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COD Reduction and Decolourisation of Distillery Waste Water by Natural Adsorbent

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Abstract
The capacity of Sugarcane Bagasse by hydrochloric acid or caustic soda on the elimination of heavy metal from aqueous solution was investigated. The experimental work was carried out at room temperature and the influence of pH, contact time and Bagasse mass was determined. Sugarcane Bagasse was found better treated efficiency by alkaline than chloride solutions. Distilleries generate huge amount of acidic, recalcitrant and colored wastewaters with high organic content. The dark brown color of distillery wastewater is mainly due to the high molecular weight organic compounds called melanoidin. Activated carbon is a well-known adsorbent due to its extended surface area, microporus structure, high adsorption capacity and high degree of surface reactively. Among the physicochemical treatment methods, adsorption on activated carbon is widely employed for removal of color and specific organic pollutant. As contact time increase the adsorption of COD and decolorization also increase. The maximum adsorption is noticed at contact time of 3-3.5 hours. The percentage of COD reduction and decolorization as function of the pH for a mass of adsorbent made from bagasse of 10 g/L and a time of contact of two hours. The percentage of COD reduction and decolorization increases with the pH. The largest adsorption of each and every metal ion occurs at pH range between 5 and 6. The percentage of adsorption of distillery waste water color and, the mass of Bagasse varied from 2 to 20 g/L, the pH of the solution being maintained to 5 with a contact time of two hours.

Keywords – Natural Adsorbent, Sugarcane Bagasse Distillery spent wash, wastewater Treatment, Fenton reagent.

INTRODUCTION

Distilleries are now a day's one of the most polluting industries generating large volumes of high strength wastewater. These effluents are containing highly color, COD, BOD, TDS and other organic matter. To meet the environmental standards and regulations, treatment of effluent is must before letting out to the environment. Research has been carried out on the treatment of distilleries wastewater. Various conventional methods have been adopted such as biological flocculation, Nano filtration, activated carbons), bio electrochemical process, ozonation-based process electro oxidation, membrane-based Nano filtration and reverse osmosis. There are three major treatment option of treatment of process industry-

Adsorption
Activated carbon is a well-known adsorbent due to its extended surface area, microporous structures, high adsorption capacity and a high degree of surface reactivity. Sugarcane bagasse and charcoal use an adsorbent for decolorization of distillery spent wash. Activated carbon is one of the most widely used adsorbent for the removal of organic pollutants from wastewater, but the relatively high cost restricts its usage.

Membrane Treatment
Electro dialysis has been explored for desalting spent wash using cation anion exchange membrane gives 50 -60 % reduction in potassium content. Nanotechnology is effective for COD and Color removal, by using nanotechnology 100 % color is removed and about 97.1 % COD is removed. Nanotechnology is more effective but high capital cost and effect on human health and the environment. Electro dialysis and reverse osmosis process are less economical and pretreatment is required for reverse osmosis.

Oxidation Process
Different oxidation process is used for treatment of waste water, such as ozone, single hydrogen peroxide, Fenton's reagent and ozone combined with hydrogen peroxide. Ozone treatment minimizes upto 76 % of color, a combination of both ozone with a low concentration of hydrogen peroxide was able to increase the color removal efficiency up to 89%.

Electrocoagulation
Colour removal efficiency of electro-coagulation is decreases with increase in concentration of melanoidin; he also mentioned that electrodes consumption increases with increase in concentration of melanoidin. Efficiency of the chemical oxygen demand (COD) removal decreses with increases in pH, spacing between electrodes plays important role in decolorization of melanoidin, COD removal efficiency accelerate with increase in the distance between electrodes . Acidic condition is more favorable for treatment of distillery spent wash due to decreased production of chlorine or hypochlorite at higher pH.

Aerobic Treatment
Anaerobic treatment is the primary treatment to treat distillery spent wash but contain high concentration of COD, suspended solids,Cl, and BOD. Effluent also contain high ration of C: N which affect the fertility of the land as C: N ratio reduces mineral nutrients so cannot be disposal and discharge directly.
The followings are the various goals of waste water treatment

1. To control pollution
2. Prevention of infectious, chronic and hazardous diseases
3. Protecting environment
4. Reusing water for gardening and agriculture purpose.
5. Increase the water resources.

I. LITERATURE RIVIEWS

Sugarcane Bagasse in its natural form is a poor adsorbent of organic compound such as metal ion and sugar colorants. Bagasse must be modified physically and chemically to enhance its adsorptive properties towards organic molecules or metal ions, routinely found in water and wastewater. This is effectively accomplished by converting Bagasse to an activated carbon. Bagasse is reported as a suitable resource for preparation of activated carbon.[4].

Adsorption by commercially available powered activated carbons resulted in only 18% color removal; combined treatment using coagulation flocculation with polyelectrolyte followed by adsorption resulted in almost complete decolorization. Low cost adsorbents such as pyorchar (activated carbon both in granular and powdered form, manufactured from paper mill sludge) and bagasse flyash have also been studied for this application. [5].

II. MATERIALS AND METHODS

Adsorption is a process which leads to the equilibrium distribution of metal between the adsorbent and the solution. The determination of the quantity of metal adsorbed is based on the interpretation of the adsorption isotherms which translate the relation between the concentration of metal in solution and its adsorbed quantity.

A. Recent Studies on the development of low cost adsorbents

The development of low – cost adsorbents prepared from cheaper and readily available materials . Solid substance with large surface area, micro porous character and chemical nature of their surface have made them potential adsorbents for the removal of heavy metals from industrial waste water .Followings are the number of materials

1. leaf mould
2. Rice husk
3. Groundnut husk
4. Coconut husk and palm pressed fibers
5. Coconut shell
6. Coconut jute
7. Coconut tree sawdust
8. Cactus
9. Olive stone cake
10. Wool and pine needles
11. Bagasse.

B. Types of Adsorption

Physisorption

Physisorption or physical adsorption occurs as result of energy differences and/or electrical attractive weak forces such as the (Van der Waals forces), the adsorbate molecules (liquid contamination) are physically attached to the adsorbent molecules (solid surface).

The reversibility of physisorption is dependent on the attractive forces between adsorbent and adsorbate. If these forces are weak, desorption is readily effected. The heat of adsorption for physisorption is at most a few Kcal/mole and therefore this type of adsorption is stable only at temperature below 150°C.

Chemisorption

Chemisorption or chemical adsorption occurs when a chemical compound is produced by the reaction between the adsorbent and the adsorbed molecule. Unlike physisorption, this procedure is one molecule thick and irreversible because energy is released and reversed the process to form the new chemical compound at the surface of the adsorbent. Biological adsorption processes for heavy metal removal

1. Algal adsorption
2. Bacterial adsorption
3. Fungal and yeast adsorption
4. Adsorption of by algal biomass

C. Adsorption Isotherms Models

Adsorption models are frequently used to describe the equilibrium between metal ions in solution and metal ions adsorbed on the surface. The two most commonly used equilibrium isotherms-

1. Langmuir isotherm model
2. Freundlich isotherm model

Factors affecting the adsorption process

1. Effects of initial concentration and contact time on adsorption
2. Effect of solution pH on adsorption
3. Effect of temperature on adsorption

D. Preparation of Adsorbents

Adsorbent (Sugarcane bagasse) collected from Sugar industry.

1. Crush the sugar cane bagasse and make powder.
2. Firstly the adsorbent was washed with distilled water.
3. Dried it at room temperature to avoid the release of color by adsorbent into the aqueous solution.
4. The activation of adsorbent is carried out by treating it with concentrated Sulphuric acid (0.1N) and is kept in an oven maintained at a temperature range of 150ºC for 24hr.
5. Again is washed with distilled water to remove the free acid and put in to oven for removal of moisture and then adsorbent is passed from 500 micron mesh size and collected for experimental use.

III. EXPERIMENTAL ANALYSIS

A. **Characteristics of distillery waste water**

TABLE I DISTILLERY WASTE WATER TREATMENT

Parameter	**Value**
pH	3.67
Total Solids	66,980 mg/l
Total Dissolved Solids (TDS)	14,660 mg/l
Chemical Oxygen Demand (COD)	34000 mg/l

B. **Selected parameters**

COD and color are the selected parameters for this experiment. Adsorption of COD and color is effective by the help of the natural adsorbent made by the sugarcane bagasse.

C. **Observations for various Time of Intervals**

Effect of Time on % COD Reduction on distillery waste

After collecting the samples of waste water and giving treatment from all the three methods for every 15 minutes interval following are results obtained for all the parameters values. Following are the observation done for the effect of time on COD reduction and decolorization of waste water.

TABLE II EFFECT OF TIME ON % COD REDUCTION

Sr. No.	**Time(Min)**	**% Reduction COD**
01	15	23
02	30	32
03	45	48
04	60	59
05	75	63
06	90	68
07	105	68

Effect of Time on % Color Reduction on distillery waste

TABLE III EFFECT OF TIME ON % COLOR REDUCTION

Sr. No.	**Time(Min)**	**% Reduction Color**
01	15	25
02	30	35
03	45	50
04	60	60
05	75	64
06	90	72
07	105	72

After collecting the samples of waste water and giving treatment from all the three methods for every 15 minutes interval following are results obtained for all the parameters values. Here are the observations done for the effect of time on COD reduction and decolourisation of waste water.

Effect of pH on % COD Reduction on distillery waste

After collecting the samples of waste water and giving treatment from all the three methods for every 15 minutes interval following are results obtained for all the parameters values. Here are the observations done for the effect of pH on COD reduction and decolorization of waste water.

TABLE IV EFFECT OF pH ON COD REDUCTION

Sr. No.	pH	% Reduction COD
01	2	45
02	2.5	60
03	3.5	75
04	4	85
05	5.5	80
06	6.5	75
07	7.5	65

Effect of pH on % Colour Reduction on distillery waste

After collecting the samples of waste water and giving treatment from all the three methods for every 15 minutes interval following are results obtained for all the parameters values. Following are the observations done for the effect of pH on Color reduction and decolorization of waste water.

TABLE V EFFECT OF PH ON % COLOR REDUCTION

Sr. No.	pH	% Reduction Color
01	2	48
02	2.5	63
03	3.5	78
04	4	88
05	5.5	84
06	6.5	78
07	7.5	68

IV. RESULT AND DISCUSSION

Followings are the representation of Reduction of various parameters with time and various pH by results analysis from observation tables.

Reduction of COD vs Time

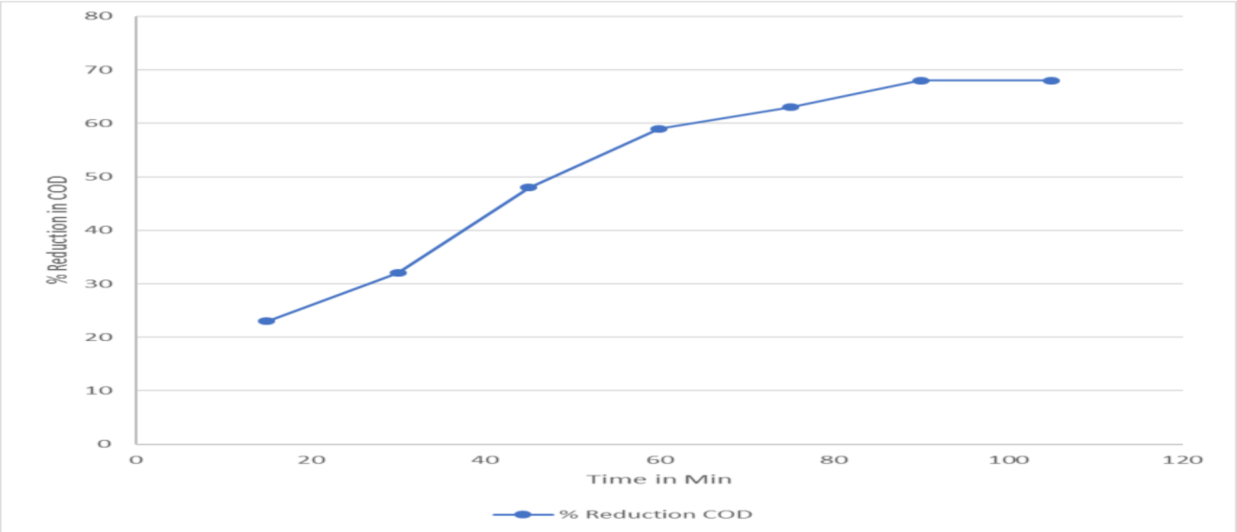

Fig.1 Reduction of COD vs pH

From the graph it was observed that rate of COD reduction is related with the increase of contact time. The maximum adsorption is noticed at contact time of 100-120 min.

Reduction of Color vs Time

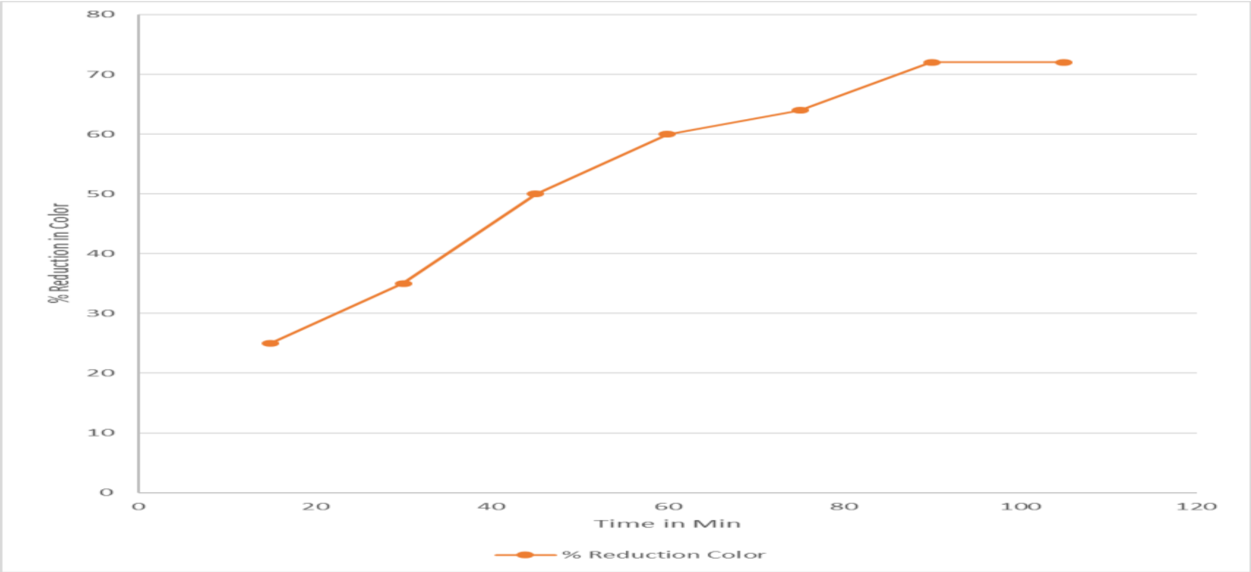

Fig.2 Reduction of Color vs pH

From above graph observed that rate of Color Reduction is related with the increase of contact time. The maximum adsorption is noticed at contact time of 100-120 min.

Reduction of COD vs Time

Graph shows the effect of pH on rate of COD reduction **.** The percentage of COD Reduction increases with the pH. The maximum adsorption occurs at pH range between 5 and 6.

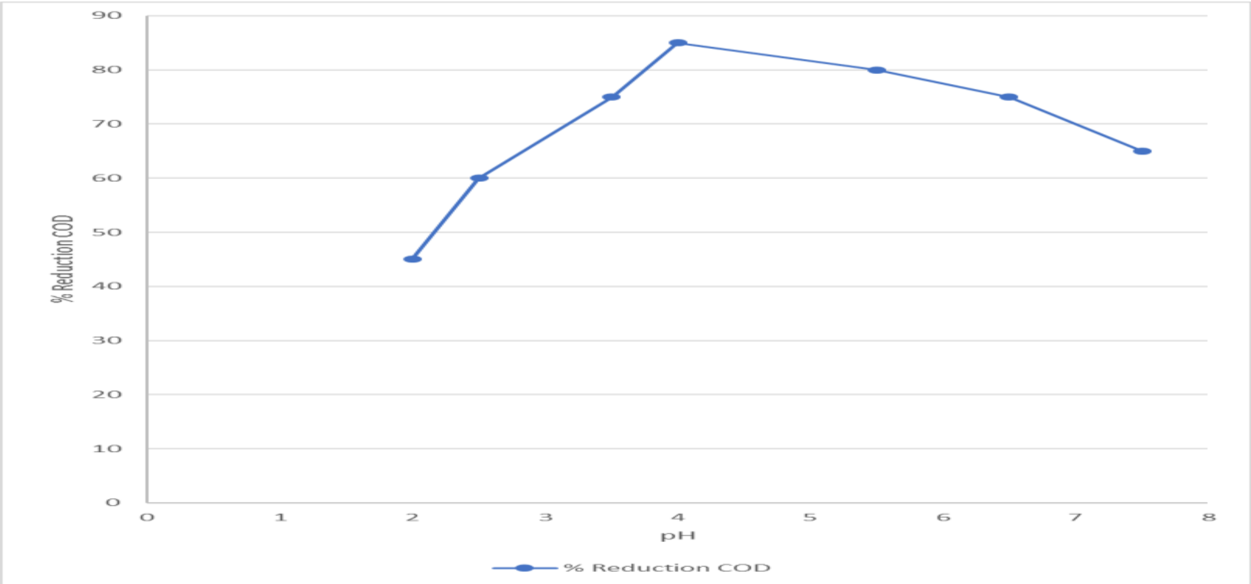

Fig.3 Reduction of COD vs pH

Reduction of Color vs Time

Graph shows the effect of pH on rate of Color reduction**.** The percentage of Color Reduction increases with the pH. The maximum adsorption occurs at pH range between 5 and 6.

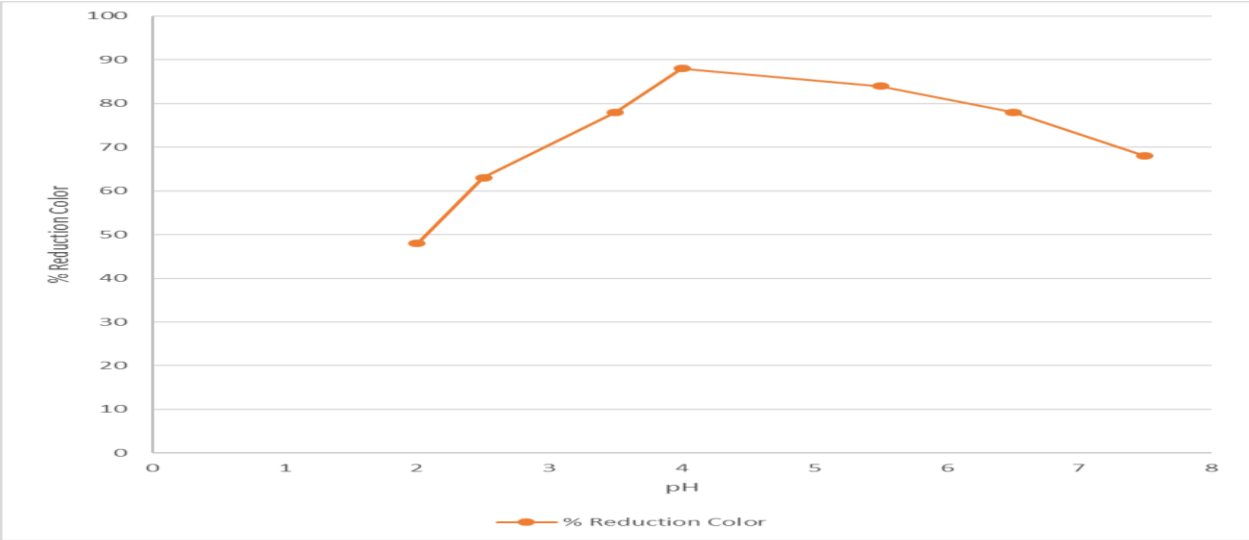

Fig.4 Reduction Color vs pH

A. Effect of Various Parameters on Rate of Adsorption

Effect of pH

The percentage of COD reduction and decolorization as function of the pH for a mass of adsorbent made from bagasse of 10 g/L and a time of contact of two hours. The percentage of COD reduction and decolorization increases with the pH. The maximum adsorption of each and every metal ion found at pH range between 5to 6.

Effect of contact time

Contact time on the adsorption of COD and Color from distillery waste water on the Sugarcane Bagasse was carried out at pH 5 with a Bagasse mass of 20 g/L while varying this parameter from 0.5 to 5 hours. It is observed that the efficiency of adsorption is related with the contact time. As contact time increase the adsorption of COD and decolorization also increase. The maximum adsorption is noticed at contact time of 3-3.5 hours.

Effect of mass of Bagasse on the adsorption

The percentage of adsorption of distillery waste water color and , the mass of Bagasse varied from 2 to 20 g/L, the pH of the solution being maintained to 5 with a contact time of two hours.

Effect of concentration of waste water on adsorption

In this experiment concentration vary between 5 – 20 ppm. As concentration increases % removal decrease at particular stage after that rate of adsorption constant

V. CONCLUSIONS

1. As per observation , it's clear that adsorbent produce from bagasse has good efficiency of COD and Color from the distillery waste water.
2. We study the removal of COD and Color at various pH , Contact Time and the Concentration optimum values of all parameters.
3. COD and Color can easily adsorb from waste water by natural material with low cost and high efficiency.
4. Adsorption is the efficient technique of removal of the COD and Color from the various types of waste water.
5. Cost of this type of process is lowest than the conventional method.

VI. FUTURE SCOPE AND BENEFITS

Future Scope

•Adsorption can be adopted to treat waste water.
• This Process improves the efficiency of conventional method.
• This can be used as an additional treatment to treat waste water.
• Adsorption process can make waste water for reusable as process water by removal of color and impurities from waste water.

Benefits:

• Capital cost significantly less than convectional technologies.
• Operating cost significantly less than convectional technologies.
• Low power requirements.
• Low maintenance.

• Minimal operator attention.
• Consistent and reliable results.

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