APPLICATION OF MINERAL SORBENTS FOR PHENOL REMOVAL FROM WASTWATER

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Abstract - Increasing concern about pollution of groundwater by organic chemicals has led to extensive research on application of various adsorbents. This study addressed sorption and removal of phenol by three types of ceramic. Ceramic types A and C were provided by Hafez Ceramic Factory in Shiraz and Ceramic type B was from Aras Ceramic Factory in Boroujen. Adsorption of phenol on ceramic powder was studied through batch experiments at 25°C. The results from the experiments show that the amount of the adsorption of the phenol at the same condition on ceramic powder type A is more than type B, C. After 30 minute type A adsorbs better than other ceramic type, in initial Phenol concentration $C_0 = 60$ ppm type A adsorb around 50% of Phenol ,type C adsorbs around 14% and Type B adsorbs around 25% of Phenol. Freundlich model fits for ceramic type A moderately well to the adsorption isotherm of phenol. The calculated model parameters are n =13.16, and logk_F =-0.345.

INTRODUCTION

Soil and water contamination by hydrocarbons from leaking storage tanks and improper disposal of hazardous wastes are of concern worldwide. Petroleum hydrocarbons are responsible for 65% of all contaminated groundwater sites (EPA/540/R-95/508b). Treatment of petroleum contaminated sites is a subject of almost unlimited scope. Sites can be as simple as a corner service station with little contamination to a refinery contaminated with hundreds of compounds over every square inch of ground. Underground petroleum storage tank systems (USTs) have been buried since the early decades of the twentieth century. Not until the mid-1970s did anyone

seriously consider the fact that these buried USTs might be leaking gasoline into the environment. The fact that approximately 85% of all USTs were steel with little or no corrosion protection went unnoticed [1]. (Cole, 1994). If proper remediation measures are not taken, the organic pollutants released from gasoline spills can lead to surface and groundwater contamination, which can be potentially toxic to biota and humans. Phenol is one of the most common aromatic contaminants in wastewater. Because of their toxicity, the presence of phenol in water and wastewater has been of great public concern. They are harmful to organisms and humans even at low concentration. Phenol has been included in the USEPA list of priority pollutants; therefore the treatment of them is a necessity.
Phenolic compounds, generated by petroleum and Petrochemical, coal conversion and phenol producing industries, are common contaminants in Wastewaters. Thus, it is necessary to identify, characterize and develop effective clean up for these hazardous contaminants. The removal of oily pollutants such as Phenol from wastewater poses a problem, particularly when they are present in low concentrations, such as in industrial water. Over the recent years, the increasing attention has been given to the quantity of other toxic materials found in these waters. Several physical, chemical and biological processes are used for the removal of phenol from aqueous solutions. Chemical oxidation, liquid membrane, osmosis, chemical precipitation, filtration,

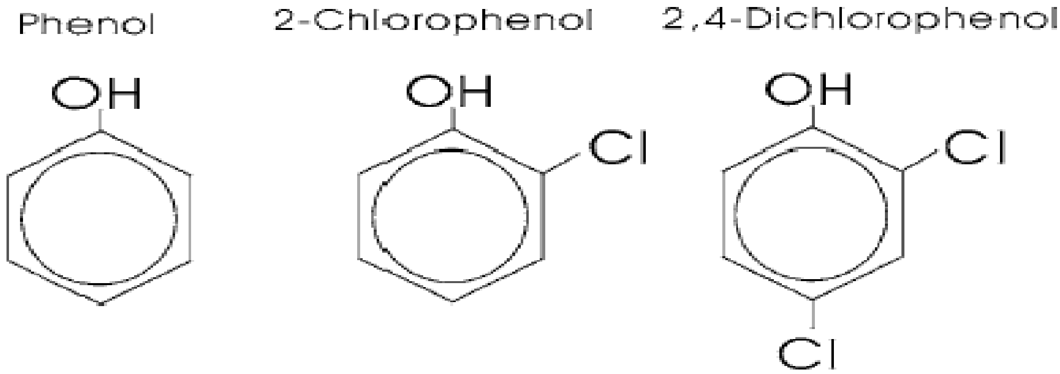


Fig (1) Schematic representation of molecular structures of phenol
And chlorophenols

Electro dialysis and adsorption are among those methods most commonly employed. Adsorption is an important technique, which is classified as a physical method. Because of its simplicity, reliability and its inexpensiveness, Adsorption is currently being used for the removal of organic and inorganic compounds from aqueous phases and since 1940s, the adsorption technology is extensively used in oil removal. Traditionally, activated carbon has been widely used as an adsorbent for removing oil. Many types of other adsorbent materials such as bentonite [3,4,5,6,7], kaolinite [8], fractured chalk [9], fulvic acid [10], humic acid [11], wood [12, 13], surfactants and surfactant-modified alumina [14], have been studied as alternatives for removing HOCs contaminants. All these adsorbent materials have specific advantages and limitations, so the need to develop low-cost adsorbents remains. This study examines the applicability of ceramic powder as a low-cost material for adsorbing oil from industrial wastewater.

MATERIAL AND METHODS

The ceramic type A, C was supplied by Hafez Ceramic Factory in Shiraz and ceramic type B was supplied by Aras Ceramic Factory in Boroujen. These ceramics are not glazed. First, crumble ceramics to the small part and then material was sieved to a very small grain size, now sorbent is ready. In each batch experiment we use 20 gram of this powder ceramic to adsorb Phenol. Adsorption isotherms were determined using the batch equilibration technique. The initial concentrations of phenol were prepared in the range of 50 to 200 mg/L. 400-mL of sample was placed in a 1-L glass. Then glass place on the magnet stirrer. Magnet stirrer prepares a homogenous condition for this test. Ceramic powder now adds to this glass and adsorption process is started. The adsorptions take long around 20 minute from start of test at the temperature 25°c. After 20 minute adsorption reach to equilibrium. And the adsorption and desorption rate are equal to each other. After reaching equilibrium, the aqueous phase was separated by centrifugation at 2000 rpm for 10 minute. A 10 mL portion of aqueous phase that separated with centrifugation was analyzed by the total organic carbon method (TOC) in order to measure concentration of Phenol equilibrium. The amounts of Phenol adsorbed were calculated by the differences between the initial and equilibrium concentrations. Isotherms were obtained by plotting the amounts adsorbed against the equilibrium concentration in solution. Freundlich isotherms were applied to analyses the equilibrium data. The Freundlich equation has the general form as:

$$q_e = K_f \ (C_e)\ \hat{}(\ 1/n), \qquad (1)$$

$$\log q_e = \log K_f + (1/n) \cdot \log C_e, \qquad (2)$$

Where: K_f – adsorption capacity (mg g−1),

1/n – Adsorption intensity.

q_e Was calculated according to the following equation:

$$q_e = \frac{V\ (C_o - C_e)}{M} \qquad (3)$$

Where: V – the volume of the solution (l),

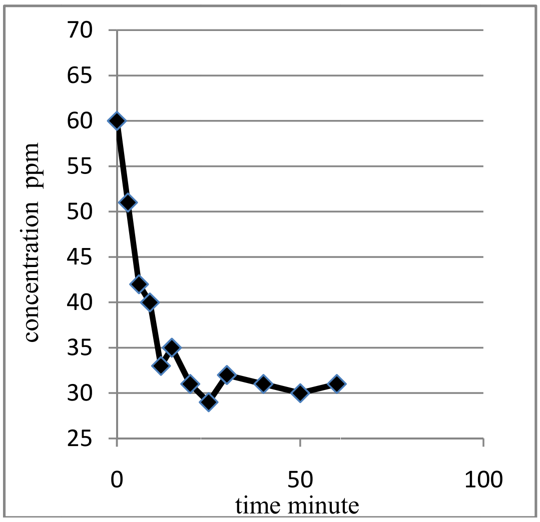
M – The mass of the adsorbent (g),

C_o – Initial phenol concentration (mg/l),

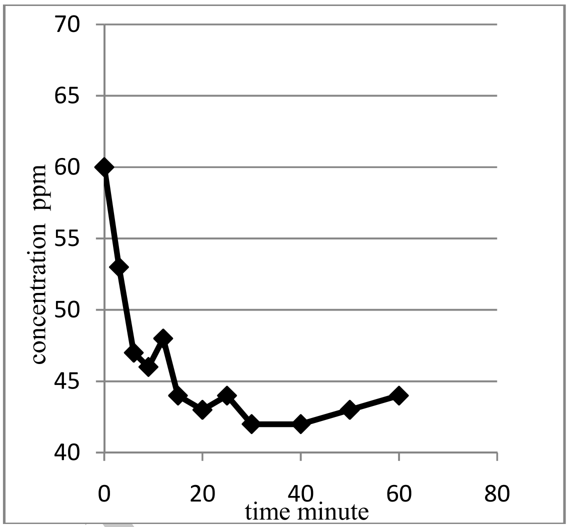
C_e – Final phenol concentration at equilibrium (mg/1).

RESULTS AND DISCUSSION

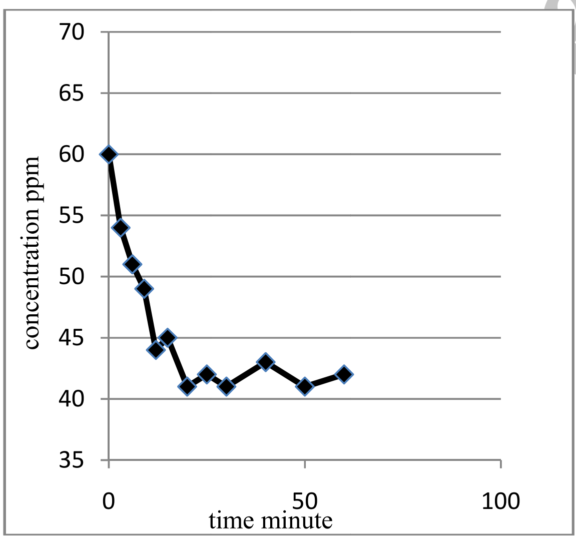
Fig (2) shows that the powder ceramic A, adsorbed around 30 ppm of Phenol after 20 minute. We can conclude that the type A capable to adsorb large amounts of phenols, we see that after 20 minute the adsorption reach to the its equilibrium. Fig (3) shows that the ceramic powder B adsorbed around 17 ppm of Phenols. And this ceramic in this condition is partially suitable and if conditions change such as temperature, pH, this ceramic powder can absorb more amount of Phenol. Fig (4) shows that when we change temperature from 25 to 40 °c the amount of adsorption for type B; change from 17 to 19 ppm. Fig (5) shows that the powder ceramic C, adsorbed around 8 ppm of Phenol after 20 minute. And this adsorbent is not suitable.



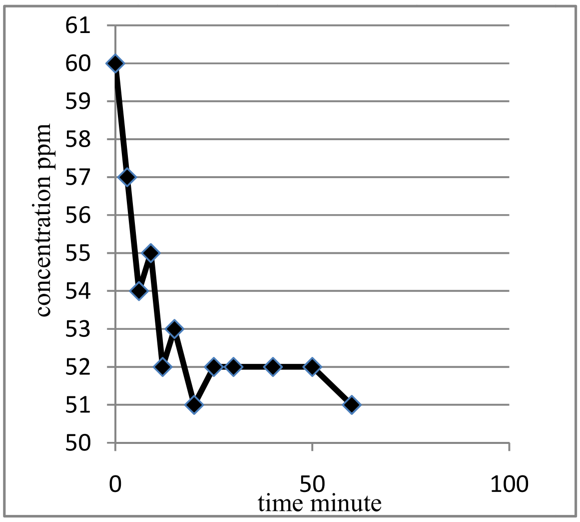
Fig(2) Decrease Phenol concentration with time
By ceramic powder type A



Fig(3) Decrease Phenol concentration with time
By ceramic powder type B



Fig(4) Decrease Phenol concentration with time
By ceramic powder type B at T = 40 °c



Fig(5) Decrease Phenol concentration with time
By ceramic powder type C

ADSORPTION ISOTHERM

Different ratios of Phenol/ceramic powder concentrations were examined in glass to determine the adsorption capacity of the adsorbent material. The Freundlich isotherm is the most widely used equation for interpretation of sorption equilibrium. The Freundlich isotherm that plot for ceramic type A show in Fig (6). Fig (6) shows the fitting of the isotherm data to the logarithmically transformed Eq. (1). The isotherm is found to be n = 13.167 and $\log K_f$ = -0.345. This Fig shows that the Freundlich isotherm partially satisfies these data.

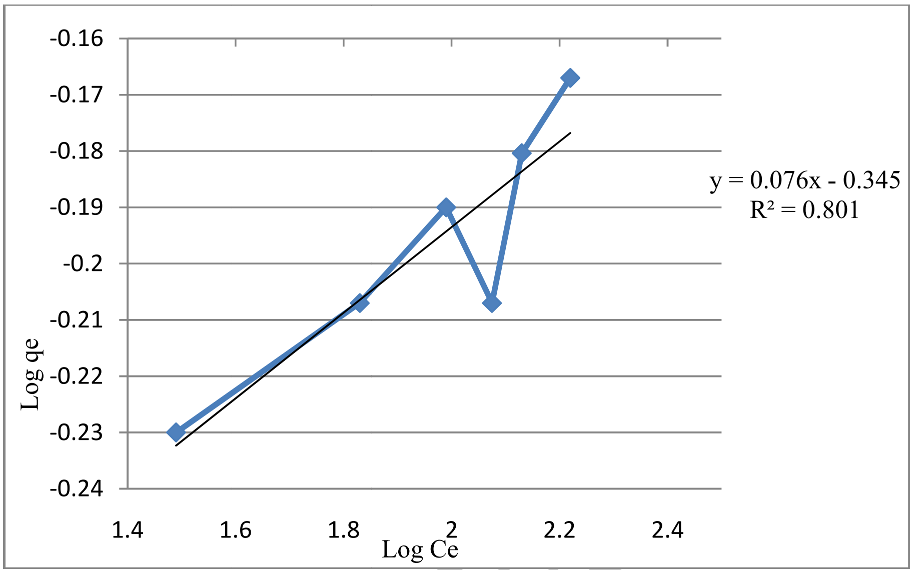


Fig (6): Adsorption isotherms and Freundlich equation

	$\log K_f$	n
ceramic type A	-0.345	13.16

Table (1): The coefficient of Freundlich equation

CONCLUSION

This study shows that the low cost mineral adsorbents can us widely to adsorb oil pollutant from water and wastewater. The ceramic powder types A, B adsorption curves for Phenol indicates that these ceramics were effective in adsorbing the Phenol and can be use. The Freundlich isotherms were found to be applicable for the adsorption equilibrium data. If we change some parameter such as temperature and pH this adsorbent will have better adsorption ,Fig (4). We can modify these ceramics and become their adsorption property better. Because of low cost and availability of these ceramics, they can be used widely in the industry. We think that with manipulation of these ceramics composition they can absorb more than these experiment.

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کاربرد جاذب های معدنی در جداسازی فنول از فاضلاب

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چکیده

اخیرا افزایش بیماریها از جمله سرطان هایی که علت آن ها آلودگی منابع آب های زیر زمینی می باشد محققین را بر آن داشته است که تحقیقاتی را در زمینه پاک سازی و جداسازی آلودگی ها از آب را صورت دهند. این تحقیق به بررسی سه نوع سرامیک A، B ، C برای جداسازی فنول از آب می پردازد. سرامیک های A و C از کارخانه سرامیک حافظ در شهر شیراز و سرامیک نوعB از کارخانه سرامیک ارس در شهرستان بروجن تهیه شده اند. جذب فنول بر روی پودر این سرامیک ها در یک آزمایش ناپیوسته در دمای ۲۵ درجه سانتیگراد انجام می گیرد. نتایج آزمایش ها نشان داد که جذب فنول بر روی پودر سرامیک A از دو نوع دیگر بیشتراست. پس از ۳۰ دقیقه جذب به تعادل می رسد و میزان جذب بر روی سرامیک A در غلظت اولیه 60 ppm در حدود 50% ، بر روی سرامیک B در حدود 25% و برروی سرامیک C ، 14% اندازه گیری شد. ایزوترم جذب بر طبق مدل فروندلیچ به دست آمده است. ضرایب معادله فروندلیچ عبارتند از : n=13.16 ، $\log K_f$ =-0.345 .

واژه‌های کلیدی : فروندلیچ ، سرامیک، ایزوترم