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Impact of the Municipal Solid Waste (MSW) Leachate on the Waters. Analysis and Treatment by the Reeds

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Abstract: *The proliferation of the wild discharge contributes to the contamination of surfaces and the ground waters by the leachate. This effluent is product of the degradation and the biochemical transformation of the fermentable matter. The subject of this study is to determinate the physicochemical parameters of leachate generated by municipal solid waste in Mostaganem city (western of Algeria). These effluents were to origin of natural treatment by the reeds Arundo donax. The results of analysis show that the leachate is characterized by the presence in strong concentrations of the organic and minerals pollutants. We also raised the presence of heavy metals in considerable quantity. The concentrations of all elements analyzed after the treatment decreased. The reeds could resist to aggressive medium, they develop more by keeping their physical aspect with the appearance of new buds, stems and roots.*

Keywords: *Discharge; Leachate; Reeds; Waste management.*

1. Introduction

The chaotic waste disposal can cause a source of toxic pollution that damages our environment. However, the landfill of waste is accompanied by complex phenomena in the interactions between the constituents of waste and rainwater seeping into their mass. The discharge is considered as a seat of physicochemical reactions decomposition of some pollutants and other biological, which are responsible for the degradation of organic matter. The direct consequences of these changes are the formation of leachate [1]. These have adverse effects on the environment in general, surface and groundwater in particular [2, 3].

The need to collect and treat leachate generated by the waste is essential before discharge into the natural environment. All physicochemical or biological processes used in treatment of municipal and industrial effluents can agree a priori [4, 5]. There are three strategies that can currently appear: the recycling of leachate [6, 7], storage and transporting of the effluents to purification station [8, 9] and in-situ treatment [10, 11].

Several studies have focused on the treatment of leachate, by physicochemical methods such as adsorption [12], the catalytic oxidation at wet air [13] and UV/H_2O photo reactor [14], or by biological methods [15, 16]. So, in our work we have chosen to treat the leachate generated from municipal waste in the city of Mostaganem by implantation the reed Arundo donax kind. But before treatment, we are interested to determine the physicochemical characteristics of these effluents.

2. Analysis and Methods

2.1. Sampling

To determine the characteristics of leachate from garbage of the city of Mostaganem, several sectors (habitat area) were selected. We brought our choice of six areas that we felt important. The average composition of municipal waste is shown in Figure 1 [17].

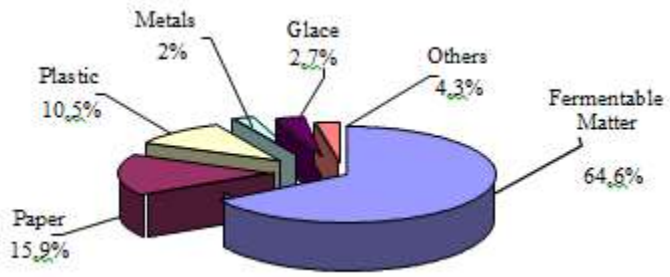

Fig. 1: Average composition of municipal waste in the city of Mostaganem

This figure illustrates the predominance of fermentable matter from other waste components. This is due to the nutritional behaviour of people that promote the consumption of fruits and vegetables.

After sampling household waste from the solid phase from different sources, we are interested in sampling the liquid phase from the fermentable matter. The leachate is collected after 24 hours of manual sorting of various constituents of garbage. Putting the degradable matter in bags with holes at the bottom to facilitate the passage of water pressed. The leachate is collected in containers placed below the bags. These effluents are filtered to remove large particles and then placed in polyethylene bottles washed and dried. The samples are stored in the refrigerator at 4 °C and protected from light after adding 2-3 drops of concentrated nitric acid. The leachate collected is analyzed to determine the physicochemical parameters.

2.2. Analysis Techniques

The main parameters measured in this study are temperature, pH, conductivity by conductimeter WTW Multiline P4 [18], turbidity by turbid meter Hach model 2100 [14], and suspended solids by centrifuge model 2173 B. Hach [18]. The concentration of sulphates, phosphates, nitrates and nitrites are determined by colorimetric using visible spectrophotometer, model 330 Turner [19]. We also used the emission spectrometry with inductively coupled plasma (AES-ICP) to determine the contents of the trace metals [20].

3. Results and Discussion

3.1. Physicochemical Parameters

In order to determine the physicochemical characteristics of the leachate generated by the garbage of the city of Mostaganem, we conducted sampling for each study area. The analyses of the main parameters are performed according to the Algerian standards. Executive Decree N° 93-160 of 10 July 1993 regulating discharges of wastewater effluent, published in the Official Journal of the Algerian Republic N° 46, helped to enforce standards of parameters indicative of pollution. The analytical results are shown in table 1.

All samples have an acidic leachate, the pH values are between 4.41 and 6.20. These values are slightly substandard. Samples taken at sector 3 have higher conductivity values in the order of 28 mS/cm. This high value indicates that these effluents contain many elements in the form of ions as the chlorides whose contents reach 13589 mg/l, largely exceeding the norm. The leachate is turbid, their content of undissolved substances is very high, and it reaches 6133 mg/l.

Organic pollution characterized by COD exceeds any acceptable value; it can reach values around 700 times the accepted standard. BOD5 reaches an excessive value of the order of 4600 mg /l, this value far exceeds the norm. Chlorides, nitrates, nitrites, phosphates, greatly exceed the required norms.

We note that the leachate generated by municipal waste from these study areas have very high in magnesium and calcium concentrations, this may be due to excessive use of detergents, milk and derivative products, green vegetables, fruits, etc.. Pollutant charge varies depending on the composition of household, age of waste and operating discharge conditions, or climatic conditions [4].

TABLE I: Physicochemical parameters of leachate

Parameter		1	2	3	4	5	6	Norm
T	°C	20.8	25	29.8	23	18.8	18.5	30
pH		5.43	4.86	5.42	4.41	6.20	5.12	5.5-8.8
χ	mS/cm	11.29	22.80	8.65	22.10	17.52	28.07	/
Turbidity	(NTU)	90	120	160	110	150	45	/
MS		723	1186	6133	388	367	482	30
COD	mg/l	47900	81600	26731	88000	24800	60800	120
BOD_5	mg/l	3425	4120	2100	4500	2000	4600	40
Cl^-	mg/l	3663	5317	4963	8504	4727	13589	200
NO_3^-	mg/l	42.20	44.72	67.36	79.4	38.53	31.82	20
NO_2^-	mg/l	0.02	0.610	0.461	0.90	0,18	0.16	0.1
P_2O_5	mg/l	0.23	1.38	0.35	0.89	1.30	6.19	2.0
SO_4^{2-}	mg/l	769.90	1635.9	2450.95	2132.16	1129.53	1146.84	/
Mg^{2+}	mg/l	1518.50	1377.00	1729.30	2365.20	907.20	1514.7	/
Ca^{2+}	mg/l	2248.2	2271.2	3152.96	4809.6	1603.2	1710.08	/

MS: Suspended matter; χ: conductivity

3.2. Metallic Elements

Municipal wastes are the wastes which are sometimes found in hazardous residues such as batteries and expired drugs that contain toxic elements. The latter may, when they exceed certain thresholds become toxic for the alive beings [21]. For this reason, it is imperative to assess the concentration of trace metals in the leachate [22]. The analysis results of all samples are shown in Table 2.

TABLE II: Composition of leachate in metallic elements trace

Element (mg/l)	1	2	3	4	5	6	Norm
Cd	0.269	0.114	0.004	0.003	0.117	0.042	0.2
Co	0.340	0.017	0.009	0.015	0.063	0.095	/
Cr	0.624	0.103	0.014	0.032	0.993	0.037	0.5
Cu	1.149	0.101	0.183	0.159	0.420	2.003	3.0
Fe	13.970	11.307	1.688	6.731	12.1	2.378	5.0
Mn	3.413	0.730	0.240	0.776	2,143	0.311	1.0
Ni	0.128	0.123	0.050	0.154	0.082	0.065	5.0
Pb	0.372	0.255	< 0.01	0.119	1.366	<0.010	1.0
Ti	0.127	0.177	< 0.01	0.026	0.297	<0.010	/
Zn	19.869	56.708	0.537	2.673	8.598	2.879	5.0

These results indicate that the leachate from each sector contains heavy metals in varying concentrations. Among these elements are slightly higher than the required norm, we include cadmium, chromium, manganese and lead with concentrations up, 0.269, 0.993, 3.431 and 1.366 mg/l respectively. A high value around 13.970 mg/l is recorded for iron, also for zinc concentration which reaches 56.708 mg/l, which is well above the recommended limit. As for the concentrations of nickel and copper in the leachate detected, they are below the required standards, which are 3 and 5 mg/l respectively.

It appears from these results that the concentrations of trace metals in the leachate are low except for some

such as iron, zinc, lead, chromium and cadmium. Certainly, if leachate samples were recovered after a few days of the sorting of household waste, the pollution charge would be excessive and the concentration of heavy metals would be more important, as it might exceed the norms due of possible dissolution of some compounds in household waste. It is for this reason that you must take into consideration this type of effluent, by recovering and treating in a treatment station before discharging.

Isidori *et al*. [23] characterized the leachate toxicity using the assessment procedure and identification of toxicity (TIE), which was a useful approach to detect and identify toxic agents. The results, which were obtained show that the toxicity was due mainly to heavy metals, suspended solids and alkali soluble compounds, such as ammonium which is a strong candidate toxic [24-26].

3.3. Treatment of the Leachate by the Reeds

There are several methods for removing heavy metals found in leachate, the most used method is the adsorption on different materials [27, 28]. The results reveal the presence of organic and inorganic chemical pollution in high proportion. Given the current state of garbage deposits and the lack of rigorous systems of underground drainage leachate, we conducted an operation of biological treatment of leachate collected at our laboratory using green plants. Theoretically, several species of plants can be used in wastewater treatment [29], but our choice fell on the reeds.

3.3.1. Description and Morphology

The reeds used are Arundo donax kind. This type of plant is perennial, spontaneous in a Mediterranean climate, belongs to the grass family. Its stems are larger, simple and dotted with large sheets [30]. They are widespread in Algeria. We took three samples of leachate, put in bags. The recovered leachate was diluted 28 times.

3.3.2. Implementation of the Reeds

We have taken care to implement a reed in each vat, natural treatment was followed for a period of 30 days. The analysis results are presented in Table 3.

From these results we see that the concentrations of all elements analyzed after 15 and 30 days of treatment were reduced, but the rate of reduction varies from one setting to another for each sample. On phosphate concentrations in the nutrient media are substandard and treatment by reed has reduced these values more with an abatement rate between 15 and 28.33%. This reduction rate is low compared to other parameters. This can be attributed to the fact that the phosphorus in the form of phosphates, which is an important element in plant nutrition, can be used only very slowly by plants.

COD decreased during the treatment period with a high rate of depression. This demonstrates the phenomenon of absorption of organics by the plant from the nutrient medium. However, the values obtained are much higher than the norm which is 120 mg /l.

Nitrate concentration decreased in a huge way with a reduction rate of 99% for all samples. They fall below the standard prescribed 20 mg /l. This decrease is due to the need reeds nitrate for their nutrition, because the majority of the nitrogen used by higher plants is absorbed in the form of ammonium and nitrate.

The chloride content in the nutrient medium has decreased during the treatment period, but remained above the norm. The chloride (KCl, NaCl) are considered as oligo-elements useful in the plant growth. After a few days of contact between the leachate and reeds implanted, the concentrations of sulfates were reduced with rates between 40 and 50% for the three samples. In general, the sulfur is one of the major nutrients, its transformation is biologically character. Organic sulfur is oxidized to sulfites and sulfates; they constitute the main source of sulfur absorbed by plants.

The values of calcium and magnesium were reduced and the rate of reduction was 72%. These nutrients elements are essential to plant growth. Some physicochemical parameters remain above the required standard after treatment (chlorides, COD). This may be due to the conditions of the treatment duration was short. The abatement rate could be improved if the treatment period was extended to 90 days. Moreover, during the treatment period, we observed that the reeds were resistant to aggressive media by further developing with the appearance of new buds, stems and roots.

TABLE III: Analyses physicochemical parameters of leachate after treatment

Parameter (mg/l)		without treatment	15 days after treatment	30 days after treatment	Abatement rate	Norm
COD	1	5760.00	3840.00	1680.00	71.00	120
	2	4320.00	2880.00	1920.00	55.55	
	3	4800.00	3260.00	2160.00	55.00	
NO_3^-	1	249.35	1.42	0.21	99.91	20
	2	81.89	1.27	0.36	99.56	
	3	416.80	1.88	0.45	99.89	
NO_2^-	1	0.950	0.140	0.005	99.46	0.1
	2	0.470	0.020	0.010	97.75	
	3	0.270	0.020	0.018	93.38	
Cl^-	1	2481.00	975,00	656.00	73.57	200
	2	2836.00	1258.00	632.00	77.71	
	3	2836.00	1152.00	596.00	79.00	
SO_4^{2-}	1	616.72	503.31	305.20	50.51	/
	2	383.13	356.93	230.53	39.83	
	3	486.82	435.09	282.49	41.97	
P_2O_5	1	0.020	0.018	0.017	15.00	2
	2	0.024	0.021	0.017	28.33	
	3	0.022	0.021	0.016	26.26	
Ca^{2+}	1	440.88	360.72	176.35	60.00	/
	2	360.72	320.64	174.35	51.66	
	3	320.64	280.56	182.36	43.13	
Mg^{2+}	1	170.10	59.53	48.60	72.01	/
	2	121.50	72.90	42.52	65.00	
	3	97.20	58.32	47.38	51.25	

4. Conclusion

The leachates collected from the fermentable matter of municipal waste in the city of Mostaganem, are characterized by the presence of organic and mineral pollutants in high concentration. The main parameters analyzed are COD, BOD5, Cl-, NO3-, NO2-, and P2O5, with concentrations well above the prescribed standard. We also noted the presence of heavy metals in substantial amount such as cadmium, chromium, cobalt, manganese, copper, iron, zinc and lead.

The wealth of food waste in organic and mineral matters has affected the composition of the leachate. These effluents have been a natural treatment by the reed Arundo donax kind for a period of 30 days. The concentrations of all elements analyzed after 15 and 30 days of treatment, are decreased with a reduction rates varying from one parameter to another.

We noted during the experiments, that the reeds were able to resist the aggressive environment. They developed more by keeping their physical aspect with the appearance of new buds, stems and roots. The leachate treatment method by Arundo donax is economical and ecological.

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