Leaching study based on metal and anion release according to the composition of CDW

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Introduction

Currently, new alternatives that are technically and environmentally viable for waste revaluation are being explored at different levels. The recycling of by-products or waste to give them a second life cycle as construction material requires: technical feasibility studies, environmental evaluation of the material, application of regulations at different scales and implementation of a production system that produces a quality material (Sanguino et al., 2020). If all these factors are taken into account when a recycled material is produced, and it will allow to obtain a product with high performance and low footprint.

This study focuses on the environmental study of construction and demolition waste (CDW) through leaching tests that measure the release of legally regulated polluting elements. The objective is to characterize the potential contamination of each of the components of the CDW. To develop this study, a treatment plant has been visited and samples of different components of this waste have been taken (mortar, concrete, tile, ceramic brick, or asphalt).

The analysis focuses on measuring the release of pollutants from each of these components. In this way, it is possible to identify which components are environmentally more sensitive and will allow optimizing decision-making in the CD&W treatment plant.

Materials and Methods

Material Description

The present work studies the pollutant release on different CDW components tested separately. The samples has been collected from a treatment plant located in Córdoba (Andalusia, Spain) consisting of: two types of mortars, three concrete samples, five ceramic elements (included sanitary ceramic) and asphalt, according to the description in Table 1:

Table 1. Comparison between theoretical predictions and experimental measurements.

Description	Code	Description	Code
single layer mortar	M-SL	Ceramic tile	C-T
masonry mortar	M-M	Ceramic stoneware	C-G
old concrete	H-V	Ceramic Solid brick	C-SB
Precast concrete block	H-BP	Sanitary Ceramic	C-S
Reinforced precast concrete	H-PP	Ceramic Hollow Brick	C-HB
		Reclaimed Asphalt	RA

Experimental methods

This research is focused on the study of the pollutant release of the list of elements indicated by EU Landfill Directive (EC, 2003): 12 heavy metals and 3 anions measured on leachates obtained according to the Compliance Batch Test (UNE-EN 12457-4: 2003). This leaching procedure establishes a liquid to solid ratio of 10 l/kg using 90 g of dry material samples with particles sizes less than 10.0 mm and deionized water. The solution was kept

under mechanical agitation per 24 ± 0.5 h. After each extraction, the sample leachate was analyzed for measuring heavy metals content by ICP-MS and anions by chromatograph, in order to obtain the release for each sample (expressed in mg/kg).

Results and discussion

The data obtained for the 11 different components of CDW tested separately will be compared with the legal limit established by the Landfill Directive (European Commission, 2003), classifying each samples according to the pollutant release as inert, non-hazardous or hazardous material. The main objective is identifying the pollutant elements released in higher amount by each type of component on CDW.

Table 2. Leachate concentrations (mg/kg) by compliance leaching test for the different CDW components tested.

Leachate (mg/kg)	M-SL	M-M	H-V	H-BP	H-PP	C-HB	C-T	C-G	C-SB	C-S	RA
Cr	0.12091	**0.75134**	0.06311	0.27293	0.12922	**1.06427**	0.04832	0.02524	0.14657	0.00535	0.01323
Ni	0.00836	0.0041	n.d.	n.d.	n.d.	0.00223	0.00982	0.01053	0.01179	0.00774	n.d.
Cu	0.00467	0.03002	0.03088	0.00976	0.00395	0.01222	0.0443	0.0144	0.01436	0.01087	0.01857
Zn	0.03522	0.03578	0.03127	0.03898	0.02936	0.02921	0.04236	0.1637	0.0478	0.05712	0.03578
As	0.00075	0.03519	0.0082	0.00069	0.00186	0.03221	0.03537	0.05075	0.0252	0.00434	0.00151
Se	n.d.	0.00844	n.d.	n.d.	0.00016	0.00376	0.0054	n.d.	0.01446	n.d.	0.00024
Mo	0.04477	0.06638	0.0313	0.18891	0.00974	0.05388	0.04211	0.00746	0.02697	0.00942	0.00799
Cd	n.d.	0.00006	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	0.00044	0.00029	n.d.
Sb	0.0036	0.01297	0.0249	0.02314	0.00233	0.02095	0.01624	0.02017	0.01059	0.0053	0.0045
Ba	1.51804	0.44925	0.4188	0.3195	1.81608	0.03383	0.28966	0.09343	1.32473	0.04525	3.76029
Hg	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
Pb	0.00039	0.00008	0.00086	0.00116	0.00048	0	0	0.01809	0.00038	0.00137	0.00029
$SO_4^=$	<20	**1850**	350	220	<20	860	670	40	150	<20	110
Cl^-	<20	40	40	50	30	220	320	50	**1220**	<20	50
F^-	< 2	3	3	< 2	< 2	< 2	12	3	< 2	< 2	< 2
Conduct. mS/cm	3200	494	866	1322	3130	445	454	101	3500	41	156
pH 20 ºC	10	6.7	10	10	10	8	6.7	7.8	6	5.6	10

According to the leachate concentrations showed in Table 1, no element exceeded the inert legal limit for the following compounds: Single layer mortar (M-SL), old concrete (H-V), precast concrete block (H-BP), reinforced precast concrete (H-PP), ceramic tile (C-T), ceramic stoneware (C-G), single layer mortar (M-M), sanitary ceramic (C-S) and recycled asphalt (RA).

On the other hand, in three materials the inert limit value was exceeded and they were classified as non-hazardous materials: (i) for chromium and sulphate M-M; (ii) for Chromium C-HB and (iii) for chloride C-SB.

Conclusions

The present study provides the release levels of each of the components of the CDW. Despite of the heterogeneity of CDW, the CDW treatment plants handle every day different CDW from different sources. Knowing the potential release of each of the components of CDW can be an important information to take into account for determining the operations within the CDW treatment plant; for instance, the stockpiling according to the presence of the components with higher potential of releasing pollutant elements or, during the feeding, with the loader, of the process treatment for obtaining recycled aggregates, compensating the CDW depending on the components for avoiding excessive presence of components with higher potential of releasing pollutant elements. According to the results, masonry mortar was identified with the most conflictive release potential pollutants.

References

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