*Research Article*

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# Kinetic study of adsorption methylene blue dye from aqueous solutions using activated carbon from starch

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ABSTRACT

In this article efficiency of activated carbon as a potent adsorbent of cationic dyes present in waste water was studied in this research. Activated carbon (AC) from starch was used to adsorb methylene blue (MB) from an aqueous solution. Various parameters such as adsorbent concentration, temperature, initial dye concentration, contact time, and pH were investigated and the optimum parameters were determined based on the experimental outcomes. The extent of methylene blue removal increased with the increased in contact time, adsorbent mass, solution pH and amount of adsorbent used. Thermodynamic parameters like the Gibbs free energy (ΔG°), enthalpy (ΔH°), and entropy (ΔS°) were also determined and they showed that the adsorption process was feasible, spontaneous, and exothermic in the temperature range of 293–333 K. The experimental equilibrium data were analyzed using the isotherms of Langmuir, Freundlich, and Tempkin. Two simplified kinetic models including pseudo-first-order and pseudo-second-order equation were selected to follow the adsorption processes.

## 1. Introduction

Dyes have long been used in the dyeing, paper industries, printing, textiles, plastics, leather, cosmetics, pharmaceuticals and agri-food industries, but the effluents discharged by these industries pose certain risks and problems environmental [01]. These industries have shown a significant increase in the use of synthetic dyes as a coloring material. Since dyes have a synthetic origin and complex aromatic molecular structures, they are inert and difficult to biodegrade when discharged into waste streams [02]. The removal of synthetic dyes is of great concern, since some dyes and their degradation products may be carcinogens and toxic and, consequently, their treatment cannot depend on biodegradation alone [03]. The Methylene blue has been studied because of its known strong adsorption onto solids, and it often serves as a model compound for removing organic contaminants and colored bodies from aqueous solutions [04]. Conventional wastewater treatments such as chemical coagulation, activated sludge, trickling filter, carbon adsorption and photo-degradation were used for the removal of dyes [05].

Many physicochemical methods have been tested, but only that of adsorption was considered to be superior to other techniques [06]. Adsorption process is a suitable technique for inorganic and organic pollutants removal from wastewater, because of the significant advantages like low-cost, availability, profitability, ease of operation, efficiency, and effectiveness than other techniques [07-09]. This technique is easy to operate and equally effective in the removal of toxic pollutants, even at low concentrations [10]. Adsorption is by nature a surface phenomenon, its performance being strongly related to the unique properties of specifically designed sorbent material. Adsorption process can be a physical adsorption which involve only relatively weak intermolecular forces, and chemisorptions which involve the formation of a chemical bond between the sorbate molecule and the surface of the adsorbent [11]. Activated carbons are the most popular adsorbents used for the removal of toxic substances from water and due to its high surface area, porous structure, high adsorption capacity, special surface reactivity, good