CHAPTER 2

LITERATURE REVIEW

Jalil *et al*. used calcined Lapindo volcanic mud (LVM) as an adsorbent to remove an anionic dye, methyl orange (MO), from an aqueous solution by the batch adsorption technique [31]. Various conditions were evaluated, including initial dye concentration, adsorbent dosage, contact time, solution pH, and temperature. The Freundlich and Langmuir models and equilibrium isotherms of the LVM were studied. The experimental data obtained with LVM fits best to the Langmuir isotherm model and exhibited a maximum adsorption capacity (q_{max}) of 333.3 mg g^{-1}. The results indicated that LVM adsorbed MO efficiently and could be utilized as a low-cost alternative adsorbent for the removal of anionic dyes in wastewater treatment.

De-oiled soya, which is a waste of soya oil industries, and bottom ash which is a waste of thermal power plants, have been used as effective adsorbents for recovery and removal of hazardous dye such as methyl orange from wastewater [13]. The effects of amount of dye and adsorbents, pH, sieve sizes were investigated. Adsorption of the dye over both the adsorbents was monitored through Langmuir and Freundlich adsorption isotherm models. In order to establish the practical utility of the developed process, attempts were made for the bulk removal of the dye through column operations. For the two columns saturation factors were found as 98.61 and

99.8%, respectively, for bottom ash and de-oiled soya with adsorption capacity of each adsorbent as 3.618 and 16.664 mg/g, respectively.

Liu *et al.* reported the adsorption of methyl orange onto ultrafine coal powder (UCP) and modified ultrafine coal powder (MUCP) from aqueous solution [32]. The influence of contact time, dosage, temperature, pH, and methyl orange concentration in the solution were investigated. The adsorption isotherms of methyl orange onto MUCP at 303, 313 and 323 K follow the Freundlich and Langmuir isotherm equation. The adsorption process is spontaneous and exothermic.

Karaca *et al.* studied the removal of cationic dye: methylene blue from aqueous solutions using a commercial activated carbon as an adsorbent [33]. Operating variables studied were pH, stirring speed, initial methylene blue concentration and temperature. Adsorption process was attained to the equilibrium within 5 min. The adsorbed amount methylene blue dye on activated carbon slightly changed with increasing pH, and temperature, indicating an endothermic process. The adsorption capacity of methylene blue did not significantly change with increasing stirring speed. The experimental data were analyzed by various isotherm models, and found that the isotherm data were reasonably well correlated by Langmuir isotherm. Adsorption measurements showed that the process was very fast and physical in nature.

The sorption of basic dyes: methylene blue and malachite green, and acid dyes: egacid orange and midlon black onto oxihumolite were studied by Pavel *et al* [34]. The sorption capacities were estimated from the parameters of the sorption isotherm. The factors influencing the sorption such as pH, the presence of inorganic

salts and surfactants were investigated. The sorbent oxihumolite was used without an additional pre-treatment except of grinding and a size classification by sieving. It was found that the maximum sorption capacities ranged from 0.070 mmol g^{-1} to 0.278 mmol g^{-1} and are comparable with the capacities of other sorbents suggested for the dye removal. The sorption capacities did not differ significantly for basic and acid dyes. The sorption of acid dyes decreased with increasing pH, whereas the sorption of basic dyes was only slightly affected by the pH value of the aqueous phase. Oxihumolite is recommended for the treatment of acid wastewaters because of its limited stability in alkaline aqueous solutions.

Mianowski *et al.* [35] measured the specific surface area determination of activated carbons by means of the low-temperature argon adsorption (the BET method) compared with the measurement of the surface area based on the adsorption of I_2 from the aqueous KI solution. It was proposed to recalculate the iodine adsorption number for the BET surface area.

Methylene blue and iodine adsorption onto an activated desert plant was studied by Bestani *et al.* [36]. The investigation aimed at identifying the effectiveness of a local desert plant characteristic of Southwest Algeria and known as Salsola vermiculata, which was pyrolyzed and treated chemically with a 50% zinc chloride solution, to remove methylene blue and iodine. The natural plant adsorption capacities were respectively 23 mg/g and 272 mg/g for methylene blue and iodine. This low-cost local plant may also prove useful for the removal of large organic molecules as well as potential inorganic contaminants.

Attia *et al.* [37] investigated the capacity of activated carbon in the removal of acid dyes. A commercial activated carbon (Prolabo) was subjected to thermal treatment at 400 and 600 ^{o}C for 2 h. Characterization of the parent, and heated products, was carried out by determining the N_2/77 K adsorption isotherms, FTIR spectra, acidic/basic sites, and adsorption of iodine, Acid Blue 74 (AB), Acid Red 73 (AR) and Acid Yellow 23 (AY) from aqueous solution. Thermal treatment resulted in some enhancement in the porosity characteristics (specific area and pore volume) particularly in micropores, although insignificant changes appear in the surface chemical properties.

Adsorption isotherms of I_2 and malachite green (MG) by rice husk-based porous carbons (RHCs) from aqueous medium were studied by Yupeng *et al.* [38]. Three samples of carbons prepared by NaOH-activation, three samples prepared by KOH-activation and two samples of commercial carbons have been studied. And the adsorption isotherms have been determined after modifying the carbon surfaces by oxidation with nitric acid and hydrogen peroxide and after degassing at 800 ˚C. The results have been found to follow the Freundlich adsorption isotherm. The adsorption capacity of I_2 on oxidation carbons has increased for hydrogen peroxide treatment and decreased for nitric acid, and that of MG is decreased. But the adsorption capacities of I_2 and MG increase on degassing. On the other hand, the adsorption of I_2 increases after modifying the carbon surfaces by HCl without oxidation. Suitable mechanisms have been proposed.