Effect of the initial pH adjustment step on COD and UV-Visible spectra of raw young and stabilized leachates

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Article Info

ABSTRACT

This work aims to assess the effect of adjusting the initial pH of raw young leachate (YL) and raw stabilized leachate (SL) sampled from the controlled landfill leachate of Fez city. The results of the pH effect (acidic and basic range) were expressed in terms of the variation of chemical oxygen demand (COD) removal and UV-visible spectra. Raw samples are characterized by high initial COD (104000 mg/L and 6000 mg/L) and initial pH 6.62 and 8.21 for YL and SL, respectively. For both samples, the highest COD removal was noticed at initial pH=12 (26% for YL and 28% for SL). Similarly, the most significant reduction of the absorbance values was observed for both samples at pH=12. These results would be a valuable contribution to better explain the phenomenon that may influence the depollution of landfill leachate, especially since pH adjustment is an almost unavoidable step in biological and physico-chemical treatment processes.

Keyword:
Young leachate
Stabilized leachate
pH adjustment
COD
UV-visible spectra

1. INTRODUCTION

Solid waste landfilling is still one of the most used techniques for solid waste management, which consequently impose the leachate production issue and consequently its treatment
before its discharging [1]–[3]. However, the heterogeneity and complexity of its composition make the choice and application of the suitable process difficult due to the factors’ interaction that may affect the treatment efficiency according to the chosen process (physical-chemical or biological) and to the leachate category (stabilized, intermediate, or young). Indeed, one of the factors that have a significant effect on the depollution performance of liquid effluents (i.e. coagulation-flocculation, Fenton, Fenton-Like, oxidation using activated persulfate, adsorption…etc) is pH [4]–[10]. Hence, further investigations are required to examine the interactions and the by-products that may result in that may occur in the raw leachate during and after the step of the pH adjustment at the basic and acidic range, which may directly influence the reactions that ensue in the treatment step and affect subsequently the process efficiency.

In this sense, this work contributes to a better understanding of the leachate mechanism treatment, by providing the analysis of COD and UV-visible spectra evolution for young and stabilized leachate during the step of the pH adjustment.

2. RESEARCH METHOD
The raw leachate samples were collected from the controlled landfill located 11 km from Fez city, Morocco. Each year, this landfill collects 1000 tons of solid trash and produces about 350–450 m\(^3\) of leachate/day. To avoid any biological or chemical interactions, the raw leachate was collected in opaque plastic bottles, transferred to the laboratory, and kept in the dark at 4 °C [10].

Chemical oxidation demand (COD) measurement was conducted following the spectrophotometric method at 600 nm after the chemical digestion step based on the acidic oxidation using the reactor “ISCO RECOD”. The UV-Visible spectrophotometer “UV-6300PC – VWR” was used to measure the COD values and to obtain the UV-visible spectra before and after pH adjustment.

The pH values were adjusted using NaOH and H\(_2\)SO\(_4\) solutions (2 M) and measured by the pH-meter “JENCO Electronics, Ltd”.

3. RESULTS AND ANALYSIS

Figures 1 and 4 show the evolution of the absorbance values of the UV-vis spectra of samples of young and stabilized leachates whose initial pH (pHi) has been adjusted to acidic and basic values. The evolution of absorbance values is particularly remarkable in the length range from 250 to 300 nm which indicates the presence of macromolecular organic compounds: unsaturated double bonds characteristic of hydrocarbons, benzene, and humic acids, and polycyclic aromatic compounds [11]–[13].

From figure 1, it is noticed that the absorbances of all the samples at different pH are lower than those of the young raw leachate with Abs\(_{\text{pH=12}}\) < Abs\(_{\text{pH=10}}\) < Abs\(_{\text{pH=3}}\) < Abs\(_{\text{pH=8}}\) < Abs\(_{\text{pH=5}}\) < Abs\(_{\text{Raw YL}}\). The decrease in absorbance is consistent with the visual aspects of the samples shown in the image inserted in the same figure, where the sample at pH=12 has the lightest color followed by that at pH=10, while the color of those at pH 3, 5 and 8 is almost the same as that of raw leachate.
The evolution of the values of the COD removal and of the final pH (pH$_f$) according to the different values of the initial pH of the YL is displayed in Figure 2. It can be observed that the best COD reduction percentage (26%) is recorded for the sample of pH$_i$=12 and the weakest (2%) corresponds to the sample of pH$_i$=8 with the following order: % COD$_{(pH=12)}$ > %COD$_{(pH=10)}$ > %COD$_{(pH=3)}$ > %COD$_{(pH=5)}$ > %COD$_{(pH=8)}$.

In addition, it can be noted that the decrease in the absorbance values in Figure 1 is consistent with the evolution of the COD removal values displayed in Figure 2. Indeed, it has been proven in the literature that absorbance values are positively correlated with COD values, especially in the 250-300 nm range which represents the aromaticity and complexity of organic compounds [14], [15].

For the values of the final pH of each sample (Figure 2), we note that pH$_f$≈pH$_i$ for the samples of pH$_i$ 3, 5, and 8, while for the pH$_i$ 10 and 12 the pH$_f$ are respectively 8.85 and 10.33.
Figure 3 illustrates the image of YL samples at different pH after centrifugation. It is clear that the height of the pellet formed in the sample tube at pH = 12 is the highest, followed by that at pH = 10, while the pellets formed for the values of pH = 3, 5, and 8 are very small amounts. This observation can be explained by the fact that the formation of flocs and their precipitation is more favorable at pH = 12 compared to other values of pH, which significantly reduced the COD and the color of the YL following the precipitation of materials in suspension.

![Figure 3. Image of YL samples after adjustment of initial pH values and centrifugation](image-url)

The UV-visible spectra were also investigated for the SL samples before and after adjustment of the initial values (pH = 3, 6, 9, and 12) (Figure 4). It is noted that the absorbances (200 – 300 nm) of the four samples after adjustment of pH are clearly reduced compared to crude SL. Moreover, the latter are almost superimposed, with a very small decrease in absorbances at pH = 12 compared to the other values of pH.

![Figure 4. UV-visible spectra of SL samples at different initial pH values; Dilution=x20; V= 20 mL; T=25 °C; 250 tr.min⁻¹/2h](image-url)

The COD reduction percentages for SL obtained at different pHᵢ values are displayed in Figure 5 and are found to be 29% (pHᵢ=3), 24% (pHᵢ=6), 8% (pHᵢ=9), and 28% (pHᵢ=12). This optimal value of the COD reduction rate at pHᵢ = 3 corroborates with the slight
Imane El Mrabet et al. Vol. 16, 2022, pp.18-23

4. DISCUSSION

The main goal of this study was to investigate the evolution of COD and UV-visible spectra after the adjustment of the initial pH of young and stabilized leachate samples. Therefore, this study makes a significant contribution to research on leachate treatment by demonstrating the effect of the pH adjustment step on the COD and UV-visible spectra variation.

The highest COD removal was noticed at initial pH = 12 (26% for YL and 28% for SL) and the lowest absorbance values were observed for both samples at pH = 12.

However, in order to better predict the suitable treatment process to apply and better control the parameters affecting its efficiency, further analyses (HPLC, GC-MS...) are necessary to deeply investigate the reactions that occur in each pH value and the by-products susceptible to be formed.

REFERENCES


Imane El Mrabet et al. Vol. 16, 2022, pp.18-23


Imane El Mrabet et al. Vol. 16, 2022, pp.18-23