

## Adsorption of Some Aliphatic Organic Acids from Aqueous Solutions on Activated Carbons

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**Summary:** Adsorption of a series of lower aliphatic and different unsaturated organic acids from their aqueous solutions on the surface of activated carbons, prepared from indigenous precursors like wood (*Acacia arabica*), rice husk (low ash) and lignitic coal (Lakhra) have been studied. It has been found that adsorption pattern follows Traube's rule and to a large extent depends upon porosity and chemical nature/surface of the adsorbent. It has further been established that the degree of adsorption of a particular acid depends upon the polarity of carboxylic group, the length of side chain as well as the nature or type of bonding. Freundlich and Langmuir plots were drawn and their constants calculated and elucidated. It has also been inferred that active carbons prepared from cellulosic precursors have proven better towards the acid adsorption as compared to that prepared from lignitic coal.

### Introduction

Active carbon has been used for many years in potable water treatment, in the pretreatment of water for its use in industry and in the safe disposal of different industrial effluents. Due to growing awareness of environmental pollution, great emphasis is now-a-days being laid on the use of this commodity as pollution control media specially in the removal of organics from liquid phase [1]. It is extensively used in the adsorption of both aliphatic and aromatic compounds. Due to non-polar nature of this adsorbent, non-polar solutes or adsorbates dissolved in a polar solvent like water will adsorb favourably on its surface than polar adsorbates. The adsorption of lower fatty acids from their solutions on activated carbon was earlier studied by Freundlich and Heller [2]. Kipling [3], observed the behaviour of aqueous solutions of weak and non-electrolytes during their adsorption on activated carbons. They found that the nature of the adsorbed phase is usually determined by the porosity and chemical nature of the adsorbent, the nature of the components of the solution, the concentration of the solution and the mutual solubility of the components [4].

The adsorption of aliphatic organic acids from their aqueous solutions by active carbon was earlier studied by many authors [5-7]. It was thereafter found that the adsorption increases

regularly as we ascend the homologous series. However, adsorption from the solution is a complex phenomenon depending on the adsorbate-solute and adsorbate-solvent interactions and also on the nature of interfacial region. The relationship among the adsorption phenomena, characteristic of adsorbates and physico-chemical nature of the surface of adsorbents has also been studied by Graham [8], Coughlin & Egara [9] and Nandi & Walker [10].

The present authors have been engaged in systematic R&D work on the development of technology for the preparation of active carbons, both powdered and granular, from the raw materials of vegetable and mineral origin and their detailed characterization [11-13]. This study has been undertaken to observe the behaviour of the three activated carbon samples prepared in these laboratories from different precursors, like *Acacia arabica*, low ash rice husk [14], and indigenous lignitic coal of Lakhra (Sindh), towards adsorption of the lower aliphatic and certain unsaturated organic acids from their aqueous solutions all along the homologous series. Langmuir and Freundlich isotherms have been drawn and their constants calculated from the relevant adsorption data. An attempt has been made to correlate these parameters with the other physical and chemical characteristics

reactions were carried out at this temperature for two hours. At the end of reaction, mixture was extracted with  $\text{CCl}_4$  and filtered. The filtrate was fractionally distilled. The expected product (substituted alkylated benzene) and initial compound that remained unused in the reaction (alkyl substituted phenyl ether) were separated.

reaction is selective. Alkylation was successful after the substitution of the hydroxyl group of phenol with ethereal alkyl group.

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Table: Yield, conversion, bps and  $^1\text{H-NMR}$  spectral data of compounds 2

Compd	lit bp ( $^{\circ}\text{C}$ ) <sup>a</sup>	bp ( $^{\circ}\text{C}$ )	yield (%)	conv (%) <sup>b</sup>	$^1\text{H-NMR}$ ( $\delta$ , $\text{CCl}_4$ )
2a	110.6	110	27	40	2.3 (s, 3H), 7.2 (s, 5H)
2b	138.3	138	28	50	2.2 (s, 6H); 7.0 (s, 4H)
2c	116.6	115	32	86	2.2 (s, 3H), 6.9-7.6 (m, 4H)
2d	162	163	31	50	2.3 (s, 3H), 6.9-7.6 (m, 4H)
2e	200.5	( <sup>c</sup> )	–	60	(Ar-OCH <sub>3</sub> ), 3.85, Ar-CH <sub>3</sub> , 2.34) <sup>c</sup>
2f	238.3	( <sup>c</sup> )	–	60	(Ar-OCH <sub>3</sub> ), 3.93, Ar-CH <sub>3</sub> , 2.35) <sup>c</sup>
2g	286	290	35	95	2.3(s, 3H), 3.1 (s, 2H), 7.1 (s, 9H)
2h	298	299	36	90	3.1 (s, 2H), 7.2 (broad, 9H).

a) CRS Handbook of Chemistry and Physics, 60 Ed.(1979-1980); b) Conversion percents were calculated from the ratio of integrals of -CH<sub>3</sub>(belong to product) signals to -OCH<sub>3</sub> (belong to reactant) signals of  $^1\text{H-NMR}$  spectra of reaction mixture, c) Not isolated, defined from the Ar-CH<sub>3</sub> signal in  $^1\text{H-NMR}$  spectrum of reaction mixture.

In this proposed method, phenolic hydroxyl groups were replaced with alkyl groups. The alkylation of aromatic rings have some problems such as formation of side products (e.g. polyalkylation and position isomerization) and inhibition of alkylation reaction at the presence of highly electron-withdrawing or highly electron releasing groups. In the method we proposed the

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