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Treatment of the uncontrolled landfill of Casablanca city by naturals materials

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Abstract. This work treats the leachate from the uncontrolled landfill of Casablanca city using the infiltration-percolation technique. To do this, we carried out a comparative study of the filtrations on different matrices to choose the best filtering medium. We used silt, fly ash, bottom ash, agricultural soil and sea sands from the Casablanca coast.
The parameters studied are: Chemical Oxygen Demand (COD), pH and heavy metals. The results obtained from adsorption technique show that these matrices used can be an effective adsorbent for the reduction of physicochemical parameters and the elimination of heavy metals.
A revaluation of the filtering sludge made in the field of pottery. The results observed are satisfactory at all levels, whether in the reuse of this liquid waste, in the field of irrigation or the recycling of filter matrices.

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1. Introduction

One of the negative impacts of human activity on our planet is wastewater discharge from uncontrolled landfill. In Morocco, the most widely adopted solid waste management method is landfilling. These are mainly uncontrolled and open-air landfills, which cause critical pollution problems [1]. One of the problems caused by the exploitation of this kind of waste, there is the production of leachate, biogas. This wastewater commonly includes organic, inorganic matter and heavy metals. These heavy metals are not biodegradable, and their presence is the main cause of groundwater pollution as they do not have any layer of protection to keep the leachate from seeping into the ground [2]. Numerous methods such as ion exchange, ion-exchange, precipitation, adsorption and reverse osmosis reported in literature for the treatment of leachate [3]. Studies on the treatment of effluent bearing heavy metals have revealed adsorption to be a highly effective technique for the removal of heavy metals from leachate.
The objective of the current study is to contribute to the research for less expensive adsorbents and the use possibilities for various wastes, which are in many cases also pollution sources. In this spirit, we tested the performance of different matrix composed of natural porous materials such as sand, agricultural soil, silt, fly ash and bottom ash for removing organic matter and heavy metals from leachate.

2. Sampling and methodology

2.1 Leachate characterization

The treated liquid discharge is young leachate from the uncontrolled landfill of Casablanca city. This discharge is located approximately 28 km from the town and has a surface area of 65 hectares.

Table 1 shows the result of the analysis of leachate by (ICP-AES). We observe that this leachate charged with heavy metals (Cr, Li, and Ni). Each value is the medium obtained after three sampling campaigns. The results obtained show that the concentration of chromium, Lithium present in the leachate are well above the required standard, respectively (0.5 mg/l,0.5 mg/l). We note that nickel is the metal element present in the water with a value of 3.64 mg/l, which is well above the regulation (0.5 mg/l).

The Chemical Oxygen Demand of the leachate studied exceeds 81900 mg/l. It has reached an extravagant value. This value shows that this waste is in the biodegradation phase. The occurrence of this biodegradation before landfilling linked to the high water content of the organic fraction of the domestic waste mass. Indeed, the water content of organic matter is sufficient from a minimum value of 55% for biodegradation [4].

Parameters	value
pH	3,74
Temperature (°C)	20,5
DCO (mg/l)	81900
Cr(mg/l)	1,07
Li (mg/l)	2,98
Ni(mg/l)	3,64

Table 1: raw leachate characterization

2.2 Adsorbents used

2.2.1 Bottom Ash

Bottom ash used in our experiments as adsorbing arise from the thermal power plant of Jorf Lasfar " JLEC " situated at a distance of 17 km from the city of El Jadida. Bottom Ash is a non-combustible residue of combustion in a furnace or incinerator. They are in the form of porous grey grains and depend on the origin of the coal and the conditions of discharge. The chemical composition of bottom ash obtained by fluorescence X technique, and crystalline structure evaluated by XRD.We note that bottom ash contains 80% of the elements SiO_2, Al_2O_3, and Fe_2O_3. Bottom ash is one of the most inexpensive and low-density reinforcement available in large quantities as solid wastes by-products during combustion [5].

2.2.2 Fly Ash

Fly ash is a residue produced during the combustion of pulverized coal in thermal power plant boilers. They are fine (0.5 and 315 microns) particles derived from minerals and often used as pozzolans in the manufacture of hydraulic cement. Fly ash is one of the most known waste, and it's used as a raw material in many industries such as the cement industry, the fly ash used as a filter was analyzed by the ICP technique. The results of this analysis show that these fly ashes are classified as silico-aluminous ash. They have pozzolanic properties because they contain 94.4% of the elements: SiO_2, Al_2O_3, and Fe_2O_3.

2.2.3 Silt

Silt is made of fine particles of clay and sand found at the bottom of a river. It is generally described as a set of agglomerates. Silt is generally created by attrition of quartz, mica and feldspar [6]. it contains 50.7% CaO, 4.5% SiO_2 and 1.5% Al_2O and 42.5% LOI (Loss on ignition), which presents the organic matter measured by the fire loss method.

2.2.4 Agriculturalsoil

The soil with which the farmer works comes from the topsoil, which is richer in organic matter. Basically, the soil consists of four main elements: water, mineral matter, air and organic matter. This wealth in mineral and organic matter gives the ground a high adsorbent capacity [7]. The agricultural soil used as a filter contains 88.72% of the silicon dioxide that causes significant adsorption.

2.2.5 sand

Samples of marine sands used in our study were accumulated along the coast of the city of Casablanca (figure 1), in different colours according to their silica and calcite composition and grain size.

Figure 1: Map shows the location of sample sites

In our study, we repeated the percolating filtration tests on more than ten matrices. They are composed of one or more natural adsorbents. We have set the same parameters for all matrices, which are essentially the leachate flow rate, an average temperature of 27°C and the preparation of all adsorbents simultaneously and under the same conditions. Table 2 presents these matrices used as adsorbents.

Table 2: The matrix used as adsorbent

Matrix	Adsorbents
F1	(Fly Ash, Sand 2, Bottom Ash, Silt)
F2	(Fly Ash, Agricultural Soil, Bottom Ash)
F3	(Silt, Fly Ash, Agricultural Soil)
F4	(Fly Ash, Agricultural Soil, Fly Ash, Silt)
F5	(Fly Ash, Agricultural Soil, Bottom Ash, Silt)
F6	(Fly Ash, Sand 2, Bottom Ash)
F7	(Silt, Fly Ash, Agricultural Soil, Bottom Ash)

The figure 2 shows the assembly of our percolation infiltration Technique used to purify our raw leachate samples.

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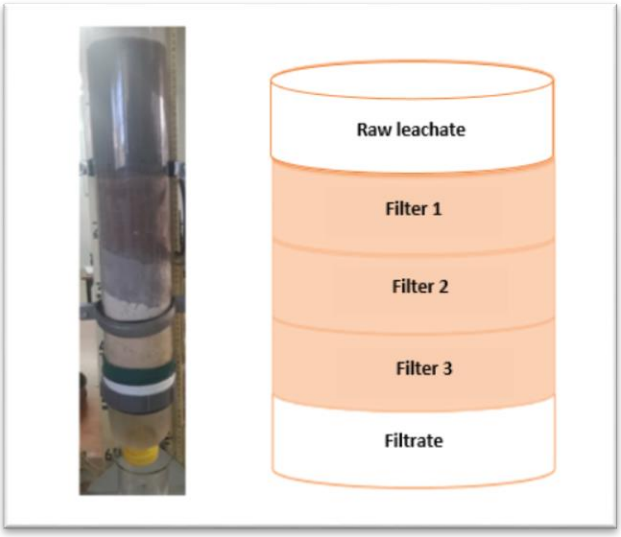

Figure 2: The experimental setup

3. Results and discussion

3.1 Results of leachate treatment using infiltration-percolation

Figure 3 shows the results obtained by the infiltration-percolation technique. We have chosen leachate discolouration as the decisive parameter. Maximum leachate discolouration is achieved by using agricultural soil, fly ash, bottom, bottom ash, sand, and silt. The decomposition of organic matter makes the leachate yellow, brown or black [8].

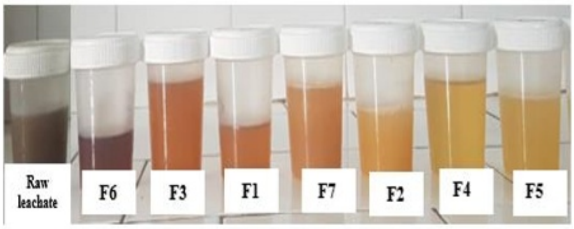

Figure 3: Filtration results

3.2 Analysis results after treatment

Figure 4 observe that there is a significant reduction in the adsorption of lithium in the matrix F4. It's compounded a high amount of fly ash, silt and agricultural soil. The main constituents of silt sediment are quartz, calcite, and a mixture of clays. We conclude that we can use slit as a low-cost adsorbent for removing metal ions from leachate [9].

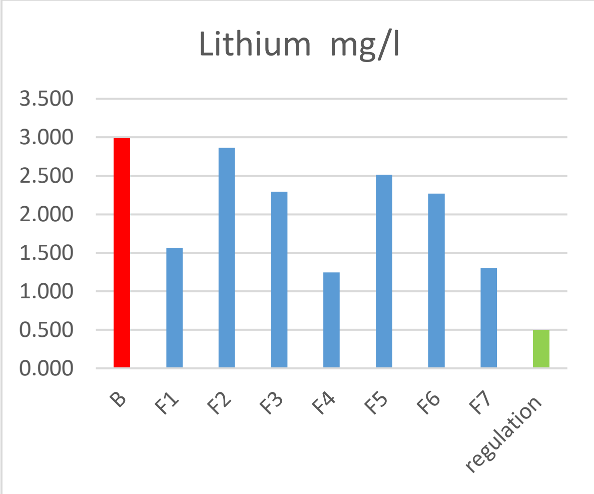

Figure 4: Abatement of Lithium after treatment in used matrix

Nickel is a toxic heavy metal that occurs naturally and is used in many industrial applications. In addition, High Ni levels affect human health and cause headaches, dry cough, nausea, tightness of the chest, dizziness, vomiting, rapid respiration, shortness of breath, chest pain, extreme weakness, and cyanosis [10-11]. Figure 5 shows a significant reduction in different filters uses, before treatment we observe a concentration of 3.64mg/l of Nickel, the Matrix F7 conducted an abatement rate 97.4% with a concentration of 0.095mg/l. A value which is strongly less than the regulation (1mg/l). This reduction of Nickel can be explained by the adsorption capacity of the bottom ash, fly ash and silt. The effectiveness of silt as an adsorbent improved with increasing calcium (CaO) content (50.7%) [12].

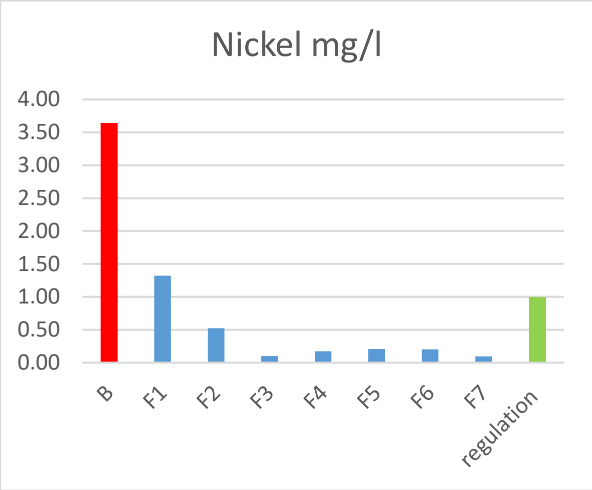

Figure5: Abatement of Nickel after treatment in used matrix

Figure 6 shows that the Chromium concentration record the highest concentration of leachate is strongly reduced after treatment, especially in matrix F4 with a reduction of 74.5% % and a concentration of 0.272 mg/l, which perfectly respects the norm (0.5mg/l). Chromium in soils is toxic to plants and animals. Therefore, the variability in the oxidation states of chromium in soils is of great environmental concern [13].

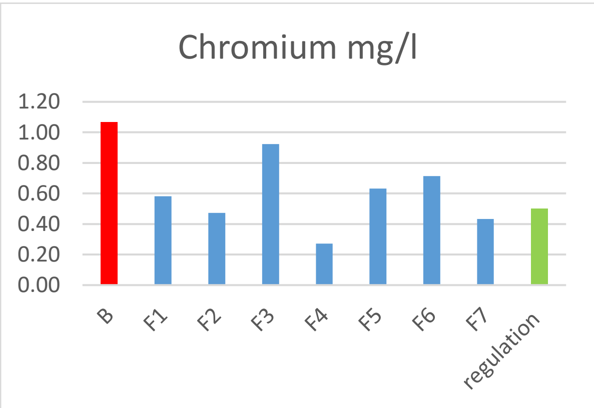

Figure6: Abatement of Chrome after treatment in used matrix

The leachate treated by infiltration shows a reduction in organic pollution in terms of COD, with a maximum for the F1 matrix, which contains fly ash, silt, agricultural soil and coal. This matrix gave a high reduction rate of 90.96% (figure7). This means that these leachates have a very high pollution potential and should therefore be treated before being released into the environment [14]. This reduction in organic matter is explained by the high adsorption properties of finer minerals, particularly fly ash and silt. In addition, fly ash contains a high silica content, an important adsorbent with a high electrical polarity and mineral elements. The latter collaborate in neutralizing the negative charges of organic matter in the leachate [15].

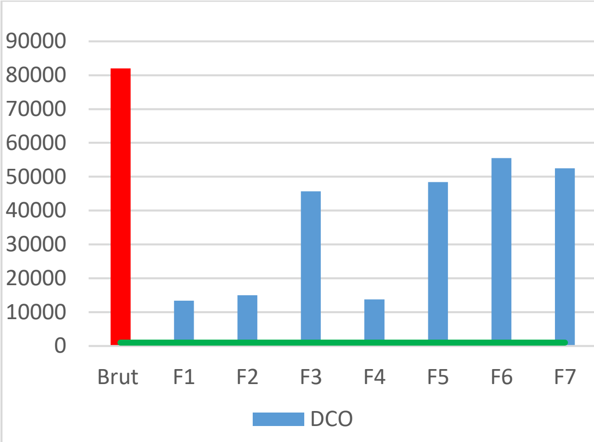

Figure7: Abatement of DCO after treatment in used matrix

4. Conclusion

The results obtained from the treatment test show: a significant reduction in terms of COD, which validates the importance of leachate treatment before their release into the environment. The F7 filtrate formed by Silt, Fly Ash, Agricultural Soil, Bottom Ash allows a very effective abatement in terms of COD, heavy metals and discoloration, as well as an increase in pH and dissolved oxygen meeting the Moroccan discharge standards.

In general, the results obtained are very significant, the technique of infiltration percolation is effective, the purified water can be well used in the field of irrigation or for the cooling liquids of industrial machines. We have revalorized the sludge that was used as a filter in the pottery field.

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