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To analyze the effectiveness of cattle dung ash as natural adsorbent for tertiary wastewater treatment

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ABSTRACT

The prevailing most widely used and convenient method in India for Wastewater treatment such as primary and secondary treatment by flocculants and coagulants as well as secondary treatment by using micro organisms and color removal by using activated Carbon. However this method is quite expensive. So the present study is about use of cow dung ash in the secondary treatment of wastewater to reduce the contaminants. Adsorption is performed at different pH of various industrial effluents will be analyzed before and after the treatment with Cow dung ash to find out the effect on effluents. These natural adsorbent is cheap, easily available and ecofriendly.

KEYWORDS adsorption, COD, wastewater treatment, cow dung ash

I. INTRODUCTION TO WASTEWATER CONTAMINANTS

Since the end of the last century a large amount of products, such as medicines, disinfectants, contrast media, laundry detergents, surfactants, pesticides, dyes, paints, preservatives, food additives, and personal care products, have been released by chemical and pharmaceutical industries threatening the environment and human health. Currently there is a growing awareness of the impact of these contaminants on groundwater, rivers, and lakes. Therefore the removal of emerging contaminants of concern is now as ever important in the production of safe drinking water and the environmentally responsible release of wastewater [1].

Wastewater from dyeing industry contains various contaminants such as color, acid, base and other substances. Color amongst these is the most obvious indicator of water pollution and it has high BOD and COD levels, solids, oils and possibly toxic organics including phenols from dyeing and finishing [2].

Tannery wastewater is a powerful pollutant. It can cause severe environmental problems related to its high chemical oxygen demand (COD) together with elevated chrome concentration and deep color content. The disposal of these wastes into the environment could be harmful since they reduce light penetration and have a derogatory effect on photosynthesis [3].

II. INTRODUCTION TO ADSORPTION PROCESS

Adsorption is a mass transfer process which involves the accumulation of substances at the interface of two phases, such as, liquid–liquid, gas–liquid, gas–solid, or liquid– solid interface. The substance being adsorbed is the adsorbate and the adsorbing material is termed the adsorbent. The properties of adsorbate and adsorbents are quite specific and depend upon their constituents. The constituents of adsorbents are mainly responsible for the removal of any particular pollutants from wastewater [4].

In a solid–liquid system adsorption results in the removal of solutes from solution and their accumulation at solid surface. The solute remaining in the solution reaches a dynamic equilibrium with that adsorbed on the solid phase. The amount Of adsorbate that can be taken up by an adsorbent as a function of both temperature and concentration of adsorbate, and the process, at constant temperature, can be described by an adsorption isotherm according to the general Eq. :

$$q_t = \frac{(C_0 - C_t)V}{m}$$

Where q_t (mg/g) is the amount of adsorbate per mass unit of adsorbent at time t, C_0 and C_t (mg/L) are the initial and at time t concentration of adsorbate, respectively, V is the volume of the solution (L), and m is the mass of adsorbent (g).

Among these the most used models to describe the process in water and wastewater applications were developed by (I)

Langmuir, (ii) Brunauer, Emmet, and Teller (BET), and (iii) Freundlich.

The Langmuir adsorption model is valid for single-layer adsorption, whereas the BET model represents isotherms reflecting apparent multilayer adsorption. So, when the limit of adsorption is a monolayer, the BET isotherms reduce to the Langmuir equation. Both equations are limited by the assumption of uniform energies of adsorption on the surface.

The Langmuir isotherm is described by the Eq. (2.2):

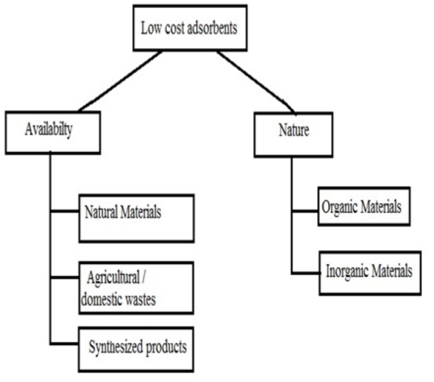
$$\frac{q_e}{q_m} = \frac{bCe}{1 + bCe}$$

Where qe (mg/g) is the amount of adsorbate per mass unit of adsorbent at equilibrium, Ce is the liquid-phase concentration of the adsorbate at equilibrium (mg/L), q_m is the maximum adsorption capacity (mg/g) and b is the Langmuir constant related to the energy of adsorption (L/mg) [1].

III. COWDUNG AS LOW COST ADSORBENT

Cow dung can be defined as the undigested residue of consumed food material being excreted by herbivorous bovine animal species. Cow dung can supply nutrients and energy required for microbial growth thereby resulting in the bioremediation of pollutants. Cow dung and its microorganisms have recently been tapped for the remediation of heavy metals like chromium, strontium and arsenic. Dry cow dung powder has recently been used as a source of adsorption for the removal of chromium from aqueous solution and achieved 73.8 % removal of chromium. Barot and Bagla (2012) detected biosorption of a radiotoxic strontium (90Sr) by dry cow dung powder. 350 mg of dry cowdung powder along with certain laboratory conditions such as pH 6, contact time of 10 min and agitation speed of 4000 rpm resulted in 85–90 % adsorption of strontium. Thus, dry cow dung powder may be preferred over other synthetic adsorbents because of their production cost, time and energy requirements. Cow dung is a cheap and economically viable resource which is easily available [5].

Figure I. Possible classification of low-cost adsorbents



IV. FACTORS AFFECTING ADSORPTION

The factors affecting the adsorption process are: (i) surface area, (ii) nature and initial concentration of adsorbate, (iii) solution pH, (iv) temperature, (v) interfering substances, and (vi) nature and dose of adsorbent.

Since adsorption is a surface phenomenon, the extent of adsorption is proportional to the specific surface area which is defined as that portion of the total surface area that is available for adsorption. The physicochemical nature of the adsorbent drastically affects both rate and capacity of adsorption. The solubility of the solute greatly influences the adsorption equilibrium.

The pH of the solution affects the extent of adsorption because the distribution of surface charge of the adsorbent can change (because of the composition of raw materials and the technique of activation) thus varying the extent of adsorption according to the adsorbate functional groups.

Another important parameter is the temperature. Adsorption reactions are normally exothermic; thus the extent of adsorption generally increases with decreasing temperature.

Finally, the adsorption can be affected by the concentration of organic and inorganic compounds. The adsorption process is strongly influenced by a mixture of many compounds which are typically present in water and wastewater [1].

V. EXPERIMENTAL

Cow dung ash an ecofriendly and low cost adsorbent was prepared by burning cow dung cakes in the muffle furnace at 500oC. Adsorption studies were performed by the batch technique using cow dung ash as an adsorbent without giving any pretreatment. A stock solution of the dyes with a concentration of 1000 mg/L was prepared and dilutions were made with distilled water to make different concentrations (10 - 100 mg/L) for the adsorption studies. A known weight of the adsorbent (1 g) was added to 50 mL of each of the above concentration in 100 mL measuring flasks. These were placed in an air thermostat for 24 hrs with occasional shaking. The samples were then filtered and analyzed using UV- spectrophotometer (Elico CL54D). The pH values of solutions were adjusted by addition of H2SO4 and NaOH [2].

VI. CONCLUSION

Cow dung ash can be used for the removal of dyes from the wastewater by adsorption. The present study shows that there is a decrease in percentage removal of dye per gram with the increase in the concentration of the dye. Change in pH values also showed a marked effect on the adsorption of dyes. As N Blue RGB was adsorbed maximum at pH 3.74, Green B showed maximum adsorption at pH 7.53 whereas for Eosin YWS it was best at 4.12. The three dyes obey the Langmuir and Freundlich isotherms and the pH value of the dye solution has a marked effect on the applicability of these isotherms. N Blue RGB at pH 8.01, Green B at pH 7.53 and Eosin YWS at pH 6.20 are best fitted to the Langmuir equation whereas these are best fitted to the Freundlich equation at pH 5.20, 9.68 and 6.20 respectively[2].

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