REMOVAL OF PHENOL BY ADSORPTION

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Abstract- Adsorption is an effective method for the treatment of phenol. In this work, phenol was removed from the wastewater by adsorption process using activated carbon generated from the dates' stone. Effects of operating parameters like initial pH(3 and 9), temperature (20^{o}C and 50^{o}C), adsorbent dosage (0.1g and 0.2g) and agitation time (1h and 2h) were investigated. The initial phenol concentration of 30 mg/L was reduced to the 0.3 mg/L corresponding to the removal efficiency of 99% at pH 3, 50^{o}C with 0.2g activated carbon. Considering the results, it can be said that adsorption of phenol from wastewater using activated carbon generated from dates' stone can be used as an effective treatment method.

Index Terms- Activated carbon, Adsorption, Phenol, Wastewater

I. INTRODUCTION

Water is a foundation of life and many people are struggling with the lack of clean and fresh water. Environmental pollution is increasing due to the industrial enlargement [1]. Phenols and its derivatives are being used extensively in industries with the different application.

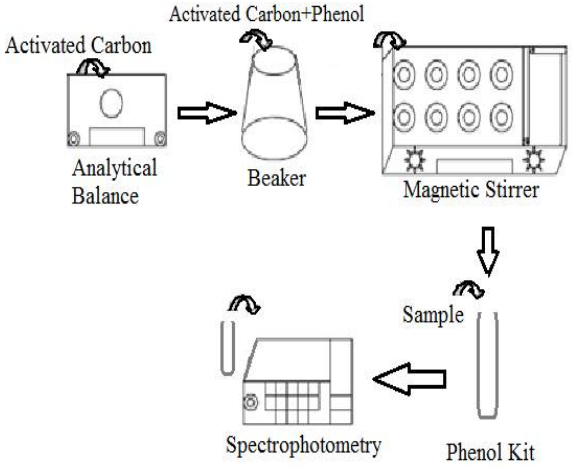
As an example industries like textile, plastics, paper, wood, dye, leather, steel, petroleum and many others use phenol [2-4]. Phenols are regarded as priority pollutants because of their high toxicity, harmful to organisms, carcinogenic, mutagenic [5, 6]. So phenol treatment from wastewater is required before discharge natural water. Some of the potential treatment methods for phenol wastewater are adsorption [7-9], biological treatment [10], reverse osmosis and oxidation [6]. Removal of phenol using activated carbon generated from different materials has been studied. Removal of phenol using activated carbon from Fox nutshell [11], using microwave-assisted activated carbons from wood chips [12] and using PET-based activated carbons [13] was investigated. Dates' stone was used for the removal of Cr (VI) [14] and also for the removal of phenol.

The studies on treatment of phenol from wastewater by adsorption with dates' stone are few in the literature. Dynamic simulation of phenol adsorption within the packed bed column filled with activated carbon derived from dates' stones was studied by Anisuzzaman et.al. [15]. Alhamed [16] researched removal of phenol using activated carbon from dates' stones. He investigated the effect of activated carbon particle sizes (1.47, 0.8, 0.45 and 0.225mm) and initial concentration of phenol (200 and 400 ppm). In this study, removal of phenol by adsorption with active carbon from dates' stone was investigated. The main objective was to investigate the effectiveness of adsorption method for the removal of phenol. Effects of initial pH of adsorbate solution, adsorbent dosage, temperature and agitation time were studied.

II. EXPERIMENTAL PROCEDURE

The stock solution of phenol was prepared in the laboratory using analytical reagent grade phenol supplied by Sigma-Aldrich by dissolving 30 mg phenol in one litter water. The solution was prepared using deionized water. The pH of the sample was adjusted to the desired value using H_2SO_4 or NaOH. Reagents used in the study were of analytical grade quality.

Activated carbon was obtained from the Department of Chemical Engineering, Anadolu University, Turkey. It was prepared from the pyrolysis of the dates' stones.



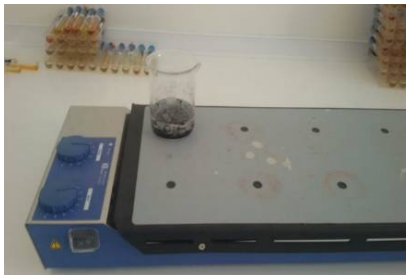


Figure 1. Experimental set-up

Batch adsorption studies were carried out using the batch contact method. 0.1 /0.2 g of activated carbon

was added into a 30 mL of phenol solution at room temperature and constant pH. It was agitated using magnetic stirrer during 2 h to attain equilibrium. The experimental setup was shown in Figure 1. After the contact time, solutions were settled and then the supernatant was analyzed for determining phenol concentration. Phenol concentrations were determined with phenol kits (concentration range 0.05-5.00mg/L, Hach Lange) by measuring absorbance at wavelength of 476 nm, using Hach Lange DR 2800 spectrophotometry.

The phenol removal efficiency (RE %) was calculated using following equation:

$RE\ \% = [(C_o\text{-}C)/C_o]x100$ (1)

C_o and C are the concentrations of phenol before and after subjecting to adsorption in (mg/L), respectively.

III. RESULTS AND DISCUSSION

Effect of pH

It has been confirmed that initial pH is a major important parameter for adsorption process [3]. The surface charge of the adsorbent and also ionization of phenol are effected by the solution pH.

The adsorption of phenol was studied at pH of 3 and 9 using different amount of adsorbent dose at the room temperature. The initial concentration of phenol was 30 mg/L and contact time was 2h. The effect of the initial pH on the phenol removal efficiency is shown in Fig. 2. As seen from Fig. 2 when the initial pH increases from 3 to 9, removal efficiency decreases from 98% to 94% for 0.2g adsorbent, from the 89.7% to 87.7%for 0.1g adsorbent. It is explained that phenol is dissociated and presented as phenolate ions ($C_6H_5O^-$)at the pH above its pKa (9.89) [17]. It can be also seen from the Fig.2 that the adsorbate dosage has no significant effect at low pH while it has effect at high pH.

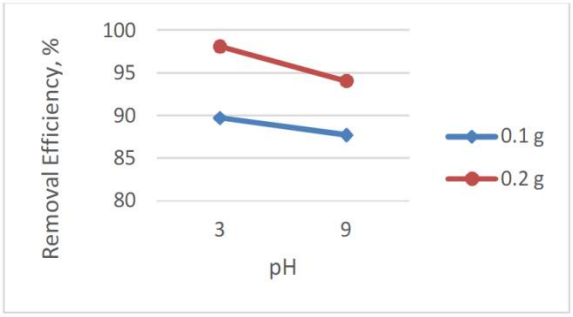


Figure 2.The effect of the pH on the removal efficiency

Effect of the adsorbent dosage

In order to study the effect of adsorbent dosage on the removal of phenol, experiments were carried out at initial concentration of 30 mg/L and room temperature with the contact time of 2h. Results are shown in Fig 3. As seen from the Fig. 3 that with increasing adsorbent dosage phenol removal efficiency increased. This increase can be due to the increase of active sites on the surface as a result of increased dosage. Similar result was found by the other researcher [3,6].

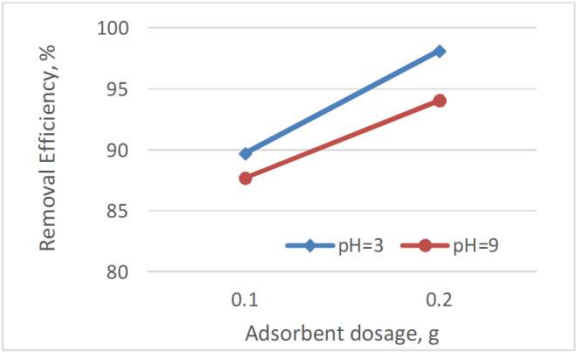


Figure 3. The effect of adsorbent dose on the removal efficiency of phenol.

Effect of the temperature

Influence of temperatures on the removal efficiency of phenol at 20 ^oC and 50^oC were investigated at pH 3. Effect of temperature at the different adsorbent dose on the removal efficiency of phenol is shown in Fig. 4. As can be seen from Fig. 4, with an increase in temperature, the phenol removal efficiency increased. This increase can be explained by the thermodynamically. Increasing temperature leads to increase an amount of adsorbed materials because of endothermic process [11].

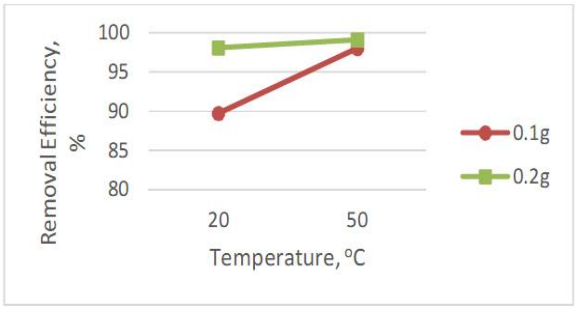


Figure 4. Effect of temperature on removal of phenol.

Effect of agitation time

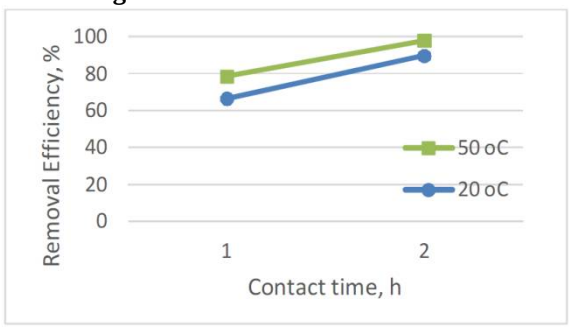


Figure 5. Effect of agitation time on removal of phenol.

Agitation time has the vital role that effect the adsorption efficiency. The effect of agitation time on removal efficiency of phenol was studied at pH 3 and 0.1g adsorbent dose. Influence of the agitation time on removal of phenol can be seen from Fig. 5 and it is clearly shown that adsorption efficiency increasing

with increasing agitation time. Agitation time is a significant parameter to specify the equilibrium time of adsorption process. Similar results were found in the literature [4].

CONCLUSION

In this study, phenol removal from wastewater by adsorption method using activated carbon produced from the dates' stone by pyrolysis was investigated. The effect of various operational parameters was investigated. Removal of phenol was increased with increasing adsorbent dosage, temperature and agitation time while it decreased with the increasing pH. The initial phenol concentration of 30 mg/L was reduced to the 0.3 mg/L corresponding to the removal efficiency of 99% at pH 3, 50oC with the 0.2g activated carbon. Considering the results, it can be said that adsorption of phenol from wastewater using activated carbon generated from dates' stone can be used as an effective treatment method.

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