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Adsorption Study of Oxalic Acid Using Biosorbents

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***Abstract* – The adsorption of oxalic acid on powdered (PM) and sulphuric acid treated (SATM) material prepared from seeds of Polyalthia longifolia was carried out. The potential of these biosorbents have been investigated for the removal of oxalic acid from aqueous solution. The batch adsorption studies have been carried out at various initial concentration and temperature. The initial concentration of oxalic acid was varied from 0.105 to 0.535 gm eq L^{-1}. The comparison of the adsorption capacities and percent adsorption of these samples were performed to evaluate the potential of these biosorbents. Maximum adsorption was found to be 30.00 % at all temperatures for lower concentration using 2.0 g L^{-1} adsorbent dose. The experimental data have been evaluated using Freundlich and Langmuir isotherms.**

***Keywords* – Biosorbents, Oxalic Acid, Batch Study, Adsorption Isotherms.**

I. Introduction

Organic acids are found in industrial waste water, particularly from byproduct waste, during synthesis of different products. Oxalic acid is reported to be hazardous [1] . Patients suffering from primary hyperoxaluria show elevated plasma concentrations of oxalic acid. Ground and surface water pollution is mainly due to discharge of organic and inorganic pollutants. Most of the organic pollutants are from textile, pulp and paper, pharmaceutical, chemical and petrochemical industries. Organic pollutants undergo oxidation producing carboxylic acids as end products [2]. Carboxylic acids are mainly dicarboxylic acids such as oxalic acid and maleic acid [3]. Chia-Yuan C., investigated the adsorption studies of homogeneous series of dicarboxylic acid [4]. Kamal K. Jain , used flyash, a waste product from thermal power plants, as an adsorbent for the removal of oxalic acid[5]. The in vitro adsorption of oxalic acid into activated charcoal, a series of neutral and ion exchange resins and onto hydrous zirconium oxide has been investigated [6]. Investigation on the adsorption of maleic and oxalic acids onto activated carbons prepared from tamarind seeds was carried out by H. Foya et. al [7]. Activated carbons due to high specific area and tunable porosity are effective in removing pollutants. High cost of activated carbon results in development of alternatives having low cost. A large number of researchers have reported the use of low cost bisorbents for the removal of pollutants from waste water. Adsorption on biosorbents is due to the various functional groups present on the surface. Polyalthia longifolia is a garden tree generating large amount of seeds. These are not useful as animal feed stock and thus become a potential source of garden waste. It was therefore thought worthwhile to investigate the potentials of these seeds – treated and untreated- for various applications. Adsorbents have been prepared from these seeds by chemical treatment.

The present work investigates the use of prepared biosorbents for the removal of oxalic acid from aqueous solution.

II. Materials and Method

Air shade dried and pulverized seed material (PM) and Sulphuric Acid treated material (SATM). Stock solution of 0.5 N oxalic acid and 0.1N Na0H were prepared. Oxalic acid of various strength was prepared from 0.5 N oxalic acid. The initial concentration of oxalic acid was determined by titrating it with 0.1N Na0H. 50 mL solutions of different concentrations were taken in a dry conical (100 ml) containing accurately weighed (2.0 g L-1) biosorbents. The flasks were stoppered and kept in a water bath to attain the required temperature. The solutions were continuously stirred at 500 rpm for 30 min. to attain equilibrium. After filtration through Whatman filter paper, the residual concentrations in the solution at equilibrium were determined by titrating it with 0.1N Na0H solution volumetrically.

III. Results and Discussion

This part describes the details of the observations for the removal of oxalic acid using PM and SATM as adsorbents under different experimental conditions.

The adsorption of oxalic acid using biosorbents PM and SATM has been studied at various initial concentrations (C0 = 0.105, 0.215, 0.322, 0.437 and 0.535 gm eq L-1) at different temperatures (30 °C, 40°C, 50°C) keeping other parameters viz. contact time (30 minutes), adsorbent dose (2.0 g L-1) and pH (at natural pH of solution) constant. Adsorbent provides surface area and adsorption sites. A fixed mass of adsorbent can sorbs only a certain amount of oxalic acid and equilibrium is attained between solute concentration in the solution and on the surface of the sorbent.

The effect of initial concentration of oxalic acid and contact time on sorption efficiency of PM and SATM has been investigated by experiments carried out at various initial concentrations (C0 = 0.105, 0.215, 0.322, 0.437 and 0.535 gm eq L-1) at original pH of solution, with 2.0 g L-1 dose of PM and SATM at various temperatures .The results presented in (Table 1, 2, and 3), indicate that the uptake capacity (mg/g) decreases while removal efficiency increases with increase in concentration at constant temperature. During the adsorption, initially the oxalic acid molecules rapidly reach the boundary layer by mass transfer and then they slowly diffuse from the boundary layer film onto the adsorbent surface, as all the available external sites have been occupied and finally, they diffuse into porous structure of adsorbent.

A decrease in % removal of oxalic acid is recorded from 30.00 % to 2.94 % for PM and 32.78 % to 8.82% for SATM at 30 °C with increase in initial concentration (C0 = 0.105, 0.215, 0.322, 0.437 and 0.535 gm eq L-1) for 30 min. agitation time. This can be assigned to the fact that at low concentration, a large number of adsorption sites are available so that oxalic acid molecules get easily adsorbed on to surface of adsorbent, but at higher concentrations molecules are in large number as compared to available sites. It is observed that as initial concentration increases there is no much large difference in increase in adsorption capacity and decrease in % adsorption at given temperature. It is noticed that chemically treated material (SATM) is suitable at room temperature for the removal of oxalic acid. This signifies that room temperature is most suitable for binding of oxalic acid molecules on the surface of the adsorbent and heat must be liberated during sorption process. This is because the tendency of molecules to escape from the solid phase to bulk phase increases with temperature indicating desorption. As temperature increases the weakening of electrostatic force of attraction between the molecules and active sites on adsorbent decreases, resulting in the substantial reduction in removal efficiency. This is in keeping with Le Chatelier's principle which expects exothermic process to be favored at low temperature, and is true for physisorption.

It is observed that chemically treated biosorbent has greater efficiency as compared to untreated material for the removal of oxalic acid. Chemical treatment may provides functional groups on the surface which causes greater adsorption.

To design a suitable reactor for waste water treatment, the knowledge about the equilibrium study is important. Several isotherm equations have been developed and employed for such analysis. The important isotherms; Freundlich and Langmuir and have been applied in this study.It is observed that the biosorption follows Langmuir isotherm.

IV. Tables and Figure

Table 1. Adsorption Capacity and % Adsorption of Oxalic Acid on PM and SATM at 30 °C

Initial Conc. of Oxalic Acid (g eq/L.)	Adsorption Capacity mg/g		% Adsorption	
	PM	SATM	PM	SATM
0.105	0.157	0.126	30.00	32.78
0.215	0.189	0.331	21.97	25.86
0.322	0.252	0.362	7.82	11.24
0.437	0.315	0.472	4.32	11.16
0.535	0.427	0.488	2.94	8.82

Table 2. Adsorption Capacity and % Adsorption of Oxalic Acid on PM and SATM at 40 °C

Initial Conc. of Oxalic Acid (g eq/L.)	Adsorption Capacity mg/g		% Adsorption	
	PM	SATM	PM	SATM
0.105	0.252	0.063	31.00	11.73
0.215	0.310	0.123	23.06	10.95
0.322	0.315	0.126	14.65	5.86
0.437	0.409	0.157	7.82	2.93
0.535	1.008	0.378	7.64	1.44

Table 3. Adsorption Capacity and % Adsorption of Oxalic Acid on PM and SATM at 50 °C

Initial Conc. of Oxalic Acid (g eq/L.)	Adsorption Capacity mg/g		% Adsorption	
	PM	SATM	PM	SATM
0.105	0.305	0.065	32.37	13.90
0.215	0.310	0.142	30.00	12.34
0.322	0.315	0.283	25.21	6.47
0.437	1.102	0.299	14.65	5.88
0.535	1.732	0.315	9.78	1.95

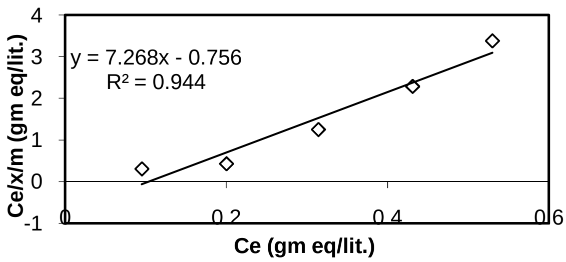

Fig. 1. Langmuir adsorption isotherm for oxalic acid on PM at 30 °C

V. Conclusion

The untreated and treated powdered material obtained from seeds of Polyalthia longifolia can be used for the removal of oxalic acid from waste water. Sorption technology can be a feasible alternative for removing oxalic acid from industrial effluents. There seems to be a good scope for the use of biosorbents in place of activated carbon as an adsorbent for oxalic acid removal.

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