A Study on Removal of Methylene Blue Dye From Waste Water By Adsorption Technique Using Fly Ash Briquette

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***Abstract*— The utilization of economic, reused waste and eco-friendly adsorbent has been researched as an option process for substitution of presently unreasonable methodology for expelling dyes from waste water. In the present paper fly ash has been used as an adsorbent. Batch experiments have been done to observe the best adsorption by varying various parameters-varying initial dye concentration, varying flow rate and varying the bed height.**

Keywords— ***Activated carbon, Adsorption, waste water, low-cost adsorbent***

I. INTRODUCTION

Discharge of colored wastewater from various industries like textile, dying, food processing, leather, cosmetics, and paper industries and so on, is a major problem for environmental management particularly in developing countries [1]. The textile industry is one of the major sources, which discharges large amounts of industrial waste water. The textile industries produce effluents which are often sullied with destructive or noxious substances and these commercial ventures additionally assumes an essential part on the world economy and in our day by day life [2]. Approximately, 10,000 different dyes and pigments are in industrial use. Dyes are synthetic aromatic water soluble and dispersible organic compounds, which cause coloration of natural water bodies when released into the environment. The dyes used in the textile industries include several structural varieties such as acidic, reactive, basic, disperse, azo, diazo and metal complex dyes. The release of contaminated water into open streams is an incredible ecological challenge because of its medication for reuse as well as its poisonous quality to individuals and creatures by sullying underground water supplies [3].

Numerous dyes and their break down products may be dangerous for living life forms. It is hard to expel the dyes from the effluent, on the grounds that dyes are not easily degradable and are not expelled from wastewater by routine wastewater frameworks [4]. There are various methods to remove dyes from the water. Following figure Fig. 1 shows the different methods:

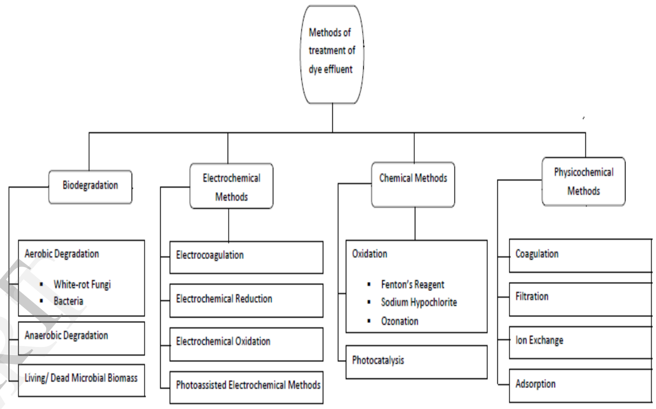

Fig. 1 Methods of dye effluent treatment

Among these methods, adsorption is a widely used for dye removal from wastewaters. Adsorption is a surface-based process of accumulation of the molecular species at the surface rather than in the bulk of the solid or liquid. The substance that adsorbs on the surface is called "Adsorbate", and the substance on which it adsorbs is called "Adsorbent". The conventional methods of removal of dye using adsorbents such as alum, ferric chloride, activated carbon, lime etc. are not considered economical [5]. The most generally utilized adsorbent for industrial provision is activated carbon due to its excellent adsorption capability. Yet the expense of the activated carbon is high and it builds with its quality. However, its use is limited due to high expenses, making this method unfavorable for the developing countries.

Abundant research and investigations have been carried out in different part of the world for the search of low cost adsorbents suitable to remove dyes from wastewater. Such adsorbents may include coffee ground, spent tea leaves, aerobic granules, wheat straw, pomelo (Citrus grandis) peel, pine-cone, pumpkin seed hull, ginger waste, skin almonds, and rice husk. But such adsorbents may be chemically activated and after the use, they will be discarded to our environment and may cause other environmental hazards.

The measure of coal waste (fly ash), discharged by production lines and thermal power plants has been expanding all through the world, and the disposal of the substantial measure of fly ash has turned into a genuine natural issue [2]. Nowadays a lot of scientists are utilizing fly ash as an adsorbent for the evacuation of different contaminations. Various studies reveal that the domestic waste water treatment is possible by fly ash created from thermal power plant. It is physically reasonable and financially feasible methodology. Appreciating the overall concern for environmental and management issues pertaining to fly ash, we have used fly ash as adsorbent in our experiment to treat the wastewater.

II. REVIEW OF RELATED WORK

The research literature in this domain is too enormous to be considered completely and analysed in depth. There have been a couple of endeavours in the literature pursuing use of low cost adsorbents for treatment of dye effluent.

M. Sarioglu et.al [4] through batch experiments the mechanism of Methylene Blue adsorption on bio solid (waste sludge) has been studied. The effects of various experimental parameters, such as pH (3-11), bio solid dosage (1-10 g l-1), contact time (5-1440 min) and initial dye concentration were investigated. Adsorption data was modelled using the Freundlich adsorption isotherm. The results showed that the dye removal increased with increase in the initial concentration of the dye and also increased in amount of bio solid used and initial pH. Further bio solid could be employed effective and low cost material for removal of dyes and colour from aqueous solution.

As mentioned by George Z. Kyzas et.al in [6], the de-colorization of dyeing wastewater using polymeric absorbents has been overviewed. They concluded that the treatment of industrial dyeing effluent that contains the large number of organic dyes by adsorption process, using easily available low-cost adsorbents, is an interesting alternative to the traditionally available aqueous waste processing techniques and De-colourization is a result of two mechanisms (adsorption and ion exchange) and is influenced by many factors including dye/adsorbent interaction; adsorbents surface area, particle size, temperature, pH and contact time.

Atul Kumar et.al [7] studied the comparison for the treatment methods of textile dye effluents. In the present paper various methods of treatment of textile effluent have been studied and discussed to find out effective treatment of textile effluents. In present years colour effluents is treated by so many techniques like Chemical oxidation, Ozonation, Ion exchange process, Electrochemical process, Electrolytic precipitation, Foam fractionation, membrane filtration, photo catalytic degradation, Adsorption. From the study it has been found that no single method is sufficient to control the water pollution by textile effluents, however all the above mentioned methods minimize the percentage of colour and other parameters in textile effluents. Out of which adsorption process has been found to be more effective method for treating dye-containing textile effluents economically.

Pooja V Shrivastava et.al explains in [8] that wastewater is treated in plants to remove undesirable components which include both organic and inorganic matters and soluble and insoluble materials. Experimental investigations have been made for color removal of textile waste water containing dyes using waste material from sugar cane industry. Adsorption of a basic dye, Methylene Blue (MB), from aqueous solution onto baggase (waste material from sugar cane) has been investigated. The parameters of the experiments include initial concentration of dye, adsorbent amount temperature and adsorption time.

Wong Y.C et.al [9] represented the use different forms of coconut fiber as absorbent in removal of methylene blue and malachite green dye. Coconut fibres were grounded and sieved into the size of 150 μm granular form and filament form of uniform size 2.0 cm for absorption test of methylene blue and malachite green dye in single dye solution. As a result, granular form of coconuts have higher percentage removal dye of methyelene blue and malachite green blue which is 98.3% and 99.0%. This study shows a major approach of turning the agricultural waste to an added value product which is absorbent for wastewater treatment especially in textile industries sector.

El-Maghraby A in [10] mentioned about removal of a basic dye from aqueous solution by adsorption using rice hulls. This work describes the use of grounded rice hull as adsorbent material. Aqueous solutions of various methylene blue dye concentrations (5-25 mg l-1) were shaken with certain amount of adsorbents to determine the adsorption capacity. Both treated and untreated rice hulls were used for methylene blue adsorption. Maximum dye was sequestered from the solution within 60-90 min after the beginning of every experiment. The adsorption capacity increased from 72 to 94 % with increasing the pH from 3 to 10.

Annaduraia G et.al [11], published paper on use of thermally treated waste biological sludge as dye absorbent. Examination was conducted for capacity of adsorbent required to recycle from microwave thermal treatment to remove a synthetic dye, Rhodamine 6G, from a water bath. Batch adsorption tests were conducted on this sludge at various pH values and solution temperatures. Adsorption capacities of sludge treated at various times were compared. An energy cost estimate demonstrates the feasibility of applying this process to dye removal. Equilibrium of dye adsorption was obtained in 30h.

Smith K.M et.al [12], reviewed the process of removal of dyes through Sewage sludge-based adsorbents. This research seeks to review the published research in this field: it covers the means of production, the characteristics and the potential applications of sewage sludge-based adsorbents (SBAs). The chemical activation utilizing alkali metal hydroxides is the most effective technique for producing high surface area SBAs.

III. MATERIALS AND METHODS

A. Fly Ash collection and adsorbent development

The briquetting of fly ash was done by making pallets of ½ inch diameter and 1 inch height. Pallets were made by mixing fly ash with water and bentonite in which amount of bentonite added was 1/10th of fly ash which act as a binder. These pallets were put in muffle furnace and heated up to 11000C at which pallets got strengthen and then allowed to cool at room temperature.

B. Apparatus

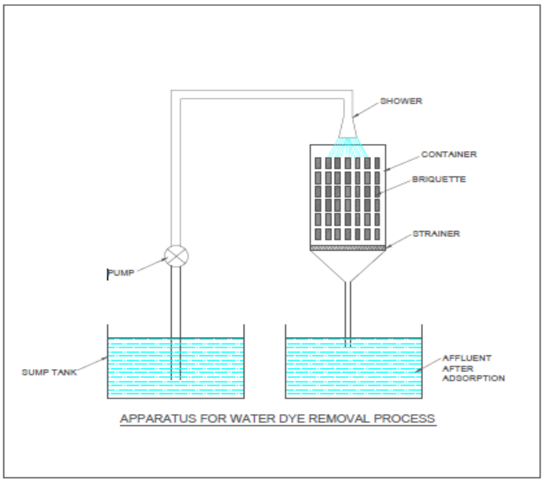

Fig. 2 Apparatus used

C. Experimental Procedure

Column experiments were conducted using glass tube of 10 inch height and 5 inch dia.

The experiments were conducted by varying three parameters

(i) Initial dye concentration
(ii) Flow rate
(iii) Bed height of fly ash pallets

The methylene blue solution of different concentration of dye were prepared and these samples were examined in UV-Visible spectrophotometer at 665 nm to check the transmittance in order to measure the colour of the solution

Distilled water was passed through the column in order to remove impurities from the adsorbent. Then the dye solution was fed to the column by peristaltic pump. The treated methylene blue dye samples were immediately collected from the exit at time intervals and measured for the remaining methylene blue to identify bed exhausting time. Experiments were continued until the column reached to initial dye concentration. All experiments were conducted at room temp (300C approx.).

Procedure was repeated by keeping the initial dye conc. Constant and varying the flow rate by adjusting the knob on pump and then by keeping constant initial dye conc. And flow rate but by varying the bed height of fly ash pallets.

IV. RESULTS AND DISCUSSION

A. Variable initial dye concentration(methylene blue)

The dye solution was prepared with different concentrations taking Flow rate 10 ml/s, bed height 6"as constant value. The graph Fig. 3shows the comparison of different concentration levels- 20mg/l, 15 mg/l, 10 mg/l, 5 mg/l

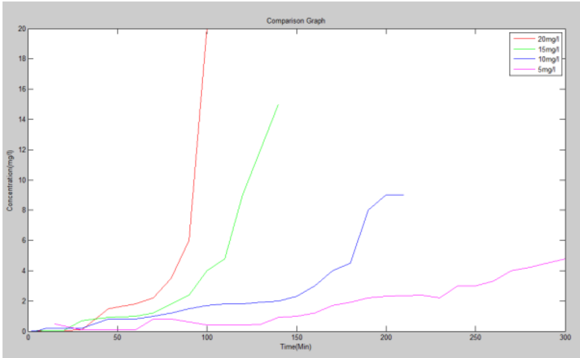

Fig.3 Variable initial dye conc.

B. Variable flow rate

The next experiment has been performed taking the initial dye concentration and bed height constant as 5mg/l and 6" respectively. Here, the flow rate is varied as 30 ml/s, 2 ml/s and 10 ml/s.

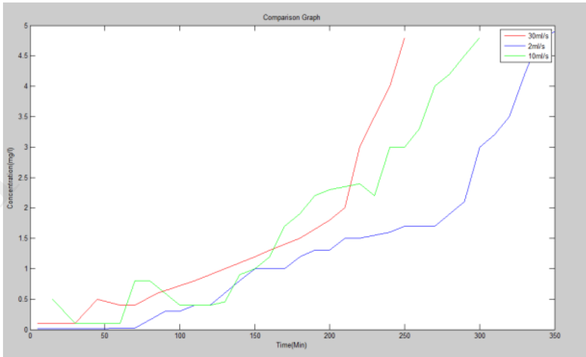

Fig.4 Variable flow rate

C. Variable Bed Height

In this experiment, the bed height has been varied as 8", 4", 6" keeping the flow rate and initial dye concentration constant at 10 ml/s and 5 mg/l respectively.

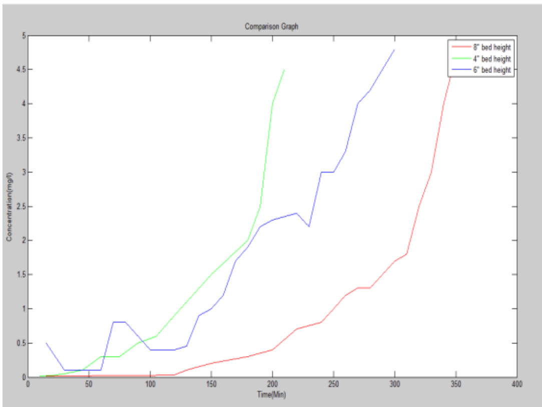

Fig. 5 Variable bed height

D. Calculation of LUB

Bed Height- 6 Inch
Flow Rate- 10 ml/s

Initial Dye Conc.	Tb	Ts	LUB
20 mg/l	20 min	100 min	4.8 inch
15 mg/l	30 min	140 min	4.71 inch
10 mg/l	45 min	210 min	4.71 inch
5 mg/l	135 min	300 min	3.3 inch

Initial dye Conc.-5 mg/l
Flow Rate-10 ml/s

Bed Height	Tb	Ts	LUB
8 “	215 min	360 min	3.3 inch
6”	135 min	300 min	3.3 inch
4”	90 min	210 min	2.28 inch

Initial dye conc.-5 mg/l
Bed Height-6 inches

Flow Rate	Tb	Ts	LUB
30 ml/s	85 min	250 min	3.96 inch
10 ml/s	135 min	300 min	3.3 inch
2 ml/s	140 min	350 min	3.6 inch

Here Tb indicates breakthrough time (which is time required to reach outlet conc. Of 0.5 mg/l)
Ts indicates Bed exhaustion time and LUB indicates Length of unused bed which is calculated by using formula

$$LUB=Z(Ts-Tb)/Ts$$

Where Z is Bed Height

V. CONCLUSIONS

Removal of dye, methylene blue (MB) from aqueous solutions by adsorption with fly ash has been experimentally determined. Various parameters have been taken into consideration. The outlet concentration is checked regularly and the breakthrough time Tb is achieved when the outlet concentration is 0.5 mg/l. It is decided at 0.5 mg/l because the BOD after that value gets more than the accepted BOD value. The various parameters and graphs are analyzed. From variable initial dye concentration comparison graph, Fig.3, it is analyzed that the effective adsorption is obtained at 5mg/l and as the initial concentration goes high, so the LUB value. The greatest LUB value is at Tb= 20 min. As the Tb is going more, the LUB is reducing. Flow rate comparison graph in Fig.4 shows that effective adsorption is achieved at 2 ml/s and as the flow rate decreases the adsorption is more effective. The greatest LUB is at 30ml/s and Tb= 85 min. as the Tb is increasing, the LUB is decreasing. The bed height comparison graph in Fig.5 shows that the effective adsorption is achieved at maximum bed height value. So as the bed height goes high, the adsorption effectiveness is more. The greatest LUB value is at 8” bed height and at maximum Tb. As the Tb goes down, the LUB also reduces. So they are directly proportional to each other. Fly ash as an adsorbent has been considered as an economic and physically reasonable one.

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