Variations in the properties of leachate according to landfill age

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Abstract

A comparative study of the composition of the leachate from different types of landfills in Spain with landfills in Europe from the point of view of one of the factors that most influence in the leachate composition, such as the landfill age, among others, was carried out. For this purpose, thirteen leachate samples from different Spanish landfills were analysed and concentrations of organic compounds, for instance COD and BOD_5, inorganic compounds, as calcium, magnesium, potassium, sodium, ammonia, chlorides, sulphates, etc., heavy metals and other physical parameters including pH and conductivity were studied in the leachate. The composition of the leachate varied widely because it is affected by many factors such as age and quality of waste, climatic conditions, among others. The results show that there are significant differences between the ages of the leachate. As a landfill increases the age, the constituents of the leachate decrease their concentration due to the processes of stabilization of the waste that occurs within the landfill. On the other hand, comparing the results obtained in the samples of young Spanish leachates with young leachates from different European landfills, large variations are observed due to not only the seasonal variations, but also the type of waste that is mostly treated in landfills.

Keywords: landfill; leachate; waste treatment; municipal waste

1. Introduction

In recent years, the amount of municipal waste generated per person has been decreasing. According to the latest data published by the Municipal Waste Statistics from Eurostat database in April 2018, in EU a total of 482 kg of municipal waste were generated per person (equivalent to 246,377 thousand tonnes) in 2016. This amount of municipal waste generated varies significantly across the EU Member States. Denmark (777 kg per person), Norway and Switzerland are the countries that generate the highest amount of waste per person and, Romania (261 kg per person) and Poland the countries with the lowest amount of waste generate. In Spain, 443kg of municipal waste were generated per person in 2016 [1]

Each European country deposits waste in landfills in a greater or lesser amount, that is, it uses the landfilling as waste treatment. In 2016, 30% of all treated waste was recycled and 25% was sent to landfill in the EU, mainly, according to the latest data collected by the Municipal Waste Statistics from Eurostat database in April 2018. In the case of Spain, the number of landfills has decreased last years, mainly due to the need to promote other waste management methods, such as recycling. However, despite this decline, Spain continues to deposit its municipal waste mainly in landfills, about 55% in 2016, and staying this percentage in the last years (Fig.1). Therefore, Spain is the second country that more wastes are landfilled.

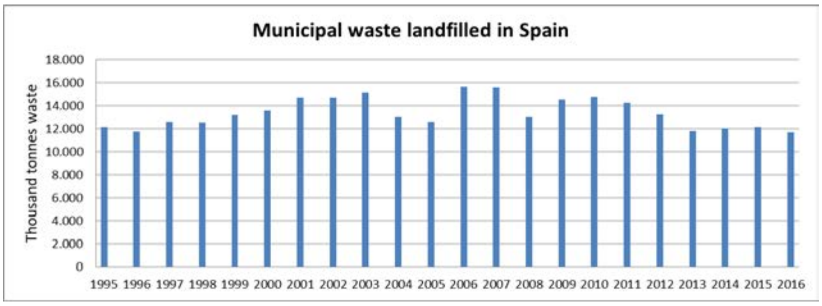

Figure1. Municipal waste landfilled in thousand tonnes in Spain [1]

One of the biggest problems in landfills is the discharge of leachate. These are generated mainly by the percolation of the water through the waste as a result of incoming rainfall in the landfill, causing its pollution [2] Directive 1999/31/EC establishes the requirements which must be complied with by the landfill in terms of design and operation, as well as the collection of leachates generated and their appropriate treatment before being discharged into the environment.

The main component of leachate is organic matters but also it contains ammonia-nitrogen, heavy metals, inorganic salts and chlorinated organics pigments. These pollutants are categorized into four groups as: organic matters, for instance COD (chemical oxygen demand); specific organic compounds, inorganic compounds and heavy metals [3].
The general characteristics of leachates as composition, quantity and potential pollutants are affected by many factors such as quality of solid waste, degree of compaction in landfill, age of waste, climatic condition, pH, chemical and biological process which occurs during degradation [4].

The composition of landfill leachate depends on the landfill age, mainly, or more specifically, of the phases of the landfill, which are categorized into: aerobic phase, anaerobic acid phase, methane fermentation phase and maturation phase. Each of these phases has different concentrations of the main pollutants.

According to the landfill age, there are leachates called young and old. Young leachates correspond to a landfill age of <5 years and old leachates correspond to a landfill age of more than 10 years. There may also be leachates called intermediates corresponding to a landfill age of 5-10 years.
Characteristics of leachate at different ages of landfill are shown in Table 1.

Table 1. Characteristics of leachate at different ages of landfill

Parameters	**Ages**		
	Young (<5 years)	**Intermediate (5-10 years)**	**Old (>10 years)**
pH	6.5	6.5-7.5	>7.5
COD (mg/l)	>10,000	4,000-10,000	<4,000
BOD (mg/l)	>2,000	150-2,000	<150
BOD/COD	>0.3	0.1-0.3	<0.1
Organic compound	80% VFA	5-30% VFA+humic & fumic	Humic & fumic
Heavy metals	Medium	Low	Low

VFA (Volatile Fatty Acid)
Source: [5]

Another factor that affects the composition of the leachates is the type of waste present in landfill (hazardous and non-hazardous waste and inert waste). In Spain, the most generated waste by households is the mixed ordinary wastes followed by the recyclable wastes in smaller amounts in 2014 (Fig. 2). So, depending on the type of waste that is mostly treated in the landfills, the composition of leachate is different.

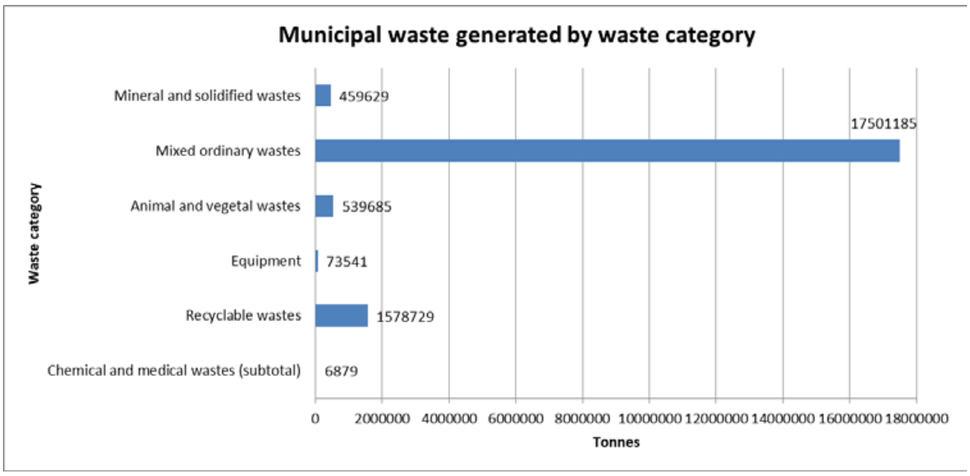

Figure 2. Municipal waste generated in 2014 classified according to the waste category [6]

Taking into account all the factors that affect the composition of the leachate, the aim of this study was to compare the leachate composition from different types of landfills in Spain with respect to the landfills in Europe and to study the effects of one of the factors that most influence in the leachate composition: the landfill age.

2. Material and methods

2. 1. Sampling and analytical method

This study was performed between March and May 2017. Leachate samples from thirteen different landfills located in Spain were collected and analysed. After the sample collection, the leachate samples were transported to the laboratory. The collected leachate was stored at 4 ºC during the period required to complete all experimental analysis. Physicochemical parameters such as pH, conductivity, solids, Biochemical Oxygen Demand (BOD_5), Chemical Oxygen Demand (COD), ammonia nitrogen, nitrate nitrogen, nitrite nitrogen, total nitrogen, total phosphorus, phosphate, sulphate, chloride, sodium, potassium, magnesium, calcium and heavy metals were measured in the leachate samples according to Standard Methods [7].

3. Results and discussion

3. 1. Overview of the leachates composition from several European landfills of different ages

As already mentioned, there are several factors that affect to the composition of the leachate. These factors vary considerably from landfill to landfill because wastes generated from European Union countries with regard to composition are basically different. It is difficult to find two leachates with the same characteristics, either in different countries or within the same country. Even in the same landfill, the composition of the leachate changes, because the waste is buried for many years in layers, and therefore, is very common that different parts of landfill are in different phases of decomposition [8].

A comparison of the leachate composition of different ages from different European landfills is shown in Table 2.

Table 2. Leachate composition from different European landfills

European landfills	Age	Parameter						
		COD ($mg\ O_2/l$)	BOD_5 ($mg\ O_2/l$)	pH	Conductivity (mS/cm)	$N\text{-}NH_4^+$ (mg/l)	SO_4^{2-} (mg/l)	Cl^- (mg/l)
Ireland [9]	Young	411-7,160	36-984	7.6-8.5	3.09-28.43	130-4,000	7.2-1,950	160-2,620
Germany [10]		6,000-60,000	4,000-40,000	---	---	---	70-1,750	---
Greece [11]		44,000-115,000	9,500-80,800	4.9-6.7	23-35.5	10-840	---	---
Sweden [13]		1,000-30,000	---	5-6	0.5-14	150-560	---	(5)-1,300
Italy [14]		2,525-3,879	500-1,800	7.2-8.7	---	512-2,229	23-61	---
Ireland [9]	Inter	190-748	6-33	6.8-8.4	2.60-10.44	63-378	21-445	130-669
Germany [10]	Old	500-4,500	20-550	---	---	---	10-420	--
Italy [14]		966-1,784	110-600	7.8-8.5	---	715-1,259	9-25	---
Romania [15]		6,200	---	7.75	---	---	1,670.75	5.03
Sweden [13]		500-4,000	---	8-9	0.5-14	80-370	---	1,000-6,000
Greece [12]		685-15,000	50-4,200	7.3-8.8	6.2-34.0	---	55-500	1,162-9,209
Poland [16]		1,183	331	8.0	---	743	---	---

All the leachate results shown in the Table 2 are from municipal solid waste landfills. According to the results shown in Table 2, in general, as the landfill age increases, the parameters that indicate the organic matter, such as COD and BOD_5, decrease due to the decomposition of leachate. Values of COD vary from 115,000 mg/l of the leachate sample obtained from a landfill in Thessaloniki (Greece) to 500 mg/l of the leachate sample from old landfills in Sweden and Germany. The pH also varies with the leachate age, being higher in the older landfills.
In some parameters, the differences or variations between leachates of the same age and different countries may be due to the different waste composition of each of the landfills or other factors already mentioned.

3. 2. Leachate characterisation from different Spanish landfill

The results of the leachate characterization study in Spain are shown in Table 3, Table 4 and Table 5. The composition of young leachates from Spanish landfills is shown in Table 3, the composition of intermediate leachates is shown in Table 4 and the composition of old leachates is shown in Table 5.

Table 3. Composition of young leachates from different Spanish landfills

Parameter	Units	Young leachate				
		Landfill 4	Landfill 5	Landfill 8	Landfill 9	Landfill 11
Ammonia nitrogen	mg N/l	4,238.7±386.9	5,245.5±465.8	2,302.1±227.4	3,990.8±367.1	2,702.2±261.4
Chloride	mg/l	7,870±1,180	6,310±946	10,300±1,545	7,640±1,146	9,360±1,404
Conductivity	mS/cm	42.8±2.4	44.7±2.5	44.8±2.5	43.2±2.4	40.5±2.2
BOD_5	mg O_2/l	12,250±2,205	12,690±2,284	11,912±2,144	4,874±877	2,310±416
COD	mg O_2/l	29,219±4,010	13,533±1,818	26,592±3,640	14,194±1,909	16,849±2,277
BOD_5/COD		0.42	0.94	0.45	0.34	0.14
Total phosphorus	mg P_T/l	148.4±17.4	74.0±9.3	75.4±9.4	97.1±11.8	148.7±17.4
Nitrate	mg/l	<3	<3	<30	<3	<3
Nitrite	mg/l	<4	<4	<40	<4	<4
Total nitrogen	mg/l	5,323.8±1,064.7	5,709.0±1,141.8	3,608.0±721.6	4,438.0±887.6	3,264.0±652.8
Phosphate	mg/l	23.1±4.6	24.1±4.8	56.7±11.3	29.2±5.8	58.7±11.7
pH	pH	8.24±0.39	8.17±0.38	7.63±0.36	8.03±0.38	8.69±0.41
Sulphate	mg/l	9.6±1.4	213.0±31.9	<60	2,250.0±337.5	511.0±76.6
Total suspended solids (TSS)	mg/l	3,104.6±392.2	159.0±24.7	639.0±90.0	398.6±58.0	185.5±28.5
Volatile suspended solids (VSS)	mg/l	1,815.0±237.9	126.0±19.9	430.0±62.3	229.3±34.7	116.0±18.4
Total dissolved solids (TDS)	mg/l	26,619±2899	25,235±2759	36,222±3863	28,217±3061	33,324±3574
Total solids (TS)	mg/l	29,724±2926	25,394±2759	36,861±3864	28,616±3062	33,509±3574
Calcium	mg/l	542.59±108.52	47.75±9.55	184.08±36.81	78.49±15.70	9.12±1.82
Magnesium	mg/l	161.35±32.27	194.66±38.93	113.33±22.66	161.70±32.34	13.18±2.64
Sodium	mg/l	5,617.84±1,123.57	4,832.05±966.41	6,869.45±1,373.89	4,694.29±938.86	5,511.10±1,102.22
Potassium	mg/l	3,172.96±634.59	2,513.91±502.78	2,959.91±591.98	3,129.35±625.87	4,853.65±970.73
Zinc	mg/l	0.99±0.20	1.27±0.25	2.68±0.54	1.16±0.23	1.58±0.32
Copper	mg/l	0.51±0.10	4.13±0.83	3.18±0.64	0.65±0.13	1.35±0.27
Chromium	mg/l	7.21±1.44	1.55±0.31	0.85±0.17	2.05±0.41	4.04±0.81
Manganese	mg/l	0.24±0.05	0.15±0.03	0.21±0.04	0.36±0.07	0.15±0.03
Lead	mg/l	0.11±0.02	0.10±0.02	0.07±0.01	0.15±0.03	0.13±0.03
Iron	mg/l	6.42±1.28	5.61±1.12	6.76±1.35	17.25±3.45	29.91±5.98
Nickel	mg/l	0.37±0.07	0.67±0.13	0.25±0.05	0.89±0.18	0.55±0.11
Cadmium	mg/l	0.004±0.001	0.003±0.001	0.029±0.006	0.076±0.015	0.075±0.015

Table 4. Composition of intermediate leachates from different Spanish landfills

Parameter	Units	Intermediate leachate				
		Landfill 1	Landfill 3	Landfill 6	Landfill 12	Landfill 14
Ammonia nitrogen	mg N/l	1,385.8±146.1	3,084.1±293.3	3,568.1±333.0	1,999.9±201.1	2,216.9±220.0
Chloride	mg/l	3,140±471	7,240±1,086	4,940±741	5,780±867	8,970±1,345
Conductivity	mS/cm	16.2±0.9	36.9±2.0	32.2±1.8	29.4±29.4	39.3±2.2
BOD_5	mg O_2/l	5,550±999	4,100±738	1,184±438	2,307±415	2,450±441
COD	mg O_2/l	12,554±1,683	13,701±1,841	10,026±1,336	8,938±1,187	13,646±1,834
BOD_5/COD		0.44	0.30	0.12	0.26	0.18
Total phosphorus	mg P_T/l	45.4±5.9	94.4±11.5	64.2±8.1	56.9±7.3	90.2±11.1
Nitrate	mg/l	<3	<3	<30	<3	<3
Nitrite	mg/l	<4	<4	<40	<4	<4
Total nitrogen	mg/l	2,101.5±420.3	3,642.6±728.5	3,386±677.2	2,550.0±510.0	2,928.0±585.6
Phosphate	mg/l	10.7±2.1	48.6±9.7	25.1±5.0	29.3±5.9	20.2±4.0
pH	pH	7.73±0.36	7.81±0.37	8.25±0.39	7.96±0.37	8.43±0.40
Sulphate	mg/l	65.8±9.9	81.0±12.1	<60	7.6±1.1	824.0±123.6
Total suspended solids (TSS)	mg/l	595.0±84.2	117.5±18.6	197.5±30.2	153.5±23.9	257.0±38.6
Volatile suspended solids (VSS)	mg/l	446.7±64.5	79.0±12.9	142.5±22.3	120.5±19.0	175.0±26.9
Total dissolved solids (TDS)	mg/l	14,166±1,612	27,372±2,976	20,361±2,259	19,076±2,126	31,923±3,434
Total solids (TS)	mg/l	14,761±1,614	27,489±2,976	20,558±2,260	19,229±2,126	32,180±3,434
Calcium	mg/l	809.97±161.99	70.23±14.04	96.88±19.38	174.85±34.97	---
Magnesium	mg/l	186.56±37.31	65.81±13.16	90.46±18.09	98.88±19.78	222.71±44.54
Sodium	mg/l	1,435.18±287.04	4,802.39±960.48	3,451.17±690.23	2,541.10±508.22	4,846.64±969.33
Potassium	mg/l	1,430.39±286.08	3,196.61±639.32	1,932.08±386.42	2,763.94±552.79	4,891.99±978.40
Zinc	mg/l	10.69±2.14	1.74±0.35	1.61±0.32	0.86±0.17	0.38±0.08
Copper	mg/l	3.28±0.66	1.93±0.39	2.57±0.51	1.07±0.21	0.53±0.11
Chromium	mg/l	1.05±0.21	2.68±0.54	0.47±0.09	2.05±0.41	13.75±2.75
Manganese	mg/l	0.75±0.15	0.13±0.03	0.31±0.06	0.75±0.15	0.36±0.07
Lead	mg/l	0.09±0.02	0.13±0.03	0.04±0.01	0.09±0.02	0.08±0.02
Iron	mg/l	14.87±2.97	9.45±1.89	9.24±1.85	9.62±1.92	4.35±0.87
Nickel	mg/l	0.46±0.09	0.55±0.11	0.31±0.06	0.39±0.08	0.58±0.12
Cadmium	mg/l	0.003±0.001	0.002±0.000	0.028±0.006	0.075±0.015	0.072±0.014

---not detected

Table 5. Composition of old leachates from different Spanish landfills

Parameter	Units	Old leachate		
		Landfill 7	Landfill 10	Landfill 13
Ammonia nitrogen	mg N/l	757.3±86.3	486.0±58.7	377.5±47.1
Chloride	mg/l	2,440±366	2,480±372	4,740±711
Conductivity	mS/cm	15.0±0.8	17.1±0.9	17.7±1.0
BOD_5	mg O_2/l	632±234	164±29	443±163.9
COD	mg O_2/l	2,725±350	3,460±448	4,777±623
BOD_5/COD		0.23	0.05	0.09
Total phosphorus	mg P_T/l	38.7±5.1	37.8±5.0	50.4±6.5
Nitrate	mg/l	<30	<30	<3
Nitrite	mg/l	<40	<40	<4
Total nitrogen	mg/l	1,541.0±308.2	1,401.0±280.2	981.0±196.2
Phosphate	mg/l	19.6±3.9	55.8±11.1	18.1±3.6
pH	pH	8.05±0.38	8.22±0.39	8.36±0.39
Sulphate	mg/l	99.2±14.9	<60	627.0±94.1
Total suspended solids (TSS)	mg/l	96.5±15.5	106.0±16.9	110.5±17.6
Volatile suspended solids (VSS)	mg/l	68.5±11.3	64.5±10.6	69.5±11.4
Total dissolved solids (TDS)	mg/l	9,004±1,057	11,089±1,283	15,333±1,735
Total solids (TS)	mg/l	9,100±1,057	11,195±1,283	15,443±1,735
Calcium	mg/l	120.61±24.12	49.14±9.83	95.33±19.06
Magnesium	mg/l	65.95±13.19	---	39.30±7.86
Sodium	mg/l	1,624.57±324.91	1,900.12±380.02	2,327.95±465.4
Potassium	mg/l	714.54±142.91	1,601.03±320.21	2,262.17±452.43
Zinc	mg/l	1.13±0.23	2.17±0.43	1.77±0.35
Copper	mg/l	5.36±1.07	3.32±0.66	1.36±0.27
Chromium	mg/l	0.44±0.09	1.03±0.21	1.45±0.29
Manganese	mg/l	0.41±0.08	0.27±0.05	2.70±0.54
Lead	mg/l	0.05±0.01	0.11±0.02	0.15±0.03
Iron	mg/l	4.09±0.82	15.80±3.16	34.73±6.95
Nickel	mg/l	0.21±0.04	0.34±0.07	0.51±0.10
Cadmium	mg/l	0.029±0.006	0.079±0.016	0.076±0.015

---not detected

According to the results obtained in the leachate samples, there are significant differences between the different ages of the leachate. It is already known, because it is one of the factors that most affect the leachate composition. As a landfill increases the age, the constituents of the leachate decrease their concentration due to the processes of stabilization of the waste that occurs within the landfill. These differences are found in some parameters such as COD, BOD_5 and ammonia nitrogen, mainly.

The tendency of the organic compounds concentrations, as COD and BOD_5, with respect to the time (leachate age), is decreasing. It is mainly due to the decomposition of leachate because of biodegradable nature and washout [4]. According to the results obtained, the parameter of COD varies from 29,219 mg/l for young leachates samples, down to 2,725 mg/l for old leachates, while BOD_5 values vary between 12,690 mg/l and 164 mg/l, respectively. These variations of the COD parameter with the leachate age are shown in the Figure 3.

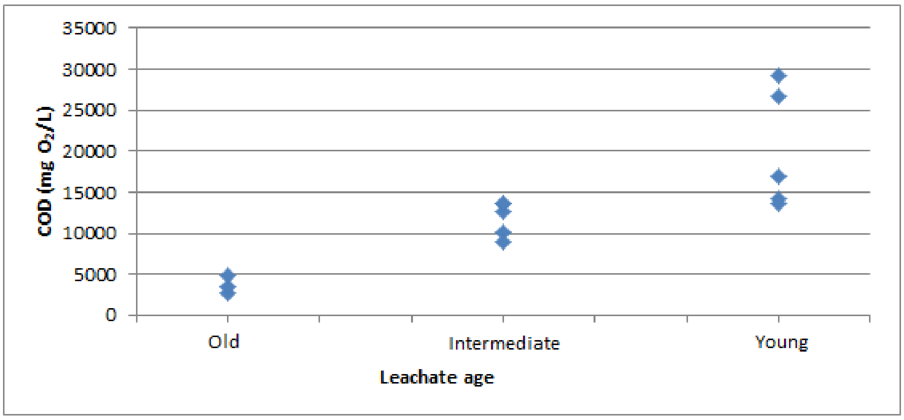

Figure 3. COD parameter variation with the leachate age.

In the Figure 3, it is observed that old leachate samples show low COD values while intermediate and young leachates show higher COD values with a wider range.

The BOD_5/COD ratio is a factor of biodegradability of organic matter and according to the Table1; this ratio tends to decrease as the age of the landfill increases. Therefore, the higher the ratio is the most biodegradable the organic matter is. This tendency was observed in general in the leachate samples analysed, with a minimum value of 0.05 for old leachates and a maximum value of 0.94 for young leachates.

Apart from organic matter, ammonia is the principal pollutant in leachate. According to Kulikowska and Klimiuk [17], the landfill age has a significant effect on its composition, especially on organics and ammonia concentrations.

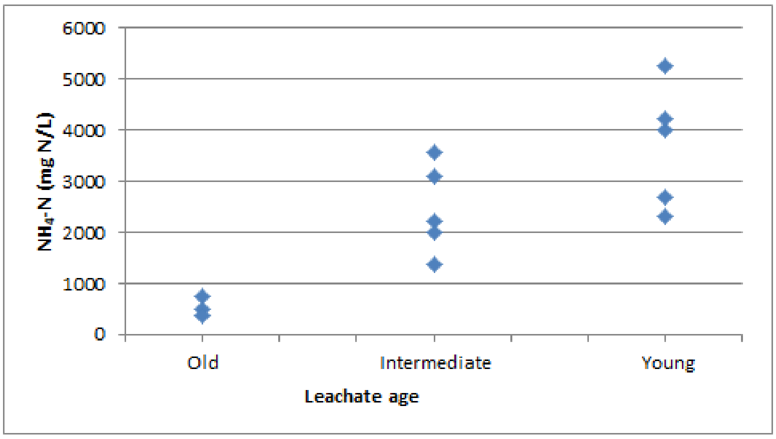

Figure 4. Ammonia nitrogen parameter variation with the leachate age.

In general, the ammonia nitrogen concentration is high, especially in young leachates. In these cases, the ammonia nitrogen values vary between 5,245.5 mgN/l and 2,302.1 mgN/l, decreasing this concentration when the age of the leachate increases. It is due to the deamination of amino acids and destruction of organic compounds that occurs in young landfills [17]. It can be observed in the Figure 4.

The pH results are all greater than 7.5, which according to the characteristics of leachates (Table 1) all landfills would be old; however it is known that this is not the case. It may be because some leachates that are exposed to the atmosphere could cause some removal of carbon dioxide from the leachate which increases the pH [18].

In terms of anions, it is worth mentioning the high concentrations of chlorides. Like organic matter, the chlorides concentration decreases as the age of the landfill increases, due to a washing phenomenon [19] but to get low chloride concentrations can last for years. High chloride content in the leachate sample reflects the presence of significant amount of soluble salts in the municipal solid waste materials. It will affect the COD analysis but it has been treated by dilution of the samples and adding mercury to the sample when the COD has been analysed. According to the results obtained, the lowest chlorides concentration in old leachates is 2,440 mg/l.

Sulphates concentration also decreases with the age of the landfill due to the reduction to sulphides in anaerobic conditions. However, in the results obtained for this parameter, several variations in its concentration can be observed. It can be due to seasonal variations.

The cations concentrations such as calcium, magnesium, iron and manganese depend on the stabilization of the landfill. The concentrations of these cations are lower in methanogenic phase due to higher pH and lower organic matter content [20]

Conductivity of the leachate samples is mainly due to the presence of the cations such as sodium or potassium. High conductivity values are observed in young leachates, due to a high presence of these cations, mainly sodium. The average conductivity value obtained in old leachates is 16.6 mS/cm with low sodium concentrations that vary between 1,624.57 mg/l and 2327.95 mg/l, while in young leachates the average conductivity is 35.2 mS/cm with high sodium concentrations.

With respect to the heavy metal concentrations, when the landfill age increases, the solubility of the metal decreases due to the increase in pH values, so decreasing the metal concentrations [12] but in general, these concentrations do not appear to follow patterns such as COD or BOD [20].

In general, fluctuation of parameters such as phosphorus, chlorides, calcium, magnesium, sulphates and heavy metals depends on seasonal variations rather than on landfill age.

3. 3. Comparison of European landfills with Spanish landfills

A comparison of some data obtained in the different landfills of Spain with the characteristics of young leachates from European landfills is presented in Table 6. In general, these data indicate large variations, even though all the leachates are from municipal solid waste landfills but it is necessary to consider another factor that also influences the leachates composition, in addition to the age of the landfill, such as the nature or types of waste that the landfill contains [19].

Table 6. Young leachate characteristics (range of values) from different European landfills

Parameter	**Units**	**Young leachate**					
		Ireland landfill	Germany landfill	Greece landfill	Sweden landfill	Italy landfill	Spain landfill
Ammonia nitrogen	mg N/l	130-4,000	---	10-840	150-560	512-2,229	2,300-5,300
Chloride	mg/l	160-2,620	---	---	(5)-1,300	---	6,300-10,300
Conductivity	mS/cm	3.09-28.43	---	23-35.5	0.5-14	---	40.5-44.8
BOD_5	mg O_2/l	36-984	4,000-40,000	9,500-80,800	---	500-1,800	2,300-12,700
COD	mg O_2/l	411-7,160	6,000-60,000	44,000-115,000	1,000-30,000	2,525-3,879	13,500-29,219
pH	pH	7.6-8.5	---	4.9-6.7	5-6	7.2-8.7	7.63-8.69
Sulphate	mg/l	7.2-1,950	70-1,750	---	---	23-61	9.6-2,250

Therefore, these large variations between the different landfills will be due, in addition to seasonal variations, among others, to the type of waste that is mostly treated in landfills.

Ammonia nitrogen is contained in plant and animal waste and in industrial waste such as fertilizers, gums, plastic, etc. [21]. On the other hand, sulphate is contained in soluble waste, such as construction wastes or ash, synthetic detergents and inert waste [22].

In general, the range of data obtained in each one of the analysed parameters of the young leachates of Spain, is higher than for the rest of the young leachates of landfills in Europe. High concentrations of ammonia and chlorides show a typical mineral profile from households waste and industrial waste, mentioned above. The organic load is very variable because depends on the degradation of the organic products present in the landfill. Most of these organic products are soluble waste derived from decomposition products of the biodegradable fraction of the waste [23].

4. Conclusions

The present study contains results of the main physical-chemical parameters of leachate samples from different Spanish landfills. The presented data indicate that the leachate age has a significant effect on its characteristics and composition but other factors, such as type of waste that is mostly treated in landfills, also have an important effect on its composition.

As a landfill increases the age, the constituents of the leachate decrease their concentration due to the processes of stabilization of the waste that occurs within the landfill.

The leachate samples from different Spanish landfills show the general tendencies of the effect of the leachate age on its composition and this effect is shown in several parameters for instance COD or ammonia nitrogen, being the lowest concentration as the leachate age increases.

Comparing the results obtained in Spanish landfills with other European landfills, specifically the young leachates, there are large variations between the same parameters, although in both cases they are municipal solid waste landfills. These variations will be due to seasonal variations, type of waste that is mostly treated, among others.

Wastes generated from European Union countries with regard to composition are basically different. The composition of the leachate changes because waste is piled for many years in layers that will be in different phases of decomposition.

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