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Removal COD of Landfill Leachate Using A Coagulation And Activated Tea Waste ($ZnCL_2$) Adsorption

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Abstract

This experimental study was conducted to investigate the effect Combination of coagulation and with modify tea waste absorbed process in leachate treatment. Samples of partially landfill leachate were taken from the artificial pond connected to the Zahedan landfill site. The average characteristics were: COD=1800 mg/l 1, BOD =500 mg/l, NH-N=21.5 mg/l 1 and pH= 7. Coagulation process was examined by using poly-aluminum chloride. A low cost adsorbent, modify tea waste was used for adsorption studies. The results showed that the maximum COD removal is 88.7% using modify tea waste adsorbent with optimum dose of 5 g/L. Therefore combination of coagulation and absorbed is sufficient for treatment of this leachate such as modify tea waste adsorption should be applied.

Keywords: Leachate, coagulation, adsorbent, tea waste, treatment.

Introduction

The characteristics of landfill leachate depend on several parameters such as design of landfill site, climate, and type of decomposed MSW at landfill site, moisture content, landfill age, pH, BOD_5/COD ratio and the stage of decomposition in the landfill [1, 2].

Leachate generated in municipal landfill contains large amounts of organic and inorganic contaminants [3, 4]. The removal of organic material based on COD, BOD and ammonium from leachate is the usual prerequisite before discharging the leachates to the environment [5]. The performance of combined treatment of municipal landfill leachate is reviewed. A combination of two coagulation- adsorption treatments can give optimum results in removal of organic compounds leachate [3].

adsorption as a surface phenomenon, operated by a fluid mixture of multi-components absorbed to the surface of a solid adsorbent via physical or chemical styles, is believed to be one of the most efficient and promising approaches for landfill leachate treatment [6], activated carbon it's expensive nature has equally motivated researchers to find substitutes [7].

This research is aimed at harnessing the potentials in tea waste, which is usually discarded after usage in cafes and restaurants. In Iran and many part of the world, tea is one of the staple drinks or beverages consumed in the society. The tea leaves contains of insoluble cell walls with some specific functional groups which are able to uptake the contaminants, thus the tea leaves can potentially use as pollutant scavengers from aqueous solutions. The functional groups which contribute in contaminant removal process may include carboxyl ate, aromatic carboxyl ate, phenolic hydroxyl, and oxeye groups of the tea leaves [8, 9]. A number of chemicals have been used for activation, some of which includes: potassium hydroxide [10, 11], sodium hydroxide [12, 13], zinc chloride [14, 15], phosphoric acid [16], and so on. Among the numerous dehydrating agents, zinc chloride in particular is the widely used chemical agent in the preparation of activated carbon. Chemical activation by $ZnCl_2$ improves the pore development in the carbon structure and because of the effect of chemicals the yields of carbon are usually high, $ZnCL_2$ has proven to be a good activating agent going by its ability to develop large pore sizes and surface areas of biomass [17, 18,19]. The aim of this study is investigate the Combination of Coagulation and absorbed Processes for Treatment of Landfill Leachate of Zahedan.

Materials and methods

Leachate characteristics and analytical method

The leachate samples collected from the landfill site in Zahedan city were analyzed. The average characteristics were: COD=1600-1800 mg/l 1, BOD =200-500mg/l, NH-N=21.5 mg/l 1, EC =5.5and pH=7.23- 7.90. COD, biological oxygen demand (BOD_5), NH3–N, total suspended solids (TSS), total kjeldahl nitrogen (TKN) and pH were measured according to the Standard Methods for the Examination of Water and Wastewater [20]. The COD was determined by the dichromate method, colorimetric method at 600 nm with Hach spectrophotometer (HACH DR/5000. The removal efficiency and sorption capacity of the bentonite were determined by Eq. (1) and (2), respectively [21, 22]:

$$Qe = \frac{(C_0 - C_e)V}{M}$$

$$RE=\left[\frac{(C_0-C_t)}{C_0}\right]\times 100$$

Where; R (%) and qe (mg/g) are the removal efficiency and adsorption capacity, respectively. Co (mg/L) is the initial COD concentration, Ce (mg/L) is COD concentration at the equilibrium, m (g) is the mass of the sorbent and V (L) is the volume of the leachate.

Coagulation and Adsorption process

Coagulation studies were performed in a conventional jar test apparatus, equipped with six beakers of 1 liter volume. The jar test process consists of three steps which is the first rapid mixing stage took place for 3 min at 100±2 rpm; aiming to obtain complete mixing of the coagulant with the leachate to maximize the effectiveness of the destabilization of colloidal particles and to initiate coagulation. Second step is slow mixing for 20 min at 40 ±2rpm [3, 23]. Then, Tea waste was taken from the waste tea leaves after tea making process. The tea waste was washed several times with distilled water to remove surface impurities and dried at 100 ^{0}C. The activation was carried out using $ZNCL_2$ for 24 h. Finally, the washed sample was again dried at 110 ^{0}C for 4 h, ground and sieved to produce desired particle size (200–250 mm). The Tea waste was added into 1000 ml Leachate Then identical mixtures were shaken on orbital shaker at 130 rpm for 60 min. The supernatant was filtered through Wattmann 40 filter paper before COD analysis [3].

Results and discuses

Effect of pH and coagulant on Coagulation

Coagulation was then performed using various coagulant dosages at the appropriate pH values. The study shows that Polyaluminum chlorides are most effective at pH equal to 6 [3]. The results show that the highest COD removal efficiencies of 79% were achieved at pH 6, 0.15 g /L of PAC. This result is mainly due to the fact that the optimum coagulant dosage produced flocs having a good structure and consistency. But in doses lower than optimum, the produced flocs are small and influence the settling velocity of the sludge. In doses higher than the optimum, in addition to the small size of floc, rest ability of floc can happen.

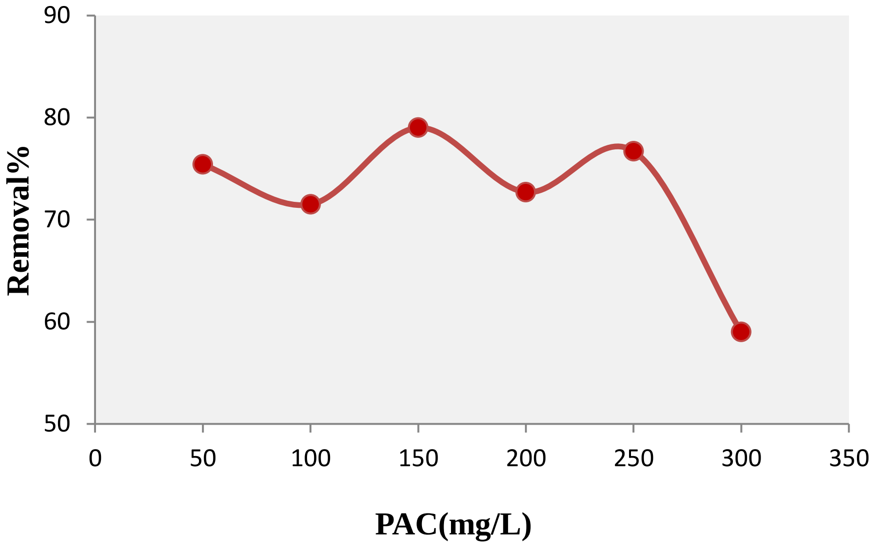

Fig01. Effect of Coagulant on leachate removal efficiency

Effect of pH on adsorption

One of the most important factors affecting the capacity of adsorbents in wastewater treatment is pH. The pH value of the solution was an important controlling parameter in the adsorption process, as can be seen from Fig02and image01. It shows that the Removal of leachate onto modify tea waste $ZnCl_2$ increases significantly with decreasing pH. The maximum removals of leachate for contact time 60 min were carried out at pH 12. The hydrogen ion and hydroxyl ions are adsorbed quite strongly and therefore the adsorption of other ions is affected by the pH of the solution. Change of pH affects the adsorptive process through dissociation of functional groups on the adsorbent surface active sites [24].

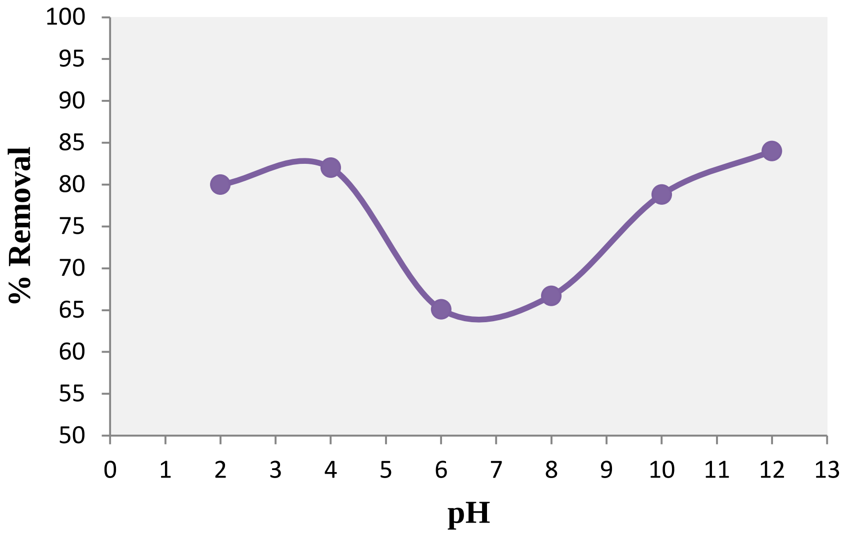

Fig02. Effect of pH on leachate removal efficiency

Image01. Effect of pH on leachate removal efficiency

Effect of adsorbent dose and Time

The effect of adsorbent dose on removal of leachate was studied by varying the dose of adsorbent from 1 to 20 g/L. From fig 3, it is evident that adsorbent dose significantly influences the amount of adsorbed. The results showed modify tea waste by Zncl2 that the removal efficiency increased from 83.3% to 89%, with an increase in the Biosorbent dose from 1 to 3 g/L.

Figure 4 shows the effect of contact time on the adsorption capacity and percent removal efficiency of leachate onto the modify tea waste by Zncl2 at 3 g/L adsorbent dosage. The uptake of leachate on adsorbent was rapidly in the first 60 min (%89) and then the adsorption rate decreased gradually from 60 to 180 min and finally reached equilibrium in about 150 min (%60). On the other hand a large number of surface sites are available for adsorption at the initial steps and after a lapse of time the remaining surface sites are difficult to be occupied because of repulsion between the solute molecules of the solid and bulk phases [25].

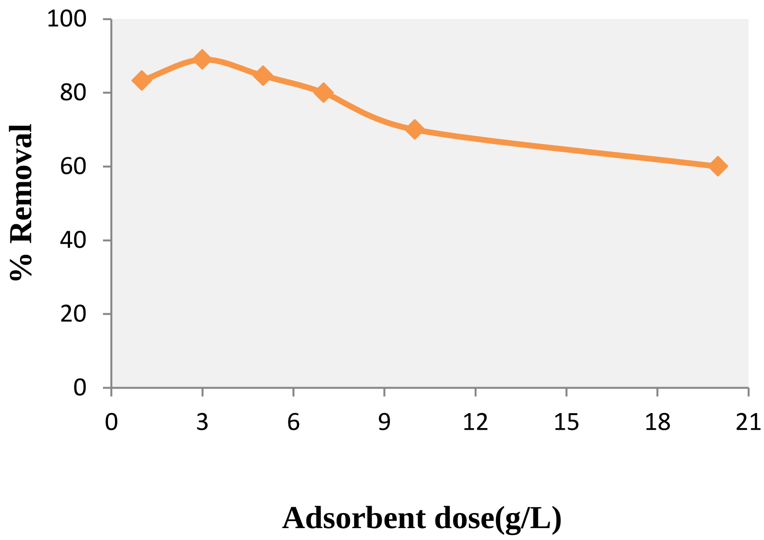

Fig03. Effect of adsorbent dose on leachate removal efficiency (pH=12 and Contact time=60 min).

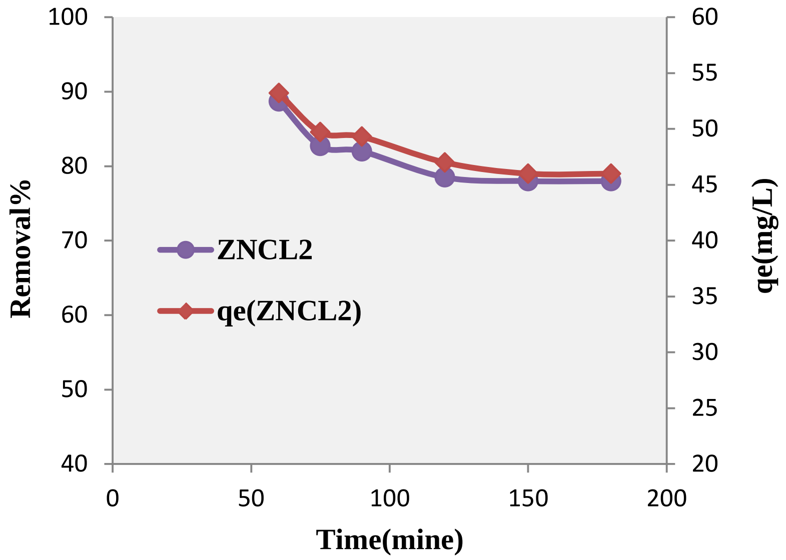

Fig04. Effect of Time on removal of Leachate by tea waste(pH=12 ,dosag=5g/Land Contact time=60 min).

Adsorption equilibrium

Langmuir sorption isotherms, which is one of the most widely used models to describe the equilibrium behavior of adsorption was used to correlate the isotherm data in this study. The Langmuir isotherm is presented the Eq. 3 [24, 26].

$$\frac{c_e}{q_e} = \frac{1}{q_m k_l} + \frac{c_e}{q_m} \qquad (3)$$

Where qe is the amount of sorbate adsorbed at equilibrium (mg/g); Ce is the equilibrium concentration of the sorbate or the sorbate unabsorbed in the solution (mg/L); q_m (mg/g) is the maximum theoretical biosorption capacity and K_L (L/mg) is a measure of adsorption energy that is indicated on the affinity between biosorbent and sorbate. The essential features of Langmuir can be expressed in terms of dimensionless constant separation factor R_L .Values of R_L indicate the shapes of isotherms to be either unfavorable ($R_L > 1$), linear ($R_L = 1$), favorable ($0 < R_L < 1$)[24]. The Freundlich equation is given by the following Eq 4[26].

$$\text{Log } q_e = \frac{1}{n} \log c_e + log k_f \qquad (4)$$

Where qe is the sorbate adsorbed at the equilibrium (mg/g); Ce is the equilibrium concentration of the sorbate or the unabsorbed sorbate in the solution (mg/L); K_F is a constant, indicative of biosorption capacity.

The results of the isotherm constants are displayed in Table1. As shown in Table 1and that the correlation coefficients for the Langmuir isotherm and Freundlich models were close to 1.0 for Modify adsorbent dose by $Zncl_2$ in tem 30 ^{0}C. The Langmuir isotherm assumes monolayer coverage of a sorbate on to the solid surface of adsorbent, uniform energy of sorption, and no transmigration of sorbate in the plane of the surface [24].

Table1.the adsorption isotherms Langmuir and Freundlich models

Tem	**Langmuir Model**				**Freundlich model**		
	q_m	k_L	R_L	R^2	n	k_f	R^2
30 ^{0}C	159.6	0.0004	0.58	1	0.625	12.6	0.998
40 ^{0}C	159	0.0007	0.44	0.7535	2.32	16.1	0.9573

Conclusions

The experimental study shows that Combination of coagulation and absorbed process can have high efficiency in treatment of the zahedan landfill leachate.

The results of this study indicate that the Adsorbent process to Optimum conditions for the operation with pH=12, bentonite dose=5g/l at time of 60 min can treatment a large impact on the concentration of leachate. Leachate requires efficient treatment techniques prior dispose to the natural environment. Selection of an appropriate efficient treatment technique depends on the quality and age of the landfill leachate.

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