STUDIES ON SURFACE PROPERTIES OF ACTIVATED GRANULAR CARBON AND ACTIVATED CHARCOAL CLOTH

BY

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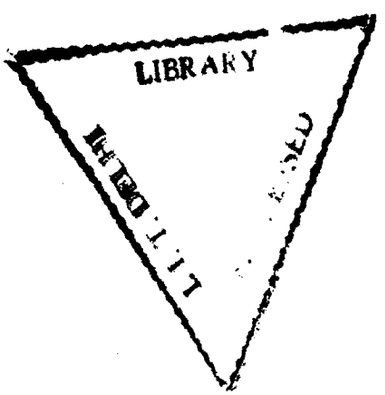

Guru Brahma Guru Vishnu Guru Devah Maheshwarah
Gururevah Param Brahma Tashmen Shree Guruweh Namah

The Guru (the teacher) is Brahma, the Guru is Vishnu,
the guru is the Lord Shiva, the Guru is verily the Supreme Brahman.
Salutations to that Guru !

CERTIFICATE

This is to certify that the thesis entitled "**STUDIES ON SURFACE PROPERTIES OF ACTIVATED GRANULAR CARBON AND ACTIVATED CHARCOAL CLOTH**" being submitted by **MR. BHABENDRA KUMAR PRADHAN** to the Indian Institute of Technology, Delhi for the award of the degree of **Doctor of Philosophy** in **Chemistry** is a record of bonafide research work carried out by him. Mr. Pradhan has worked under our guidance and supervision, and has fulfilled the requirements for the submission of this thesis which, to our knowledge, has reached the requisite standard.

The results contained in this dissertation have not been submitted in part or in full to any other University or Institute for the award of any degree or diploma.

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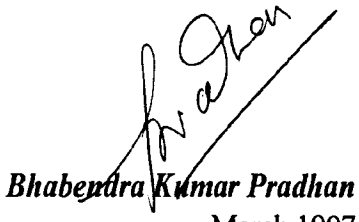

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ABSTRACT

This thesis comprises of the studies conducted on activated carbons *i.e.*, activated charcoal cloth and activated granular carbon in order to correlate the effect of surface oxygen complexes, porosity and pore size distribution of activated carbons with their applications in the purification of waste water treatment and adsorption of organics from vapour phase.

Activated carbons having different surface characteristics and porosity have been prepared from the original samples by oxidation with different oxidising agents like nitric acid, hydrogen peroxide, ammonium persulphate and heating the treated samples at higher temperature under the flow of dry nitrogen gas. The change in the composition of activated carbon by such treatments has been assessed by elemental analysis. The quantitative determination of the various surface functional groups is done by bulk chemical analysis. The detailed structure of the surface functional groups have been elucidated by FTIR spectroscopy. The surface morphology of various activated carbon samples have been observed by SEM and the effect of surface treatments on the morphology has been evaluated. The change in the structure of activated carbon samples by such treatments have been determined by X-ray diffraction studies.

The nitrogen adsorption isotherms of the activated samples have been constructed to study the effect of surface functional groups on the porosity and pore size distribution of activated carbon samples. The effect of various surface treatments on the shape of the isotherms along with different parameters like micropore volume, specific surface area and

the pore diameter obtained by the analysis of the isotherms by methods like BET, α_s, t-plot and Dubinin-Radushkevich are discussed. All nitrogen adsorption isotherms of activated carbon samples can generally be categorised to the Type I in the BDDT classification even though their shape varies significantly from one adsorbent to another and in a few cases, the isotherms show hystersis loop of H_4. These loops are explained on the basis of model proposed that these arise due to the presence microporosity. The micropore size distribution has been estimated from the method proposed by Roberts. The correlation between surface oxygen content and surface area has also been described.

In order to have a better idea about the porosity and pore size distribution of activated carbon and to study its molecular sieve effect, adsorption of three vapours with varying molecular size, shape and polarity *viz.* benzene, methanol, ethanol have been studied. Some adsorption isotherms of vapours on activated carbon samples shows hystersis loops and these extend down to a lower P/P^o value than that of nitrogen isotherms. This phenomenon is believed to be due to the rearrangement of adsorbate molecules inside the mesopores influenced by their surface functional groups. The effect of surface oxygen on the extent of adsorption capacity of oxidised samples is lesser than that of heat treated sample irrespective of the polarity and other chemical nature of the adsorbate molecules. The adsorption capacity of granular activated carbon is more than that of activated charcoal cloth. It is presumed that the porosity of the adsorbate and not its chemical structure alone is the predominant factor determining the adsorption capacity of vapours. The monolayer adsorption capacity of these vapours and the micropore volume of the samples are calculated by BET and Dubinin-Radushkevich methods.

Adsorption of phenolic compounds from aqueous solution on activated carbons at 300 K has been studied. The adsorption capacity of the activated carbons depend on the surface area, the porosity of the carbon and solubility of the phenolic compounds. The relative affinity of the phenolic compounds towards the surface of carbon is related to the electron donor-acceptor complexes formed between the basic sites on the surface of carbon and the aromatic ring of the phenol. The relative affinity of phenolic compounds for a given activated carbon increases in the following order

p-aminophenol < phenol < p-nitrophenol < p-chlorophenol

The effect of the change of solution pH on the adsorption of the above-mentioned compounds clearly shows that the adsorption capacity of activated carbon depends on the pH of the respective phenolic compound solution.

Adsorption of chromium Cr(III) and Cr(VI) on activated carbons from aqueous solution on activated carbons has also been studied. The adsorption capacity of activated carbons depends on the surface oxygen complexes of activated carbons. Adsorption of both Cr(III) and Cr(VI) is enhanced by the presence of surface oxygen complexes of acid type on activated carbon. The adsorption capacity of activated charcoal cloth is higher than that of granular activated carbon and also the adsorption capacity of oxidised activated carbon is more than that of the degassed one.

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