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STUDIES ON ADSORPTION OF ACETIC ACID FROM AQUEOUS SOLUTION BY USING LEAVES OF MANILKARA ZAPOTA

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Abstract: One of the serious environmental problems is the existence of acetic acid in industrial wastewaters. Very small concentration change of acetic acid present in water can drastically change health problems of both humans and animals. Over the last decade researchers have turned their attention in cheaper adsorbents. This paper studies about the effective use of the leaves of Manilkara Zapota (commonly known as Sapota) as biosorbent for removal of acetic acid. The effects of various parameters such as time of contact, adsorbent dosage and initial concentration are done experimentally using a batch process. Amongst them acetic acid also plays a crucial role. So this research is carried out and the data has been evaluated using Freundlich adsorption isotherm model. This paper discusses about the effect of different parameters on adsorption such as adsorbent dosages, initial concentration and contact time at room temperature.
Keywords: adsorbent dosage, adsorption, initial concentration, Manilkara Zapota, Saponin

INTRODUCTION

Environmental pollution is one of the biggest problems faced in this present era. It has exponentially increased over the decade. One of the serious environmental problems is the existence of acetic acid in industrial wastewaters. Very small concentration change of acetic acid present in water can drastically change health problems of both humans and animals [1–3]. Acetic acid is considered a volatile organic compound. Acetic acid is used in the synthesis of vitamins, antibiotics, cosmetics, dyes, insecticides, photographic chemicals, plastics, pharmaceuticals and hormones [4–6].

Over the last decade researchers have turned their attention in cheaper adsorbents. There were many adsorbents used for removal of acetic acid. Few of them are alloy surface (Au/Pd), activated carbon obtained from maize cobs, coconut shell activated charcoal, date seeds activated carbon, activated carbon from rice husk and waste wood, activated carbon from Jatropha curcas seed coat and fruit pericarp [7–9].

The purpose of this study is to explore the application of activated carbon obtained from leaves of Manilkara Zapota. Sapodilla or sapota (Manilkara zapota) is commonly known as chiku in our country. It has a ripened fruit which is sweet, malty flavor. But its raw one is hard to touch as it contains high amounts of saponin. Compounds extracted from the leaves have anti–diabetic, antioxidant, anti–inflammatory, controls b.p and hypocholesterolemic properties (Figure 1).

This paper discusses about the effect of different parameters on adsorption such as adsorbent dosages, initial concentration and contact time at room temperature.

Figure 1: Sapota Leaves

The objectives of the study are:

- To check the suitability of leaves of Manilkara Zapota to remove Acetic acid from wastewater.
- To perform batch experiments for studying the effect of initial concentration, adsorbent dosage and contact time of acetic acid solution on the removal of acetic acid.
- To test the suitability of Freundlich isotherm for the adsorption of Acetic acid.

MATERIALS AND METHODS:

The adsorbate used is Acetic acid. The solvent used is distilled water. The adsorbent used is Activated carbon obtained from leaves of Manilkara Zapota.

— **Preparation of adsorbate**

Acetic acid solutions were prepared by diluting the requisite amount of acetic acid with water to obtain the adsorbate solutions of different initial concentrations. Fresh solutions were prepared daily before starting the experiments. We have taken 5, 10, 15, 20, 25 ml of these solutions to conduct our experiments [10–11].

— **Preparation of adsorbent**

The raw material used for preparation of the adsorbent was collected from MVGR College of Engineering (A), Vizianagram district, Andhra Pradesh, India.

The following procedure was adopted for adsorbent preparation [12]:

≡ The leaves of Manilkara Zapota were collected from campus of MVGR College of Engineering (A), Vizianagaram, Andhra Pradesh, India.

≡ These leaves were washed with normal tap water and dried in sun light until the weight of the leaves became constant.

≡ Then these leaves were powdered in ultra–fine grinders and screened through BSS sieves (100,150, 240 mesh), maintaining the average particle size in the range of 100 to 240 mesh.

≡ The adsorbent thus obtained is stored in closed (airtight) glass bottles for its subsequent use.

— **Experimental procedure**

This experiment was conducted in a batch process. Five glass conical flasks were used for the experiment. The five glass flasks were added with different concentrations of acetic acid solution. After that they were titrated against standardized sodium hydroxide of 3N. After that the samples of activated carbon (obtained from leaves of Manilkara Zapota) with identified weight were positioned into each of the flask. The flasks with acetic acid and activated carbon contents are thoroughly agitated in a shaker.

For equal mixing the shaker was kept at constant speed throughout the experiment. After that the sample was filtered using a filter paper. After that we added distilled water again to the filtrate as it was found to be in maroon red in color.

After that, it is titrated using the 3N standardized NaOH solution. The experiment was conducted under different parameters and the data so obtained was able to determine the adsorption capacity of the respective adsorbent [12–13].

The respective procedure is done with the change in initial concentrations, adsorbent dosage and time of contact.

RESULTS AND DISCUSSION

— **Effects of initial concentration**

The concentration of the active sites of the adsorbent plays an important role in attracting the Acetic acid from the solution. The effect of initial concentration on the rate of adsorption is shown in the Figure 2.

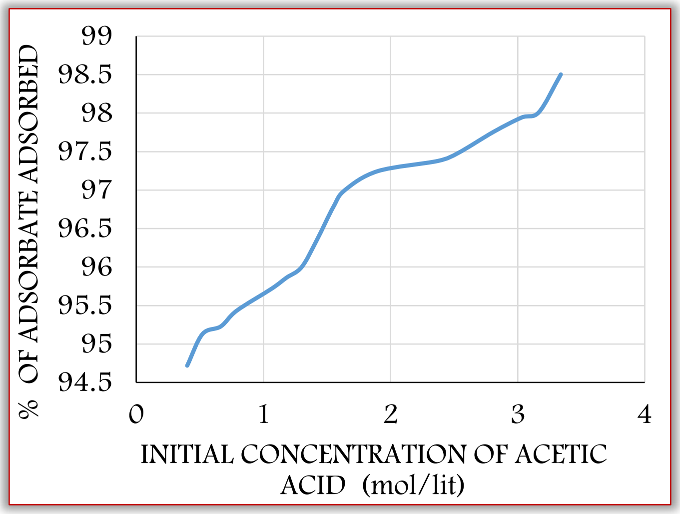

Figure 2: Effect of Initial Concentration on % of adsorbent adsorbed

It is also observed that % removal of acetic acid increases with the increase in the initial concentration. Rate of adsorption also increases with the increase in initial concentration as depicted in Figure 2.

— **Effects of adsorbent dosage**

The effect of % removal of adsorbate on adsorbent dosage is shown in the Figure 3. From this Figure it is observed that as adsorbent dosage increased, the % removal of acetic acid also increased.

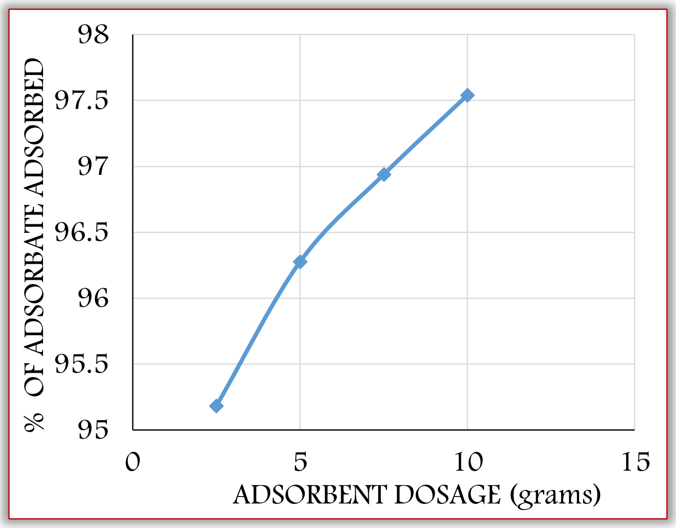

Figure 3: Effect of adsorption dosage on acetic acid adsorption

— **Effect of contact time**

In an adsorption experiment, contact time parameter plays a crucial role. Experiments were performed at three different times at a temperature of 28 to 30 °C. Figure 4 represents the variation of % of adsorbate adsorbed with change in the contact time.

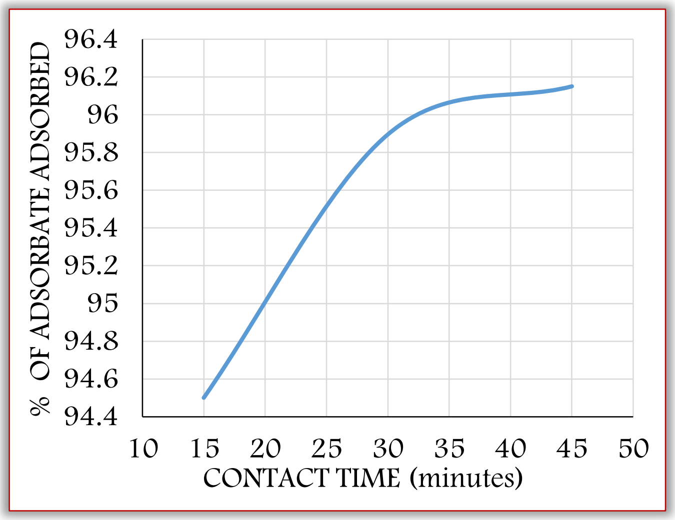

Figure 4: Effect of contact time on % of Adsorbate adsorbed

— **Freundlich Adsorption Isotherm**

The Freundlich isotherm can be written as:

$$\log qe = \log Kf + (1/n) \log Ce$$

where:

» Kf and n are characteristics of the adsorbate–adsorbent system, which identify the capacity of adsorption.

» 1/n is a function of the strength of the adsorbate for a given adsorbate–adsorbent system.

» Kf and n are obtained by fitting the present experimental data on qe and Ce for Cr(VI) in accordance with above Freundlich adsorption isotherm equation.

If n = 1 then partition between the 2 phases (solute in the solution and the solid adsorbent) are independent of the concentration.

1/n gives the slope of above equation.

If 1/n is > 1 (or n <1) indicates that the adsorption between adsorbent and solute is favorable [12].

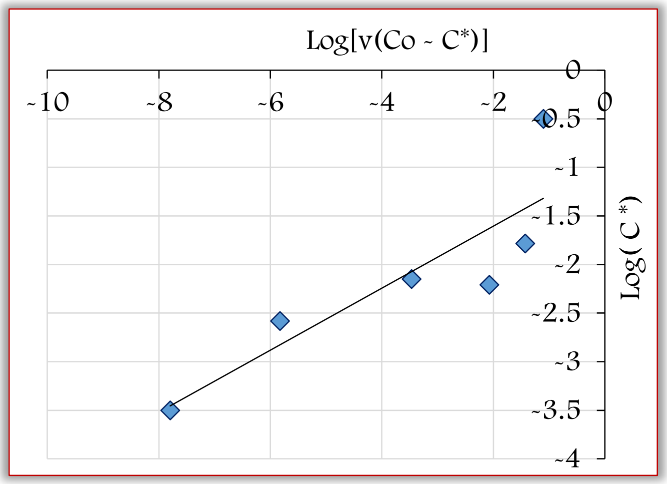

Figure 5: Freundlich Adsorption Isotherm

The equilibrium data for the removal of acetic acid by adsorption with the leaves of Manilkara Zapota at 30°C were verified using the Freundlich isotherms. Figure 5 confirms that adsorption for the current study logically follows the Freundlich adsorption pattern and 1st order kinetics.

CONCLUSIONS

The study shows that adsorption can be used as an efficient method for removal of pollutants from water and thus decontaminating it. However, this process is restricted due to the high cost of the traditional adsorbents like activated carbon. This study explored the potential of low cost adsorbent for its ability to adsorb the acetic acid for the marketable use because of its being widely available and efficient. The adsorption of acetic acid on activated carbon (obtained from leaves of Manilkara Zapota) from water was considered to investigate the adsorption potential of the respective adsorbent. The results showed that leaves of Manilkara Zapota can be used as a cheap, good and accepted adsorbent for the recovery of Acetic acid from the aqueous solutions.

The entire experiment was summarized and the results are jotted down as follows:

— The adsorption increases with an increase in adsorbent dosage.

— The experimental adsorption data logically follows the Freundlich adsorption isotherm.

— The % removal of acetic acid increases with the increase in initial concentration of acetic acid.

— This adsorbent could also replace the presently used adsorbents for the removal of acetic acid and can be categorized under low cost adsorbents.

— While carrying out the experiment, highest acetic acid adsorption of about 98.1% is achieved.

Acknowledgements:

The authors wish to gratefully acknowledge the support of the Management of MVGRCOE (A), Vizianagaram for carrying out the research work.

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ACTA TECHNICA CORVINIENSIS – Bulletin of Engineering
ISSN: 2067–3809