

INTRODUCTION

1. INTRODUCTION

“Water and air, the two essential fluids on which all life depends, have become global garbage cans”

- Jacques Yves Cousteau

The uses of chemicals are more due to increasing human population. As a result, a large number of harmful chemical compounds are released into the environment which leads to water pollution (Kaushik and Sharma, 2011). About 97% of water on the earth is in the ocean, 2% of water is frozen up in glaciers and ice caps and less than 1% of water on the earth is fresh. A tiny fraction of water exists as water vapour in the atmosphere (<http://oceanservice.noaa.gov/facts/oceanwater.html>).

Pollution

The term pollution is derived from Latin word “Pollure” which means to defile. Pollution is an undesirable change in the physical, chemical and biological characteristics of air, land and water which affects the human life and other living species (<http://in.answers.yahoo.com>).

Water Pollution

Water Pollution is caused due to the discharge of harmful chemicals and waste material into the water bodies by the industries, which makes the water unfit for basic needs and also endangers the aquatic life.

The presence of organic compounds in the polluted water helps the growth of algae and other weeds which consume more oxygen dissolved in the water. This process lowers the amount of oxygen and reduces the oxygen content needed for other aquatic living species ([http:// in.answers.yahoo.com](http://in.answers.yahoo.com)).

Synthetic dyes

A synthetic dye is a chemical substance used to give colour to the materials (**Balakrishnan *et al.*, 2008**). The industries like textile, paper and pulp, plastics, pharmaceutical, foodstuffs, cosmetics, paints, tanneries, detergents and leather use synthetic dyes to colour their products (**Mona Shouman *et al.*, 2012**).

There are over 10,000 dyes have been made with an annual production of 7×10^5 metric tons worldwide are commercially available (**Sunil Kumar and Arti Jain, 2010**).

In India, the dyeing industries come under the category of small- scale industries. These industries produce 3900 million litre of waste water per day. From this, about 12% of waste water comes from the textile and dyeing industries (**Piyush Malaviya *et al.*, 2012**).

Environmental effects of dyeing industrial effluents

- ✎ The water containing dyes have an inhibitory effect on photosynthesis, which endanger the life of aquatic living organisms. Dyes and their metabolites are carcinogenic, mutagenic and toxic in nature (**Sunil Kumar and Arti Jain, 2010**).
- ✎ Coloured dyes are aesthetic and also affects the amount of light entering into the water bodies, causing damage to living species in water (**Satish Patil *et al.*, 2011**).
- ✎ The presence of very small amount of dyes in water (less than 1 ppm) is highly visible and it remains in the surroundings for a very long period because of their excellent thermal and photo stability ([http:// textile learner. blog spot.in/ 2011/04](http://textilelearner.blogspot.in/2011/04)).
- ✎ A dye degradation product causes potential health hazards in humans and when discharged into the land surface, it will affect the soil fertile capacity (**Chhonkar, 2000**) and loss of agricultural production takes place (**Gupta and Ray, 2005**).
- ✎ Triphenyl Methane dyes and Azo dyes are nephrotoxic and hepatotoxic in nature.
- ✎ Environmental Protection Agency (EPA) says that it is necessary to remove the dyes from wastewater before they get discharged into the water bodies in order to save the life of aquatic living organisms (**Boeningo, 1994**).

Removal technique

The removal of dyes from wastewater is very difficult because they are not easily biodegradable and stable to the oxidizing agents. Some of the methods like flocculation, precipitation, coagulation and filtration are used to remove dyes, but they are expensive and produce large amount of sludge. Therefore, the most efficient and simplest method followed nowadays is the adsorption method (Narayana Saibaba *et al.*, 2011).

Adsorption

Adsorption technique is a surface phenomenon, where the solid surface in contact with a solution has a tendency to accumulate a surface layer of soluble molecules because of the imbalance of surface forces (Dalia Khalid Mahmoud *et al.*, 2012). Adsorption process is an efficient and economic process for removing dyes, pigments and other colourants, for its initial low- cost, simplicity, ease of operation (Garg *et al.*, 2003).

Adsorption using commercial activated carbon has been successfully followed to remove dyes from wastewater, but adsorption using commercial activated carbon is not economical due to its high cost. So many investigators have focused on using low- cost substances as adsorbents. Many agricultural waste materials like maize cobs, tamarind fruit shell, coir pith, saw dust and banana pith etc were used to prepare low- cost activated carbon (Theivarasu *et al.*, 2011). Hence in this present work, the removal of Crystal Violet dye from an aqueous solution and also from a dyeing industrial effluent have been studied using a low- cost adsorbent prepared from the pods of *Leucaena leucocephala* and commercial activated carbon.

Crystal Violet (CV) dye

- Crystal Violet dye is a monovalent cationic triphenyl methane dye having molecular formula $C_{25}H_{30}N_3Cl$.
- CV dye comes under the brightest class of soluble dyes and has a high tinctorial value (Rammel *et al.*, 2011).
- CV dye is used as an important ingredient for Gram's Method of classifying bacteria (Papita Das *et al.*, 2012).

Structure of Crystal Violet dye

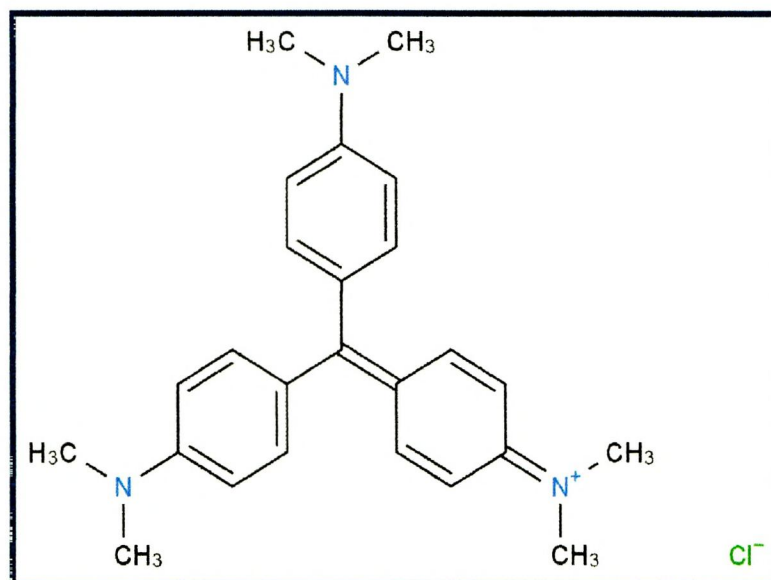


Figure- 1

Physical characteristics of Crystal Violet dye

Dye name	: Crystal Violet
Molecular formula	: $C_{25}H_{30}N_3Cl$
IUPAC Name	: Tris (4- (dimethylamino) phenyl) methylium chloride
Other names	: Gentian Violet, Methyl Violet 10B, Aniline Violet, Hexamethyl- p- rosaniline chloride.
CI Name	: Basic Violet 3
CI Number	: 42555
Molecular weight	: 407.979 g/mol
Appearance	: Solid
Colour	: At room temperature, the dye is green in colour. When dissolved in water, it has a blue- violet colour.
Melting point	: 205 ⁰ C, 478 K
λ_{max}	: 590 nm
Extinction co- efficient:	87, 000 $M^{-1} cm^{-1}$

3-D Structure of Crystal Violet dye

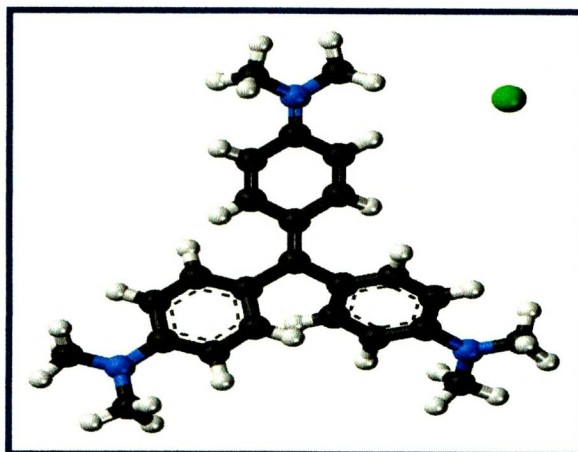


Figure-2

Merits of Crystal Violet (CV) dye

- Crystal Violet dye plays a major role in textile dyeing and paper printing. It is used as a dermatological agent and as a veterinary medicine. It can act as an additive to poultry feed to restrain the propagation of mold, intestinal parasites and fungus (**Gandhimathi *et al.*, 2012**).
- CV dye is also used for the dyeing of cotton, silk, wool, nylon and leather and act as a biological stain (**Rammel *et al.*, 2011**).
- CV dye is used to find the bloody finger prints and also used for latent printing (**Prasad Sudamalla *et al.*, 2012**).

Demerits of Crystal Violet (CV) dye

- In human beings, the CV dye cause eye irritation and so permanent injury to the cornea and conjunctiva takes place (**Papita Das *et al.*, 2012**).
- CV dye is harmful by ingestion and cause cancer (**Mona Shouman *et al.*, 2012**).
- CV dye cause mutagenic and mitotic poisoning in humans. The presence of CV dye in water gets readily absorbed into the fish tissues and endangers their life (**Prasad and Santhi, 2012**).
- In extreme cases, the CV dye affects the respiratory system and cause kidney failures and also it is highly toxic to mammalian cells (**Papita Das *et al.*, 2012**).

Therefore, the removal of Crystal Violet dye from the industrial effluents becomes environmentally important.

Objectives

- To prepare a low- cost and eco- friendly activated carbon from the pods of *Leucaene leucocephala*.
- To study the effect of variation of initial concentration of Crystal Violet dye solution from an aqueous solution.
- To find out the variation of adsorption of Crystal Violet dye solution with pH variation.
- To determine the effect of variation of adsorbent dosage on the removal of Crystal Violet dye from an aqueous solution.
- To determine the effect of variation of temperature on the removal of Crystal Violet dye solution.
- To interpret the results of the study in terms of
 - ✓ Lagergren rate equation
 - ✓ Elovich rate equation
 - ✓ Intraparticle diffusion rate equation
 - ✓ Langmuir adsorption isotherm
 - ✓ Freundlich adsorption isotherm
- To compare the adsorption efficiency of the low- cost adsorbent prepared from pods of *Leucaene leucocephala* with that of commercial activated carbon for the removal of Crystal Violet dye from aqueous solution and also from the dyeing industrial effluents containing Crystal Violet dye.