

**Table 8** Comparison of the predicted and experimental PCP and PCDDF removal yields obtained by attrition using the optimal operating conditions ( $T = 25^{\circ}\text{C}$ ,  $\text{BW} = 2\%$  (w/v) and  $\text{DP} = 40\%$  (w/w) –  $[\text{PCP}]_i = 8.7 \pm 2.9 \text{ mg.kg}^{-1}$  and  $[\text{PCDDF}]_i = 5,719 \pm 180 \text{ ng TEQ.kg}^{-1}$ )

<i>Assay</i>	<i>PCP content in treated soil (mg.kg<sup>-1</sup>)</i>	<i>PCP removal yields (%)</i>	<i>PCDDF content in treated soil (ng TEQ.kg<sup>-1</sup>)</i>	<i>PCDDF removal yields (%)</i>
<b>Experimental values</b>				
1	2.88	66.5	2,156	63.2
2	2.86	67.8	2,244	59.3
3	2.95	66.1	2,171	62.5
Average	<b>2.89</b>	<b>66.8</b>	<b>2,190</b>	<b>61.7</b>
Standard deviation	0.05	0.92	47	2
<b>Predicted values</b>	<b>2.87</b>	<b>67.2</b>	<b>2,059</b>	<b>64.0</b>