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A study on the efficiency of PEG as additive for phenol removal from waste water using tamarind shell ash as adsorbent

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ABSTRACT

The potential of polyethylene glycol (PEG) of molecular weight 2000 as additive for phenol adsorption from aqueous solution using tamarind shell ash was studied. Batch studies were carried out under varying conditions of contact time, adsorbent dose and pH for samples with and without PEG. The results showed that for all the process conditions studied, the addition of PEG enhances the removal of phenol from its aqueous solution. The amount of adsorption was found to decrease with pH and increase with contact time and adsorbent dose.

KEYWORDS

Phenol adsorption;
Tamarind shell ash;
Polyethylene glycol;
Adsorption additive;
Freundlich isotherm.

INTRODUCTION

Since the past several decades there is a growing concern about wide spread contamination of surface and ground water by organic pollutants. Many industrial wastes contain organic pollutants which are difficult to be removed using conventional biological treatment processes[1]. These organic compounds pose significant threats to the environment and public health because of toxicity, incremental accumulation in the food chain and persistence in the eco system[2]. Phenols as a class of organics are similar in structure to the more common herbicides and insecticides in that they are resistant to bio degradation. Some phenols are highly soluble in water and their presence in water supplies are noticed due to the taste and odour. Phenols are harmful to organisms at low concentrations and have potential to harm human health. Thus phenols are considered as hazardous pollutants.

There are number of methods for removing phenol from aqueous solution like oxidation[3], precipitation[4], ion exchange[5], solvent extraction[6] and adsorption[7]. In the recent times, extensive research is going on to develop innovative and promising adsorbing materials for the treatment of contaminated waste waters[8]. Adsorption of organic compounds using natural adsorbents leads to the search of more economic, practical and efficient techniques. Number of natural and waste materials like rice husk, tamarind shell ash, fly ash, wood and saw dust, tea waste, bagasse etc are emerging as potential adsorbents for organic pollutants[9-13].

Number of additives like polyoxyethylene-23-lauryl ether, polysorbate 80, Poly ethylene glycol, polyvinylpyrrolidone (PVP), sodium carboxymethylcellu-

lose etc are used for enhancing the adsorption of various materials on adsorbents.[14-17]. In the present work, an attempt has been made to utilize a waste material tamarind shell ash for the removal of phenol in aqueous solutions. Poly ethylene glycol (PEG) is added as an additive to enhance the efficiency of tamarind shell ash as adsorbent.

MATERIALS AND METHODS

All the chemicals used in the work were of Analytical reagent grade. The tamarinds were procured from local market.

Tamarind shell ash

The tamarind shells were washed properly with water to remove the dirt, dried in sunlight and crushed. The crushed shells were burned in an electric oven for three hours at 400 ^{0}C temperature to obtain its ash. The tamarind shell ash thus obtained was sieved through a 80 mesh size sieve. This ash was used as the adsorbent for removal of phenol from its aqueous solution. The surface area of the ash was measured by BET method.

Phenol stock solution

The stock solution of phenol was prepared by dissolving 1 gm of phenol in 0.1 N 100 ml sodium hydroxide solution and diluted upto 1000ml with distilled water.

Adsorption studies

Adsorption studies were conducted using the batch technique. The studies were carried out by varying parameters like contact time, concentration of adsorbent and P^H with and without using PEG of molecular weight 2000. The amount of residual phenol was determined using double beam UV-Visible spectrophotometer (electronics India-model 1372). 4-amino antipyrine was used as a complexing reagent with phenol and the absorbance of the colored complexes were measured at 500 nm λmax.

Various batches of adsorption study were prepared by taking different amounts of ash (0.1, 0.3, 0.5, 1, 2, 3 & 4 gm per 100 ml of phenol stock solution). The samples were stirred using a magnetic stirrer for one hour. The pH was maintained at 7. After one hour the residual phenol content was measured for each batch.

Similarly the adsorption studies were carried out by varying the contact time (0.5, 1, 1.5, 2.5, 3, 3.5 hours) and pH[5,7,9,12]. All the studies were carried out with and without PEG of molecular weight 2000 as an additive. The concentration of PEG was kept uniform for all batches as 0.6 gm per batch.

Adsorption isotherm

Freundlich isotherm is expressed as

$$q = k(Ce)^{1/n}$$

The constants for Freundlich adsorption isotherm were determined to determine the relationship between the amount of phenol adsorbed and the equilibrium concentration of the adsorbate.k and 1/n are the Freundlich constants related to adsorption capacity and adsorption intensity respectively of the adsorbent.

RESULTS AND DISCUSSION

The adsorption characteristics of tamarind shell ash in presence of PEG as additive were studied by varying pH, contact time and amount of adsorbent. The surface area of the adsorbent was determined to be 55 m^2/g. The results for each study are discussed below. The experimental data was fit into Freundlich isotherm with R^2 values of 93.75 and 92.94 for systems with and without PEG. The higher R^2 value indicates the effectiveness of PEG as additive for phenol adsorption. The values of Freundlich constants are given in TABLE 1.

TABLE 1 : Freundlich constants

	k	1/n	R^2
Without PEG	0.45	0.2	92.94
With PEG	0.58	0.23	93.79

Effect of pH

The adsorption of phenol from its aqueous solution is dependent on the pH of the solution which affects the surface charge of the adsorbent and degree of ionization. The amount of phenol adsorbed decreases with increasing pH value. This can be attributed to the dependence of phenol ionization on the pH value. Phenol being a weak acid will be adsorbed to a lesser extent at higher pH values due to the repul-

sive forces prevailing at higher pH value. Also in the higher pH, phenol forms salts which readily ionize leaving negative charge on the phenolic group[18]. pH also affects the surface charge of the cells used as sorbent. At low pH values, the surface of the sorbent would be surrounded by hydronium ions which enhance the phenol interaction with binding site of the sorbent by greater attractive forces[19,20]. In presence of PEG as additive, the adsorption efficiency was found to be more than in case without PEG (figure 1).

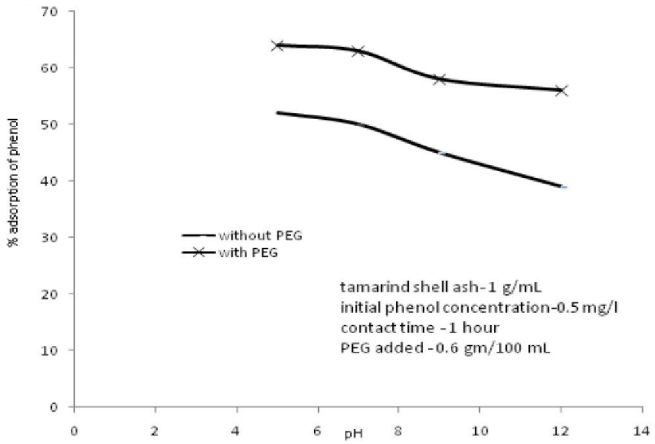

Figure 1 : Effect of pH on phenol adsorption with and without PEG

Effect of contact time

The equilibrium time required for the adsorption of phenol on tamarind shell ash was found to be 3 hours for system without PEG and 2.5 hours for the system with PEG. This indicates that the use of PEG as additive decreases the time required for the adsorption of phenol on tamarind shell ash (figure 2).

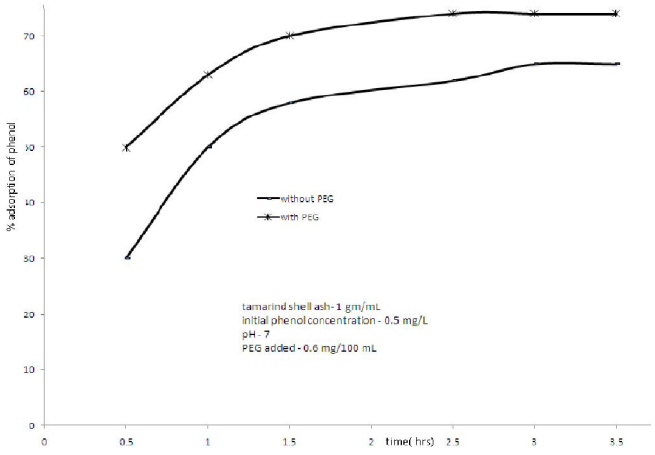

Figure 2 : Effect of contact time on phenol adsorption with and without PEG

Effect of adsorbent dosage

The efficiency of phenol adsorption using tamarind shell ash is found to increase with increase in adsorbent dosage for both the cases with and without PEG. In case of system without PEG, the optimum amount of adsorbent concentration for 100 mL of solution was found to be 3gm whereas for the system with PEG as additive, the optimum amount was 2gm (figure 3).

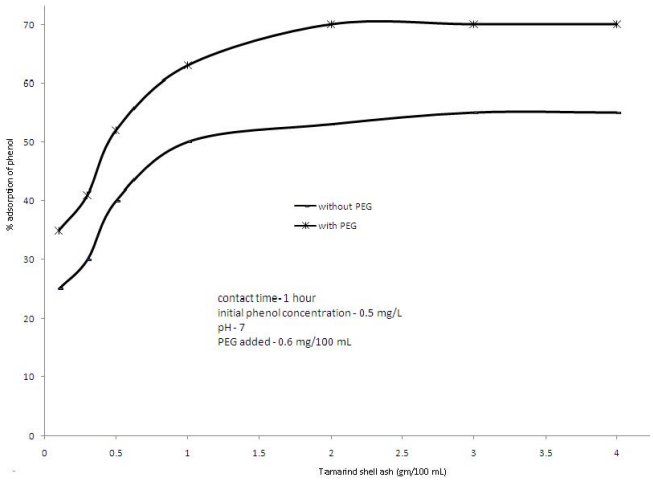

Figure 3 : Effect of adsorbent dose on phenol adsorption with and without PEG

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