

# Study of Different Parameters on Removal of Methyl Violet Dye Using Coconut Shell Powder as an Adsorbent

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**Abstract:-** The dyeing business is one of the most water-intensive industries. The effluent from the dyeing industry comprises a variety of chemicals and coloring compounds, and it must be properly treated before being dumped into any water body. However, dye house effluents are extremely difficult to treat properly because to their considerable variability in composition. In most cases, a combination of multiple techniques of treatment is required to eliminate all toxins from the wastewater. As a result, adsorption became one of the most efficient ways for removing color from textile effluent. In this paper, an attempt is made to remove the colored ingredient Methyl Violet present in the colored solution by using a cheaply available adsorbent, coconut shell powder of specific size. In this work, the effect of variation in the parameters like dosage of adsorbent, temperature of the solution and initial concentration of the solution are studied and the adsorption removal efficiency is studied through an experimental approach. The adsorbent used is dry coconut shell of size -100 BSS mesh number. The dosage of adsorbent was varied from 10 gms to 50 gms and It was discovered that the adsorption removal efficiency was varying between 72.9 % to 89.6 %. The Additional factors that were examined are effect of temperature on adsorption and effect of initial concentration. The temperatures varying from 50<sup>0</sup>C to 70<sup>0</sup>C. It was determined that the adsorption removal effectiveness of Methyl Violet was found out to be decreasing from 64.6 % at 50<sup>0</sup>C to 47.9 % at 70<sup>0</sup>C. Adsorption efficiency was shown to decrease as temperature increased. The initial adsorbent concentration ranged from 30 to 70 ppm. It was shown that increasing the starting concentration enhanced the adsorption removal effectiveness from 85% to 88%. Based on the results of the preceding experiments, it is possible to infer that coconut shell powder is an efficient adsorbent for removing Methyl Violet from waste water, with an 89.6% removal rate.

**Keywords:-** Methyl Violet, Adsorption, Coconut Shell Powder, Dyes.

## I. INTRODUCTION

Many manufacturing workers have had skin ailments and respiratory issues as a result of dye toxicity and improper waste disposal. In particular, the discharge of dye-containing effluents into the aquatic environment is undesirable because of their color, emitted directly, and breakdown products are toxic, carcinogenic, or mutagenic to living forms, mostly due to carcinogens such as benzidine (Ackmez Mudhoo, 2020), naphthalene, among other aromatic chemicals. The textile sector is responsible for utilizing and manufacturing 1.3 million tons of dyes and pigments, the majority of which are manufactured synthetically (Boruah, 2020). The textile sector is among the world's largest, generating an amazing 60 billion kg of fabric annually and consuming up to 9 trillion gallons of water. 10-25% of the dyes used in textiles are eliminated after the process of dyeing, and 2-20% is released as aqueous effluents in various environmental components (Hiral Surti, 2019). Below **Figure-a** shows the various types of dyes.

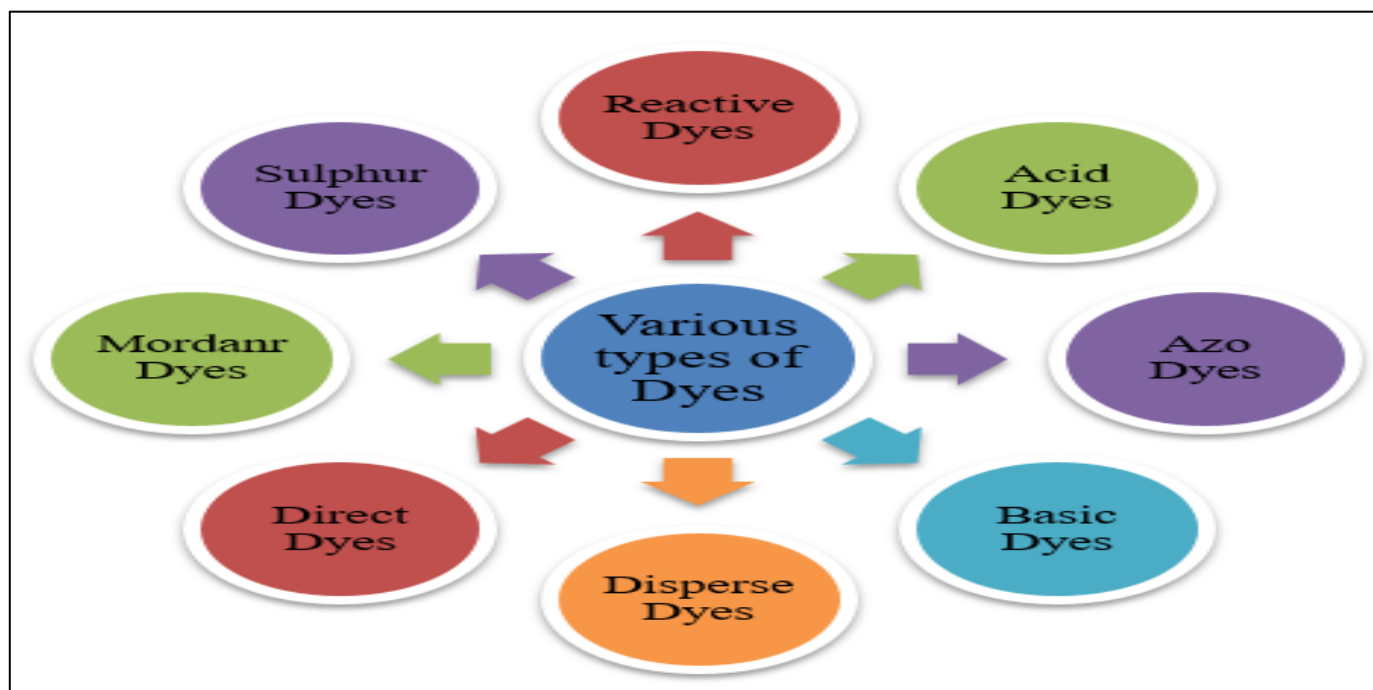


Fig 1: Shows the Various Types of Dyes

Textile, pharmaceutical, and cosmetic industries, as well as food, paper, leather, and paint industries, are all sources of dye house effluents. Azo dyes are the biggest category of colorants in terms of both quantity and manufacturing volume, accounting for 60-70% of all organic dyes produced globally (Rania Al-Tohamy, 2022). Market demand for dye and dye intermediates is expected to grow to 15,00,000 tons in 2014 (Kumar, 2014). At present, India contributes about 6~7% of the share in the global market (Narula, 2017). This research focuses on the removal of methyl violet color from wastewater using coconut shell powder as an adsorbent. Adsorption is an outermost phenomena. Since biblical times, solids have been employed to remove contaminants from both gaseous and liquid solutions. Adsorption refers to the preferential partitioning of gases or liquids over the outermost layer of a rigid substrate.

#### A. Statement of the Paper

The dyeing business ranks as one of the most water-intensive industries. The effluent from the dyeing industry comprises a variety of chemicals and coloring compounds, and it must be properly treated before being dumped into any water body. However, dye industry effluents are extremely difficult to treat properly because to their considerable variability in composition. To remove all pollutants from wastewater, a combination of treatment processes is often necessary. As a result, adsorption emerged as one of the most effective methods for removing color from textile effluent (Rania Al-Tohamy, 2022).

In this paper, an attempt is made to remove the colored ingredient present in the colored solution by using a cheaply available adsorbent, coconut shell powder of specific size. In this paper, the effect of variation in the parameters like Dosage of Adsorbent, Temperature and initial concentration of the solution on the variation of efficiency of adsorption of

colored ingredient present in a colored solution is studied through an experimental approach. The adsorbent utilized is dried coconut shell with a -100 BSS mesh number. The Investigation of the above experimental investigation provides information regarding.

The shift in optical density values of a colored solution following adsorption. The quantity of solute extracted from a colored solution per gram of adsorbent at various starting solution concentrations and constant adsorbent dose. The percentage adsorption effectiveness of a colored solution when varied amounts/doses of adsorbent are added to the same initial concentration. The percentage efficacy of colored solution adsorption at different temperatures with the same initial concentration (Hamed Biglari, 2016). The ideal amount of adsorbent used with no change in the adsorption efficacy of the colored solution. The time chosen for contacting the adsorbent with the colored solution. Challenges that developed throughout the experimental approach. The physical dimensions of the adsorbent utilized in the experiment.

## II. ENVIRONMENTAL PROBLEMS DUE TO THE DYE HOUSE EFFLUENTS

Many manufacturing workers have had skin ailments and respiratory issues as a result of dye toxicity and improper waste disposal. In addition to their color, dye-containing effluents should not be discharged into aquatic environments because their breakdown products are hazardous, carcinogenic, or mutagenic to living things. This is because they contain carcinogens like benzidine, naphthalene, and other aromatic compounds (Tjandra Setiadi, 2006).

**A. Air Pollution:**

The majority of processes in textile mills emit gases into the atmosphere. Gaseous emissions have been recognized as the second most serious environmental hazard in the textile sector (BABEL, 2013). Speculation about the volumes and types of air pollutants produced by textile activities has spread, although air emission statistics for textile manufacturing processes are often unavailable.

**B. Water Pollution:**

Water is used extensively in the textile sector's manufacturing processes, notably in plant coloring and finishing. Textile plant wastewater is considered the most polluting of any industrial sector (Chandrakant R. Holkar, 2016), both in terms of volume and effluent composition. Unfortunately, most dyes escape standard wastewater treatment methods and remain in the environment due to their strong resistance to light, temperature, water, detergents, chemicals, soap, and other characteristics such as bleach and sweat. due to their high thermal and light endurance, dyes may persist in the surroundings for a prolonged amount of a period of time preventing biodeterioration. The characteristics of water to be tested for pollution include (Omer, 2019);  $P^H$ , heat, alkaline levels, dissolved oxygen (DO), electric conductivity, total dissolved solids (TDS), total suspended solids (TSS), total hardness, chemical oxygen demand (COD), and total solids (TS).

**C. Various Environmental and Health Hazards:**

The most severe environmental problem with dyes is their ability to absorb and reflect sunlight into water. Light absorption lowers algae photosynthetic activity, which has a profound influence on the food chain (Yevhen Maltsev, 2021). Many colors and their byproducts from breakdown are carcinogenic, mutagenic, or dangerous to human health. Coloring agents are typically introduced into the environment via industrial effluents. The existence of extremely tiny amounts of water that are easily visible has a substantial influence on the quality and purity of waterways including rivers, lakes, and others, potentially causing harm to the ecosystem. The very toxic and mutagenic hues decrease the penetration of light and activity in photosynthesis (Rania Al-Tohamy, 2022), resulting in oxygen deprivation and restricting downstream benefits including recreation, drinking water, and irrigation.

**III. SOURCE OF DYE HOUSE EFFLUENTS:**

Until the middle of the nineteenth century, all colors used in textile products were obtained naturally, with the development of Mauvine by Perkin in 1856 (Tânia F. G. G. Cova, 2017). From that point, there has been no going back in the invention of synthesis dyes since they were affordable and available in a wide spectrum of hues, had high color fastness, and, most importantly, were simple to manufacture. The textile sector is responsible for utilizing and manufacturing 1.3 million metric tons of dyes and pigments, the large portion of which are manufactured synthetically. The textile sector is one of the world's largest, producing an astounding 60 billion kg of fabric per year and consuming up to 9 trillion gallons of water (Militky, 2020). 10 to 25% of the

dyes used in textiles fade away by the process of dyeing, with the remaining 2-20% discharged as aqueous effluents into different environmental components. Dye house effluents come from a variety of sectors, including textiles, drugs, cosmetics, food, pulp and paper, leather, and paint.

**A. Various Coloured Ingredient Used in Dye House Industries**

The Azo dyes are the most common type of colorant in terms of both quantity and production volume, accounting for 60 to 70 % of all the natural dyes produced globally. The market demand for dyes and dye intermediates is predicted to increase to 1500000 tons in 2014 (Kumar, 2014). At now, India accounts for around 6% of the worldwide market. Methylene blue, Malachite green, Rhodamine-B, Dyes, Astrazone blue, Maxillon red, Telon blue, Methyl Violet, Water-soluble dyes, Aniline blue, Congo red, Crystal violet, Naphthol blue black, Safranin-O, Basic dyes Basic blue: 3; Basic red: 22; Basic black: 9.

**IV. INTRODUCTION TO ADSORPTION**

Adsorption processes is a surface phenomenon. Since biblical times, solids have been used to remove impurities from gaseous and liquid solutions. Adsorption is the preferential separation of substances from the fluid-like over the outermost layer of a solid substrate (Slejko, 2016). From the early days of using bone char to decolorize sugar solutions and other foods to the later implementation of activated carbon to remove nerve gases from the battlefield, to today's thousands of applications, the adsorption phenomenon has validated to be a useful tool for purification and separation. Adsorption phenomena occur in most natural physical, biological, and chemical systems, and adsorption procedures involving solids such as activated carbon and synthetic resins are widely utilized in industrial applications as well as for water and waste-water treatment (Alexander E. Burakov, 2018). Adsorbents which are employed in water purification to eliminate organic contaminants (dyes), particularly ones that are not degradable or have a strong taste, color, or odor. Throughout adsorption, the solid a substance that becomes saturated or almost saturated with the adsorbate. Breaking down the adsorbed compounds regenerates the adsorbent, permitting it to be re-used while recovering the adsorbate (Despina A. Gkika, 2022).

Adsorption is the process of separating a material from one phase and accumulating or concentrating it on the surface of another. The adsorbent is the adsorbing phase, while the adsorbate or solute is the substance that is concentrated or adsorbed on its surface. Adsorption differs from absorption, which occurs when material moved from one phase to another (for example, liquid) interpenetrates the second phase to produce a "solution". The adsorption rate is defined as the rate at which the adsorbate is transported from the overall solution to the sites of adsorption via the particles (Alexander E. Burakov, 2018). This may be theoretically divided into the following sequential steps; Adsorbate diffusion occurs across a stationary solvent layer that surrounds each adsorbent then Diffusion through the macro-pore. Further to which Diffusion through tiny pores, and lastly Adsorption at the suitable

location. The fourth phase is supposed to occur much faster than the second. If the system is vigorously agitated, the exterior diffusion layer around the adsorbent will be very thin, giving minimal resistance to diffusion. As a result, it is plausible to assume that the principal resistance to adsorption occurs during pore diffusion. Adsorption is classified into two types based on the nature of the forces acting among the molecules of adsorbate and the adsorbent.

#### A. Physical Adsorption (Physisorption):

Physical adsorption occurs when the attraction between the adsorbate and the adsorbent is due to Vander Waal's forces. It is sometimes referred to as Vander Waals adsorption. Physical adsorption has a relatively weak force of attraction between the adsorbate and adsorbent, therefore it may be readily reversed by heating or reducing the pressure (Dr. Nagham Mahmood Aljamali, 2021).

#### B. Chemical Adsorption (Chemisorption):

Chemical adsorption occurs when the attraction between the adsorbate and the adsorbent is almost as strong as chemical bonding. It is sometimes referred to as Langmuir adsorption. The force of attraction in chemisorption is quite high, making adsorption difficult to reverse (Dr. Nagham Mahmood Aljamali, 2021).

#### C. Adsorption Isotherms:

Once a mixture gets in contact with a solid adsorbent, adsorbate molecules are transferred from the solution to the solid until the adsorbate concentrations in the two phases are equal. At equilibrium, an equal amount of solute is adsorbed and desorbed simultaneously, which is known as adsorption equilibrium. Adsorption isotherms reflect (M.V. Bagal, 2021) Adsorption is important in a range of chemical processes, including the design of heterogeneity chemical reactors and adsorption-based product purification, since it provides equilibrium data at a certain temperature. Numerous empirical and theoretical frameworks have been developed to represent various types of isotherms of adsorption and characterize dynamic equilibrium. The Langmuir adsorption isotherm and the Freundlich adsorption isotherm, Brunauer-Emmet-Teller (BET) adsorption Isotherm, Redlich-Peterson (R-P) adsorption Isotherm.

##### ➤ Langmuir Adsorption Isotherm:

The Langmuir adsorption isotherm describes the equilibrium between an adsorbate and an adsorbent system in which adsorbate adsorption is restricted to one molecular layer at or before a relative pressure of unity is achieved. Although the isotherm proposed by Langmuir in 1918 (Stadie, 2019) is generally appropriate for describing the chemisorption process when ionic or the covalent chemical bonds arise across the substance that adsorbs and adsorbate, the equation is followed in many systems with moderately low coverage and can be easily extended to describe the behavior of the binary adsorption system. Langmuir assumes that the fractional surface coverage ( $\theta$ ) is directly related to the rate of desorption from the surface, and that the adsorption and desorption rates are equal in equilibrium. It focuses on four assumptions:

- The outermost layer of adsorbent is uniform, that is, all the adsorption sites are equivalent.
- Adsorbed molecules do not interact.
- All adsorption occurs through the same mechanism.
- At the maximum adsorption, only a monolayer is formed: molecules of adsorbate do not deposit on other, already adsorbed, molecules of adsorbate, only on the free The outermost layer of adsorbent.

The quantity of material adsorbed on a surface at a given temperature is determined by the amount of that substance in the gas or liquid phase that comes into contact with the surface; this relationship is known as the adsorption isotherm. The isotherm is important for determining the interactions between adsorbate and adsorbent.

#### D. Process Parameters Affecting Adsorption:

The quantity of adsorption is dependent on the following factors: Surface area of adsorbent. Nature of the adsorbate and adsorbent. Activation of Adsorbent Temperature of the Solution (Dr. Nagham Mahmood Aljamali, 2021), The starting solution concentration, adsorbent dose, agitation time, and solution pH. On the other hand, the amount absorbed by an adsorbent from the adsorbate solution is influenced by a number of parameters, including the starting concentration of the solution, temperature of the solution, pH values, time of contact, level of agitation, adsorbent type, and adsorbent dosage.

##### ➤ Initial Concentration of the Solution:

The pollutant's starting concentration has a significant impact on its adsorption elimination. In general, as the adsorbate concentration increases, so does the quantity of adsorbed material. With lowering concentrations, the percentage of removal rises.

##### ➤ Temperature of the Solution:

Temperature is a significant control element in adsorption. Adsorption is generally exothermic, meaning that the extent and rate of adsorption decrease as the system's temperature increases. Some adsorption studies show that adsorption rates increase with temperature. This increase in adsorption is mostly owing to an increase in the number of adsorption sites caused by the breakdown of specific internal bonds around the edge of the adsorbents' active surface areas.

##### ➤ pH:

The pH of the mixture has a significant influence on adsorption. As the pH rises, cation adsorption increases while anion adsorption decreases. Because hydrogen and hydroxyl ions are strongly adsorbed, the adsorption of other ions is regulated by the PH of the solution. The adsorptive process is altered by PH variations, which dissociate functional chains on the active regions of the adsorbent. This creates a shift in the kinetics and equilibrium parameters of the adsorption process. The surface clearly preferentially adsorbs anions at lower pH due to the presence of H<sup>+</sup> ions, However, the deposition of OH<sup>-</sup> ions makes it active for cation adsorption at a greater pH level.

➤ *Contact Time:*

It is crucial to evaluate the impact of time within adsorbent and adsorbate. During physical adsorption, the majority of the species of adsorbate are adsorbed on the surface of the adsorbent after a brief period of contact. Adsorbate absorption is rapid in the early stages of contact, but slows as it approaches equilibrium. Adsorbate has a strong chemical interaction, and the adsorbent requires a longer contact time to reach equilibrium. Adsorption data show that heavy metal uptake is rapid in the early stages of the contact time, but then slows as it approaches equilibrium.

➤ *Degree of Agitation:*

For the adsorbent and solution to make proper contact during batch adsorption, agitation is essential. Mass transfer is controlled at lower agitation rates because the stationary fluid layer surrounding the particle thickens. The film's resistance to mass transfer and thickness decrease with increasing agitation, leading to intra-particle diffusion control of the process. In processes governed by intra-particle mass transfer, agitation has no effect on the rate of adsorption since the solution inside the process remains unchanged regardless of the intensity of agitation.

➤ *Nature of Adsorbent:*

Various solids are used as adsorbents to remove pollutants from liquids. Activated charcoal, silica gel, activated alumina, and molecular sieves are popular industrial fluid adsorbents. Adsorption capacity is proportional to the exposed surface area. The capacity for adsorption of non-porous adsorbents is proportional to the diameter of the particle, but that of porous materials is essentially unaffected by the particle size (Dr. Nagham Mahmood Aljamali, 2021). Activated carbon is the most used adsorbent for water filtration. Macro pores are bigger channels or holes having a diameter of 1000 degree Å. Micropores, with diameters ranging from 10-1000Å, account for the majority of adsorption surface area.

➤ *Effect of Adsorbent Dose:*

With increased adsorbent dose, the number of accessible adsorption sites and surface area increase, resulting in a surge amount of dye adsorbed. Although the proportion of adsorption rises with increasing adsorbent dose, the quantity adsorbed per unit mass decreases.

*E. Adsorption of Solutes from Solutions:*

Pores or finely split particles can also absorb dissolved chemicals from a solution. So, activated carbon is used to eliminate colored contaminants from solutions. Charcoal may also absorb dyestuffs. Adsorption from solution typically follows the same principles as solid-gas adsorption. It is impacted by the same causes. As a result, some adsorbents are better at adsorbing specific solutes than others (Akshay C. Jadhav, 2021). Increased temperature reduces the amount of adsorption. The specific mechanism of adsorption from solution is unclear. However, the capacity of the given amount of adsorbent is limited, and hence adsorption may occur until a unimolecular layer is produced.

## V. INTRODUCTION TO ADSORBENT

Researchers employ adsorbents to remove colors from synthetic dye house effluents. There are two methods for treating adsorbents: physical and chemical. The physical approach of treating adsorbent comprises activation by heating in an oven. The chemical approach of treating adsorbents involves activation with acid or alkali. Researchers have lately begun to utilize organic acids (Segun Michael Abegunde, 2020) for the acid treatment of adsorbents since the addition of inorganic acids pollutes and increases the cost. Sometimes a mix of the two procedures is utilized.

*A. Usage of Low-Cost Adsorbent Available from a Cheap Source:*

Researchers are widely using the adsorption technique to remove colors from synthetic dye house effluents. The most common adsorbent used is commercially accessible activated carbon. Regardless of the extensive use of adsorption in treatment of wastewater systems, easily accessible activated carbon remains a pricey commodity. In the past few years, there has been a growing need for safe and affordable methods to treat dye house effluents. This has led researchers to concentrate on creating inexpensive adsorbents using the most cost-effective sources (Sivamani S, 2009). Consequently, the various low-cost ways to produce adsorbent are discussed in this review study, along with an investigation into their potential for treating dye house effluents. Preparing adsorbents in the least expensive manner involves;

➤ *Fly Ash:*

A byproduct of burning coal in thermal power plants is fly ash. Fly ash is mostly composed of silica, alumina, iron oxide, calcium oxide, magnesium oxide, and residual carbon (Sivamani S, 2009). Fly ash has several advantages over other adsorbents, chief among them being its abundance and easy availability, which makes it a great option for investigating a cost-effective color removal technique. Another advantage is that it contains pozzolanic particles, which react with lime in the presence of water to form cementation calcium-silicate hydrates, which may solidify fast after the pollutants have been adsorbed.

Following investigation, the fly ash adsorbent was found to contain 60.10% SiO<sub>2</sub>, 18.60% Al<sub>2</sub>O<sub>3</sub>, 6.40% Fe<sub>2</sub>O<sub>3</sub>, 6.30% CaO, and 3.60% MgO. The surface area, porosity, and bulk density of the adsorbent are 40.16 m<sup>2</sup>/g, 0.43, and 3.51 g/cm<sup>3</sup>, respectively. The kind of coal used and the level of combustion, however, affect the composition of fly ash. I used and the degree of combustion. The fly ash adsorbent was employed to remove several colors from aqueous solutions, including Methylene blue, Malachite green, and Rhodamine B.

➤ *Bagasse Pith:*

A byproduct of the sugar refinement process is bagasse pith. It is used to describe the cane pulp residue left over after sugar is extracted. Lignin, pentosan, and cellulose make up the majority of bagasse pith. The study concentrated on using

bagasse pith to adsorb dyes (Maxillon red, Telon blue, and Astropine blue). They found that bagasse pith is more economically desirable than commercially available activated carbon based on cost study. (Sivamani S, 2009).

➤ *Sewage Treatment Plant Bio-Solids (Sludge):*

Bio-solids (sludge) from a sewage treatment facility were used as an adsorbent in aqueous solutions to extract basic dyes, including Basic blue 3, Basic red 22, and Basic black 9. Batch mode adsorption tests are performed by adjusting the contact time, starting dye concentration, initial adsorbent dose, agitation rate, temperature, and  $P^H$ . The results showed that simple dyes' ability to adsorb was greater (22-24 mg/g) at lower temperatures (25-30°C), adsorbent dose (0.5-0.75% w/v), higher initial PH (8-9) and agitation rate (150-200 rpm). The solution reached equilibrium within two hours of operation.

➤ *Cassava Peel Activated Carbon:*

The elimination of dyes using activated carbon produced from cassava peel was investigated. Cassava peel is an agricultural byproduct of the food processing industry. Activated carbons (Sivamani S, 2009) made from scrap cassava peel using physical and chemical processes were assessed for their capacity to extract metal ions and colors from aqueous solutions. They discovered that the material impregnated with  $H_3PO_4$  was more efficient than the heat-treated materials, although both were effective adsorbents for dyes and metal ions.

➤ *Soil as Adsorbent:*

To remove colors from aqueous solutions, such as Methylene blue, Malachite green, and Rhodamine B, the soil was used as an adsorbent. At ideal circumstances, the dyes Methylene blue, Malachite green, and Rhodamine-B have color removal percentages of 89.18%, 83.20%, and 71.56%, respectively.

➤ *Jack Fruit Peel Activated Carbon Peel:*

An adsorbent called activated carbon made from jack fruit peel was used to extract Rhodamine-B, a basic dye, from an aqueous solution. The initial dye concentration, adsorbent dosage, and pH are changed in batch mode adsorption experiments. The highest color removal rate achieved was 96%. Jack fruit peel activated carbon was also employed as an adsorbent to remove the color Malachite green from an aqueous solution (Sivamani S, 2009). In batch mode adsorption testing, the initial dye concentration, pH, and temperature are changed.

➤ *Coconut Shell Powder:*

In this paper, Coconut shell powder of specific size (-72 BSS mesh number) is used as an adsorbent. Coconut shell powder possesses favorable properties like low ash content, high volatile content, high carbon content, high surface area and high hardness (Seri Nur Iman Hidayah Ahmad Nadzri, 2020). Coconut shells have been converted into carbon through Thermal cracking and other activation techniques to adsorb synthetic dyes, Ethyl Orange, Tartrazine yellow, Phenol red, Malachite green and Mixilon blue. Below **figure-1** shows the image of powdered coconut shell.



Fig 2: Coconut Shell and Coconut Shell Powder used as Adsorbent

## VI. EXPERIMENTAL APPROACH TO STUDY OF THE EFFECT OF PARAMETERS ON THE BATCH ADSORPTION OF METHYL VIOLET DYE IN AQUEOUS MEDIUM USING COCONUT SHELL POWDER AS AN ADSORBENT

### A. Apparatus Utilized for Conducting the Experimental Approach:

Wrist Action Shaker, Colorimeter, Cuvettes, Conical Flasks, Beakers, Measuring Jars, Crucible/China dish, Conical Funnels, Volumetric Flasks, Filter Papers, Spatula, Weighing Balance, and Specific Gravity Bottle.

### ➤ Reagents Utilized for Conducting the Experimental Approach:

Gentian Violet B (Solute or Adsorbate), and Coconut Shell Powder (Adsorbent).

### B. Colorimeter:

A colorimeter measures color and is most common known method for determining the concentration of biological substances. It measures absorbance and wavelength between 400 and 700 nm (nanometers), which is the visible spectrum of light in the electromagnetic spectrum. Light absorption occurs when light strikes a colored solution and is either absorbed or transmitted (Dmytro V. SNIZHKO, 2017). A colored solution absorbs all of the hues of white light while selectively transmitting only one, which is its own color.

➤ *Principle of Colorimeter:*

A solution is a homogeneous combination of two or more substances in a single phase with varying concentrations depends upon the solute-solvent relationship. The concentration of a solution can be found in a number of ways. The Beer-Lambert equation will be used because colorimetry will be used to measure the transmittance and concentration of the solution. According to this law, a solute's absorbance and concentration are proportionate.

The Colorimeter lets light flow through a cuvette holding a sampled solution, which absorbs little amount of the incoming light. A colored chemical compound solution absorbs part of the light radiation ( $I_a$ ) when it comes into perpendicular contact with a beam of light of a certain wavelength and intensity ( $I_0$ ). Before reaching the detector, the remaining light ( $I_b$ ) will pass through the solution. This leads to the demonstration of the following equation.

Thus,  $I_0 = I_a + I_b$ .

The quantity of molecules in the solution affects how much light is absorbed (concentration of the solution).

➤ *Beer-Lambert's Law:*

In simplified form, the colorimeter's operating concept depends on Beer-Lambert's law (Karki, 2022), which says that the concentration of a color solution and the length of a light channel across it determine how much light is absorbed by the solution.

$$A \propto (C) (l)$$

$$A = \epsilon Cl$$

Where,

A = Absorbance / Optical density of solution (nano meter)

C = Concentration of solution (PPM)

l = Path length (cm)

$\epsilon$  = Absorption coefficient

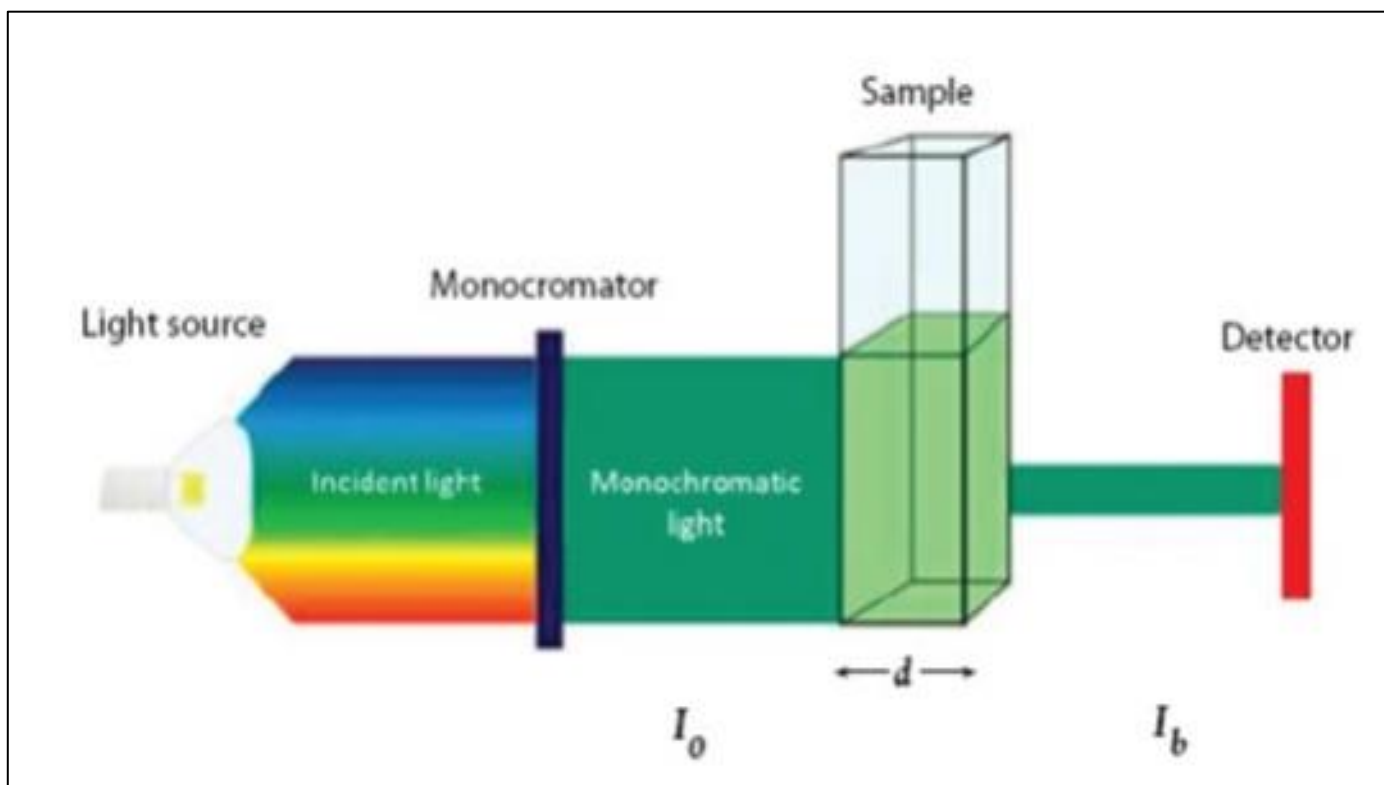


Fig 3: Principle of Working of Photoelectric Colorimeter

➤ *Parts of Colorimeter:*

A colorimeter consists of five key pieces (Karki, 2022). Tungsten filaments are the most popular type of light source used in colorimeters. Monochromator; To pick a certain wavelength, filters or monochromators are employed to divide light from its source. Sample holders, also known as test tubes or cuvettes, are utilized to contain color solutions

and are made of visible wavelength glass. Photo Detector System: When light strikes the detector system, an electric current is generated, reflecting the galvanometer measurement. Measuring device; The current from the detector is transferred into the measuring device, the Galvanometer, which displays a meter value that is proportionate to the intensity of light.



Fig 4: Photoelectric Colorimeter with Cuvette

➤ *Working of the Colorimeter:*

A colorimeter has to be calibrated before it can be used. This is done by using standard solutions that have known concentrations of the solute that needs to be measured in the test solution. To do this, standard solutions are filled into cuvettes and set within the cuvette holder of the colorimeter. A beam of light focused on the solution at a wavelength designated for the test is used. The light beam passes through several lenses and filters before arriving at the solution. The filter divides the light beam into various wavelengths so that only the necessary wavelength can pass through and reach the cuvette holding the standard or test solutions. These lenses are used to route colored light in the colorimeter. It examines the reflected light and compares it to a specified standard solution (Karki, 2022).

When monochromatic light (light with a single wavelength) enters the cuvette, some of it is reflected, some gets captured by the solution, while the remaining passes through it and falls on the light detecting device. The photo detector system measures the intensity of transmitted light and converts it into an electrical impulse given to the galvanometer (Paschotta, n.d.). The galvanometer measures electrical impulses and displays them in digital format. The absorbance or optical density of the measured solution is represented digitally by electrical impulses. If the solution's absorption is high, the solution absorbs more light; if the absorption is poor, the solution transmits more light, impacting the galvanometer measurement and corresponding

to the solute concentration in the solution. By entering all of the data into the formula provided in the section below, one may quickly establish the solution's concentration.

Formula used to determine the Concentration of a substance in the Test solution.

$$A = \epsilon Cl$$

For two solutions i.e. Test and standard,  
 $\epsilon = \text{Constant}$   
 $l = \text{Constant (using the same Cuvette or Standard cell)}$

For Test sample:

$$A_T = \epsilon C_T l \text{ ----- (1)}$$

$$A_S = \epsilon C_S l \text{ ----- (2)}$$

From Equations (1) & (2), we have,

$$\frac{A_T}{A_S} = \frac{\epsilon C_T l}{\epsilon C_S l}$$

$$\Rightarrow \frac{A_T}{A_S} = \frac{C_T}{C_S}$$

$$C_T = C_S \left[ \frac{A_T}{A_S} \right] \text{ ----- (3)}$$



$$\text{Adsorption efficiency} = \frac{(\text{Initial concentration} - \text{Final concentration})}{\text{Initial concentration}} \times 100 \text{ ----- (4)}$$

Where,

- C<sub>T</sub> = Concentration of the test solution (PPM)
- A<sub>T</sub> = Absorbance/ Optical density of the test solution
- C<sub>S</sub> = Concentration of the standard solution (PPM)
- A<sub>S</sub> = Absorbance / Optical density of the standard solution

Equation (3) is modified as follows to calculate the final concentration of the colored solution after adsorption.

$$C_{\text{Final}} = C_{\text{Initial}} \left[ \frac{A_{\text{Final}}}{A_{\text{Initial}}} \right] = C_{\text{Initial}} \left[ \frac{OD_{\text{Final}}}{OD_{\text{Initial}}} \right] \text{ ----- (5)}$$

Where,

- C<sub>Initial</sub> = Initial concentration of the colored solution before adsorption (PPM)
- C<sub>Final</sub> = Final concentration of the colored solution after adsorption (PPM)
- A<sub>Initial</sub> = OD<sub>Initial</sub> = Absorbance or Optical density of the colored solution before adsorption.
- A<sub>Final</sub> = OD<sub>Final</sub> = Absorbance or Optical density of the colored solution after adsorption.

$$\text{Removal of solute per gram of adsorbent} = \frac{(\text{Initial concentration} - \text{Final concentration})}{\text{Dosage of adsorbent}}$$

$$\Rightarrow \text{Removal of solute per gram of adsorbent} = \frac{C_{\text{Initial}} - C_{\text{Final}}}{\text{Doage of adsorbent}} \text{ ----- (6)}$$

**C. Shaking Machine Wrist Action:**

Shaking Machine Wrist Action is used to vigorously shake different solutions/chemicals using a conical flask put into clamps. Mixing solutions in tiny flasks or beakers can be accomplished by placing them on a top platform equipped with a shaker.

➤ *Salient Features of Shaking Machine Wrist Action:*

The shaker is mounted on ball bearings, and the rotator has a covered metal platform with rubber clamps (optional). It can hold flasks with volumes starting at 100 ml to 1000 ml. The compact counterbalanced drive mechanism ensures high stability and reliability even in continuous operation. It is equipped with a heavy-duty motor with variable speed, and its speed can be controlled through a variable speed regulator knob. supply.



Fig 5: Shaking Machine Wrist Action

**D. Adsorbent Preparation:**

Collect coconut shells from various locations, then clean them and let them dry in the sun for about two days. The husk is removed from the shell surface using grinding wheels to provide a clean surface, and the size is decreased to 1-2 cm using a hammer before being transformed to fine powder

using a pulverized machine. Sieving is done using several mesh numbers, which are 36, 52, 72, and 100 B.S.S. Finally, we store the adsorbent (coconut shell powder) according to its size. **Figure 5.1 to 5.3** shows the various stages of coconut shell being powered.



Fig 6: Preparation of Adsorbent (Coconut Shell Powder)

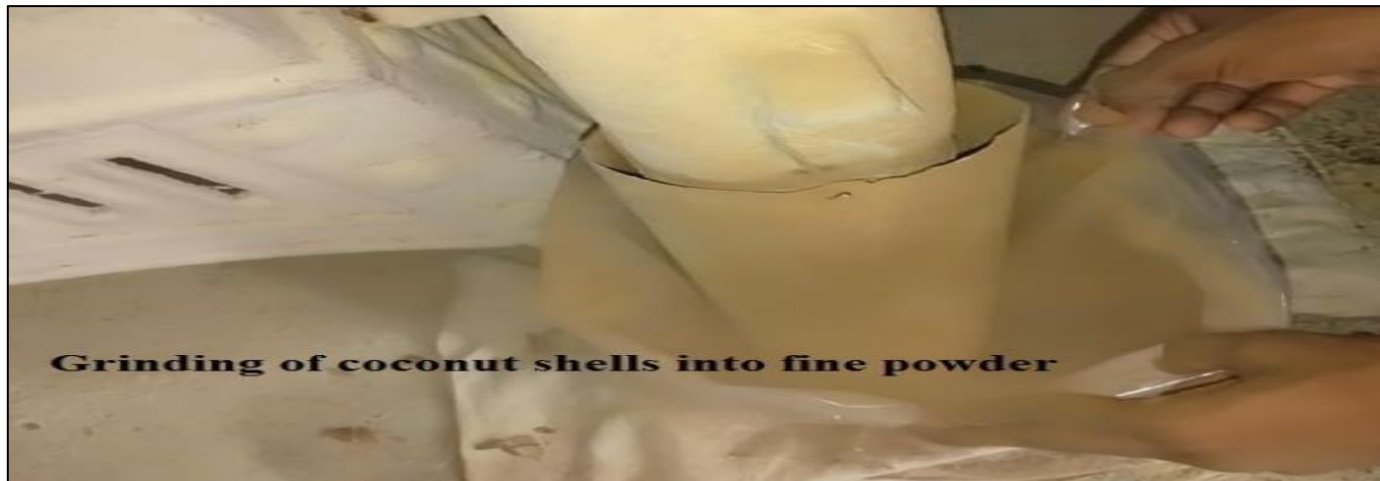


Fig 7: Preparation of Adsorbent (Coconut Shell Powder)

**E. Sample Preparation:**

➤ *Scheme-1: Effect of Dosage of Adsorbent*

To evaluate adsorption effectiveness when the amount of colored solution in terms of concentration (Gentian Violet-

B solution) is constant and a varied amount of adsorbent (Coconut shell powder) is used. The adsorbent size chosen is -100 B.S.S. (0.15mm). The adsorbent amounts used are 10gm, 20gm, 30gm, 40gm, and 50gm.

Table 1: Sample used for Scheme-1 Experimental Approach

S.No.	Quantity of Solute (Gentian Violet-B) (mg)	Quantity of Distilled Water (Liters)	Acquired Concentration of the Colored Solution ( $\frac{\text{mg}}{\text{liter}}$ or PPM)
1	8	0.1	80

$$\begin{aligned} \text{Concentration of the solution} &= \frac{\text{Quantity of Gentian Violet - B (mg)}}{\text{Quantity of distilled water (liter)}} \\ &= \frac{8\text{mg}}{0.1 \text{ liter}} \\ &= 80 \frac{\text{mg}}{\text{liter}} = 80 \text{ PPM} \end{aligned}$$



Fig 8: Scheme-1 Sample

➤ *Scheme-2: Effect of Temperature*

To measure the adsorption effectiveness when the adsorbent (Coconut shell powder) amount (30gm) is maintained constant (the adsorbent size chosen is -100B.S.S.), the starting concentration of the solution is kept constant at 80 PPM, and different temperatures of the colored solutions are tested. The temperatures of the colored solutions tested are 50°C, 55°C, 60°C, 65°C and 70°C.

Table 2: Sample used for Scheme-2 Experimental Approach

S.No.	Quantity of Solute (Gentian Violet-B) (mg)	Quantity of Distilled Water (Liters)	Acquired Concentration of the Colored Solution ( $\frac{\text{mg}}{\text{liter}}$ or PPM)
1	8	0.1	80

$$\begin{aligned} \text{Concentration of the solution} &= \frac{\text{Quantity of Gentian Violet - B (mg)}}{\text{Quantity of distilled water (liter)}} \\ &= \frac{8\text{mg}}{0.1 \text{ liter}} \\ &= 80 \frac{\text{mg}}{\text{liter}} = 80 \text{ PPM} \end{aligned}$$

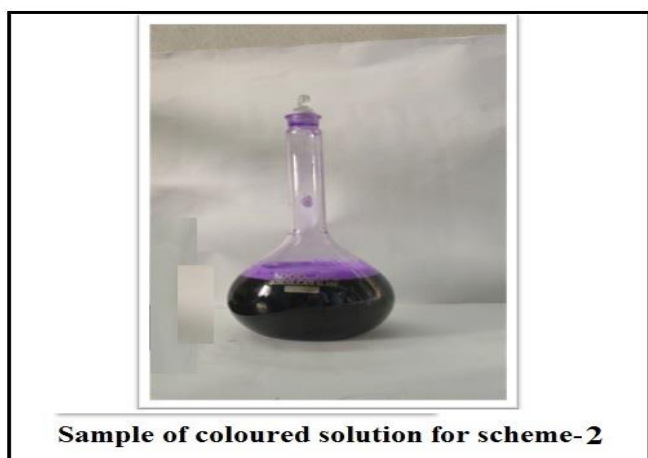


Fig 9: Scheme-2 Sample

➤ *Scheme-3: Effect of Initial Concentration*

To calculate the quantity of solute removed from a colored solution per gram of adsorbent for various beginning solution concentrations using a constant adsorbent dose. The quantity of coconut shell powder (30gm) remains constant (the adsorbent size chosen is -100B.S.S.). The starting concentration of the solution is 30PPM; 40PPM, 50PPM, 60PPM, and 70PPM are examined.

Table 3: Sample used for Scheme-3 Experimental Approach

S.No.	Quantity of solute (Gentian Violet-B) (mg)	Quantity of distilled water (liters)	Acquired concentration of the colored solution ( $\frac{\text{mg}}{\text{liter}}$ or PPM)
1	3	0.1	30
2	4	0.1	40
3	5	0.1	50
4	6	0.1	60
5	7	0.1	70

$$\begin{aligned} \text{Concentration of the solution} &= \frac{\text{Quantity of Gentian Violet - B (mg)}}{\text{Quantity of distilled water (liter)}} \\ &= \frac{3\text{mg}}{0.1 \text{ liter}} \\ &= 30 \frac{\text{mg}}{\text{liter}} = 30 \text{ PPM} \end{aligned}$$

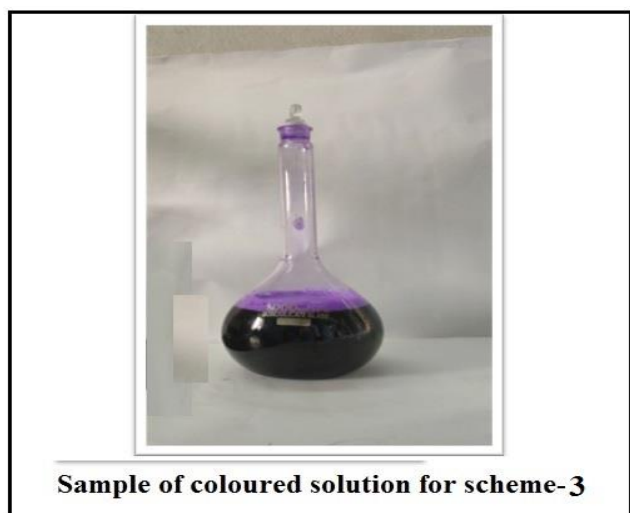


Fig 10: Scheme-3 sample

**VII. EXPERIMENTAL APPROACH FOR SCHEME-1: EFFECT OF DOSAGE OF ADSORBENT**

The experimental method comprises removing a colored component/dye ingredient (Gentian Violet-B) from a colored solution at a consistent concentration (80PPM) using varying amounts of a low-cost adsorbent (coconut shell powder).

➤ *Scheme – 1: Effect of Dosage of Adsorbent*

To evaluate adsorption effectiveness when the amount of colored solution in terms of concentration (Gentian Violet-B solution) is constant and a varied amount of adsorbent (Coconut shell powder) is used. The adsorbent size used is - 100B.S.S. (0.15mm). The adsorbent amounts used are 10gm, 20gm, 30gm, 40gm, and 50gm.

• *Procedure*

The sampled solution is made at a uniform concentration of 80 PPM. The initial optical density (OD-1) is measured using a photoelectric colorimeter after placing

the sample in a thoroughly cleaned cuvette. The solution with a certain concentration is then transferred to five conical flasks to be able to add varied amounts of adsorbent (coconut shell powder). The quantity of adsorbent used is indicated in the tabular form-4 for scheme -1. The weight of the adsorbent is measured using a weighing balance. Conical flasks are closed with a lid. Teflon tape is utilized for adequate enclosure, preventing sample leakage. Conical flasks are attached to a wrist action shaker holder with the appropriate stiffness. Ensure that all of the conditions for starting the procedure are met before proceeding. After commencing the procedure, the wrist action shaker should be left for 2 hours at a speed of 5 points. After 2 hours, the wrist action shaker is stopped, and the sample is filtered through 11-micron filter paper in a measuring jar. After adsorption, the final optical density (OD-2) of colored solutions is evaluated using a photoelectric colorimeter with the sample placed in a well-clean cuvette. The amount of colored solution in terms of concentration after adsorption is estimated using equation (5). The adsorption efficiency is also determined using Eq. (4). The removal of solute per gram of adsorbent is computed using equation (6).

• *Observations and Calculation for Scheme-1: Effect of Dosage of Adsorbent*

Specimen calculation for the amount of adsorbent = 10gm.

$C_{\text{Initial}}$  = Initial concentration of the colored solution before adsorption (PPM) = 80PPM

$C_{\text{Final}}$  = Final concentration of the colored solution after adsorption (PPM)

$A_{\text{Initial}} = OD_{\text{Initial}}$  = Absorbance or Optical density of the colored solution before adsorption = 0.96

$A_{\text{Final}} = OD_{\text{Final}}$  = Absorbance or Optical density of the colored solution after adsorption = 0.26

$C_{\text{Final}}$  is calculated using the equation (5) as follows,

$$C_{\text{Final}} = C_{\text{Initial}} \left[ \frac{A_{\text{Final}}}{A_{\text{Initial}}} \right] = C_{\text{Initial}} \left[ \frac{OD_{\text{Final}}}{OD_{\text{Initial}}} \right] \text{----- (5)}$$

$$C_{\text{Final}} = 80\text{PPM} \left[ \frac{0.26}{0.96} \right] = 21.67\text{PPM}$$

Adsorption Efficiency is calculated using the equation (4) as follows,

$$\text{Adsorption efficiency} = \frac{(\text{Initial concentration} - \text{Final concentration})}{\text{Initial concentration}} \times 100 \text{----- (4)}$$

$$\text{Adsorption efficiency} = \frac{(80 - 21.67)}{80} \times 100 = \frac{58.33}{80} \times 100 = 72.9\%$$

Eq (6) ⇒

$$\begin{aligned} \text{Removal of solute per gram of adsorbent} &= \frac{(\text{Initial concentration} - \text{Final concentration})}{\text{Dosage of adsorbent}} \\ &= \frac{(80 - 21.67)}{10} = \frac{58.33}{10} = 5.833 \end{aligned}$$

Table 4: Tabular form for Scheme-1: Effect of Dosage of Adsorbent

S.No.	Dosage of adsorbent (gm)	Initial OD	Initial Concentration (PPM)	Final OD	Final Concentration (PPM)	Removal of solute per gram of adsorbent	Adsorption efficiency
1	10	0.96	80	0.26	21.67	5.833	72.9
2	20	0.96	80	0.18	15	3.25	81.3
3	30	0.96	80	0.1	8.3	2.39	89.6
4	40	0.96	80	0.1	8.3	1.79	89.6
5	50	0.96	80	0.1	8.3	1.43	89.6

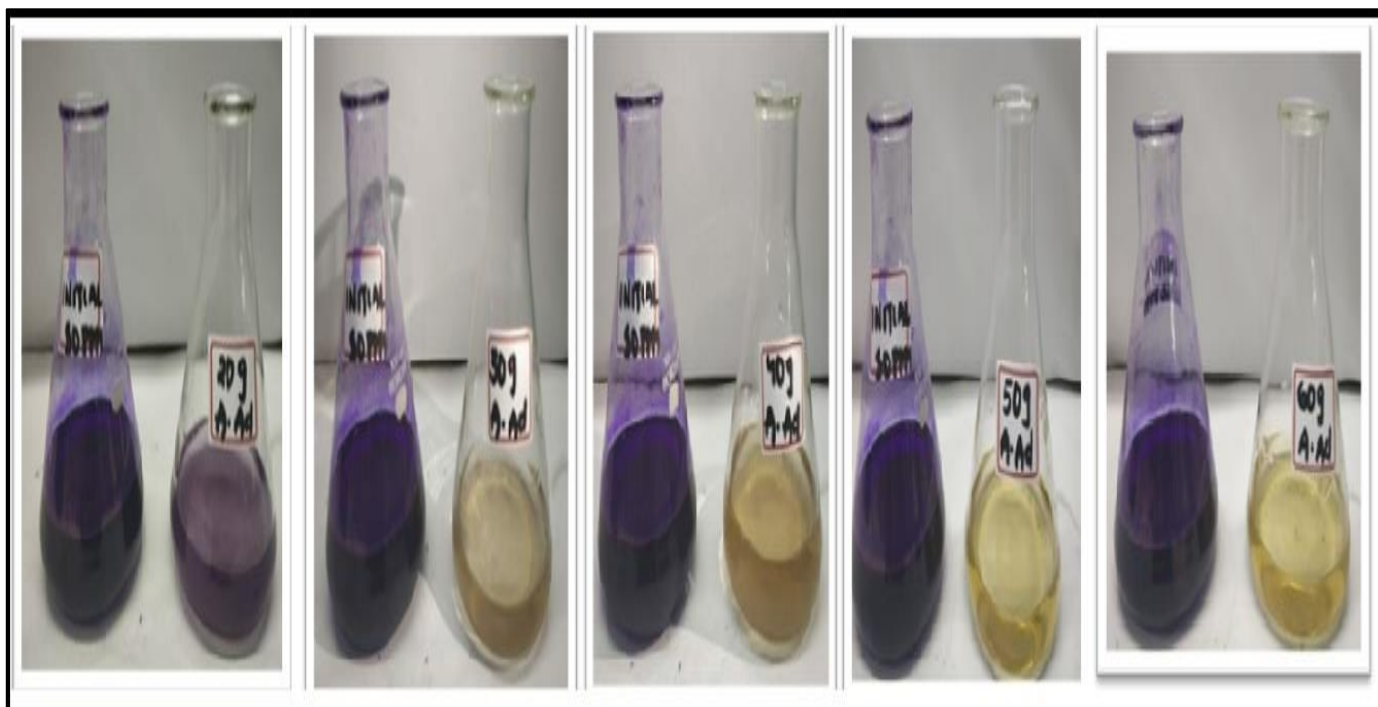
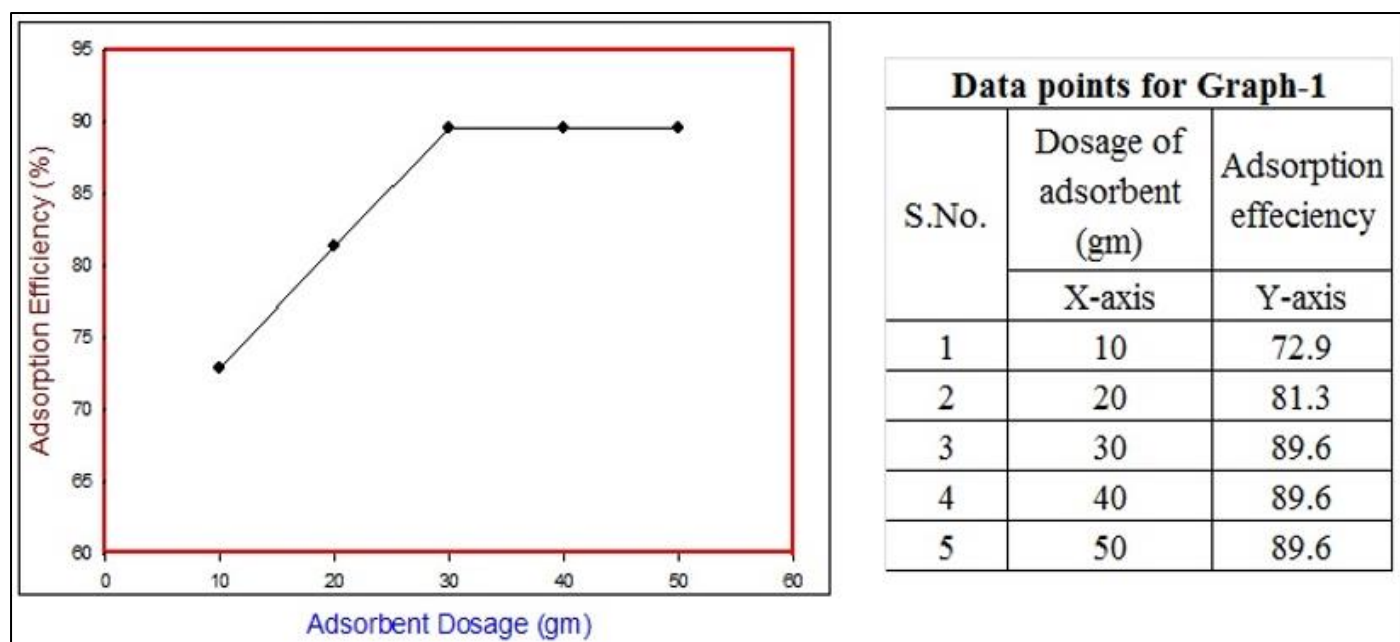


Fig 11: Change in the Color of the Colored Solution before and after Adsorption

➤ Graphical Representation for the Effect of Dosage of Adsorbent:



Graph 1: Effect of Dosage of Adsorbent

The concentration difference increases as the adsorbent dosage in the solution increases. The pushing strength for solute transport increases as a result. The adsorption efficiency rises as a result.

➤ Experimental Approach For Scheme-2: Effect Of Temperature

To measure the adsorption effectiveness when the adsorbent (Coconut shell powder) amount (30gm) is maintained constant (the adsorbent size chosen is - 100B.S.S.), the starting concentration of the solution is kept constant at 80 PPM, and different temperatures of the colored solutions are tested. The temperatures of the colored solutions tested are 50°C, 55°C, 60°C, 65°C and 70°C.

• Procedure:

A solution sample of 5nos is made at a known concentration of 80PPM. The samples are evaluated at temperatures ranging from 50°C to 70°C. The initial optical density (OD-1) of the samples are measured by inserting the solutions into a cuvette and putting it in a photoelectric colorimeter. A fixed amount of adsorbent (30gm) is put to each conical flask holding the colored solution with the same concentrations (80PPM) stored at varied temperatures 50°C, 55°C, 60°C, 65°C and 70°C. Conical flasks are closed with a cork arrangement equipped with a thermocouple. Conical flasks are put atop a heater/magnet stirrer setup. The temperatures for the samples are set to 50°C, 55°C, 60°C, 65°C, and 70°C, respectively, with an RPM of 450. The procedure is begun after ensuring that the prerequisites for starting it are met. After commencing the procedure, heat with stirring for 2 hours at 450 RPM. After 2 hours, the heating with stirring arrangement is stopped, and samples are filtered through 11-micron filter paper in a measuring jar. The final optical density (OD-2) values of the samples are recorded by pouring the solutions into a cuvette and putting

it in a photoelectric colorimeter. The concentration of the colored solution after adsorption is estimated using equation (5). Using Eq. (4), the adsorption efficiency is also ascertained. Equation (6) may be used to calculate the amount of solute removed per gram of adsorbent.



Fig 12: Equipment having Heater with Magnetic Stirrer Arrangement

➤ *Observations and Calculation For Scheme-2: Effect Of Temperature*

Specimen calculation for the sample tested at 50°C, quantity of adsorbent = 30gm.

$C_{Initial}$  = Initial concentration of the colored solution before adsorption (PPM) = 80PPM

$C_{Final}$  = Final concentration of the colored solution after adsorption (PPM)

$A_{Initial}$  =  $OD_{Initial}$  = Absorbance or Optical density of the colored solution before adsorption = 0.96

$A_{Final}$  =  $OD_{Final}$  = Absorbance or Optical density of the colored solution after adsorption = 0.34

$C_{Final}$  is calculated using the equation (5) as follows,

$$C_{Final} = C_{Initial} \left[ \frac{A_{Final}}{A_{Initial}} \right] = C_{Initial} \left[ \frac{OD_{Final}}{OD_{Initial}} \right] \text{----- (5)}$$

$$C_{Final} = 80PPM \left[ \frac{0.34}{0.96} \right] = 28.3PPM$$

Adsorption Efficiency is calculated using the equation (4) as follows,

$$\text{Adsorption efficiency} = \frac{(\text{Initial concentration} - \text{Final concentration})}{\text{Initial concentration}} \times 100 \text{----- (4)}$$

$$\text{Adsorption efficiency} = \frac{(80 - 28.3)}{80} \times 100 = \frac{51.7}{80} \times 100 = 64.6\%$$

Eq (6) ⇒

$$\begin{aligned} \text{Removal of solute per gram of adsorbent} &= \frac{(\text{Initial concentration} - \text{Final concentration})}{\text{Dosage of adsorbent}} \\ &= \frac{(80 - 28.3)}{30} = \frac{51.7}{30} = 1.72 \end{aligned}$$

Table 5: Tabular form for Scheme-2: Effect of Temperature

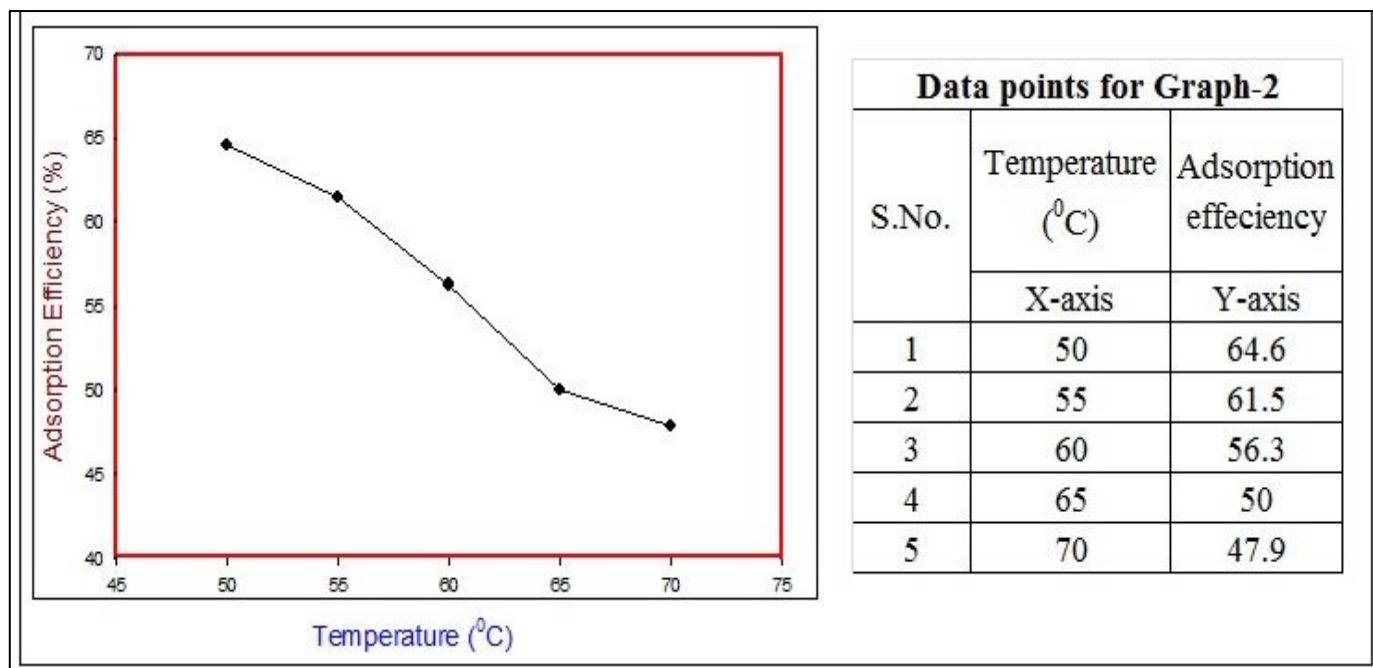
S.No.	Dosage of adsorbent (gm)	Temperature (°C)	Initial OD	Initial Concentration (PPM)	Final OD	Final Concentration (PPM)	Removal of solute per gram of adsorbent	Adsorption efficiency
1	30	50	0.96	80	0.34	28.3	1.72	64.6
2	30	55	0.96	80	0.37	30.8	1.64	61.5
3	30	60	0.96	80	0.42	35	1.5	56.3
4	30	65	0.96	80	0.48	40	1.33	50
5	30	70	0.96	80	0.5	41.67	1.27	47.9



Fig 13: Change in the color of the colored solution before and after adsorption

The adsorbent quantity and starting concentration were held constant, while the sample temperatures were fixed at 50<sup>o</sup>, 55<sup>o</sup>, 60<sup>o</sup>, 65<sup>o</sup>, and 70<sup>o</sup> degrees Celsius, respectively.

➤ *Graphical Representation for the Effect of Temperature:*



Graph 2: Effect of Temperature

The solvent (water) in the original solution evaporates as the temperature rises, increasing the solution's ultimate concentration. As a result, the driving force (concentration difference) decreases dramatically, reducing adsorption efficiency.

➤ *Experimental Approach for Scheme-3: Effect of Initial Concentration*

To calculate the amount of solute removed per gram of adsorbent as the starting concentration of the colored solution (Gentian Violet-B solution) changes. The adsorbent (coconut shell powder) is measured as 30gm. The adsorbent size used is -100B.S.S. (0.15mm). The initial concentration of the solution is maintained at 30PPM, 40PPM, 50PPM, 60PPM and 70PPM are tested.

• *Procedure:*

A solution sample of five distinct beginning concentrations was created. The initial optical density (OD-1) is measured using a photoelectric colorimeter after placing the sample in a thoroughly cleaned cuvette. Add 30gm of adsorbent (coconut shell powder) to solution samples with varying starting concentrations. The amount of adsorbent used is indicated in the tabular form-6 for scheme -3. The weight of the adsorbent is measured using a weighing balance. Conical flasks are closed with a lid. Teflon tape is utilized for adequate enclosure, preventing sample leakage. Conical flasks are attached to a wrist action shaker holder with the appropriate stiffness. Ensure that all of the conditions for starting the procedure are met before proceeding.

Table 6: Tabular form for Scheme-3: Effect of Initial Concentration

S.No	Dosage of adsorbent (gm)	Initial OD	Initial Concentration (PPM)	Final OD	Final Concentration (PPM)	Removal of solute per gram of adsorbent	Adsorption efficiency
1	30	0.93	70	0.14	10.5	1.98	85
2	30	0.9	60	0.12	8	1.73	86.7
3	30	0.86	50	0.1	5.81	1.473	88.4
4	30	0.78	40	0.1	5.13	1.16	87.2
5	30	0.67	30	0.1	4.48	0.851	85.1

After commencing the procedure, the wrist action shaker should be left for 2 hours at a speed of 5 points. After 2 hours, the wrist action shaker is stopped, and the sample is filtered through 11-micron filter paper in a measuring jar. After adsorption, the final optical density (OD-2) of colored solutions is evaluated using a photoelectric colorimeter with

the sample placed in a well-clean cuvette. The concentration of the colored solution after adsorption is estimated using equation (5). The adsorption efficiency is also determined using Eq. (4). The removal of solute per gram of adsorbent is computed using equation (6).



**VIII. OBSERVATIONS AND CALCULATION FOR SCHEME-3: EFFECT OF INITIAL CONCENTRATION**

Specimen calculation for the sample with an initial concentration of 70PPM, quantity of adsorbent = 30gm.

$C_{Initial}$  = Initial concentration of the colored solution before adsorption (PPM) = 70PPM

$$C_{Final} = C_{Initial} \left[ \frac{A_{Final}}{A_{Initial}} \right] = C_{Initial} \left[ \frac{OD_{Final}}{OD_{Initial}} \right] \text{----- (5)}$$

$$C_{Final} = 70PPM \left[ \frac{0.14}{0.93} \right] = 10.5PPM$$

Adsorption Efficiency is calculated using the equation (4) as follows,

$$\text{Adsorption efficiency} = \frac{(\text{Initial concentration} - \text{Final concentration})}{\text{Initial concentration}} \times 100 \text{----- (4)}$$

$$\text{Adsorption efficiency} = \frac{(70 - 10.5)}{70} \times 100 = \frac{59.5}{70} \times 100 = 85\%$$

Eq (6) ⇒

$$\begin{aligned} \text{Removal of solute per gram of adsorbent} &= \frac{(\text{Initial concentration} - \text{Final concentration})}{\text{Dosage of adsorbent}} \\ &= \frac{(70 - 10.5)}{30} = \frac{59.5}{30} = 1.98 \end{aligned}$$

$C_{Final}$  = Final concentration of the colored solution after adsorption (PPM)

$A_{Initial} = OD_{Initial}$  = Absorbance or Optical density of the colored solution before adsorption = 0.93

$A_{Final} = OD_{Final}$  = Absorbance or Optical density of the colored solution after adsorption = 0.14

$C_{Final}$  is calculated using the equation (5) as follows,

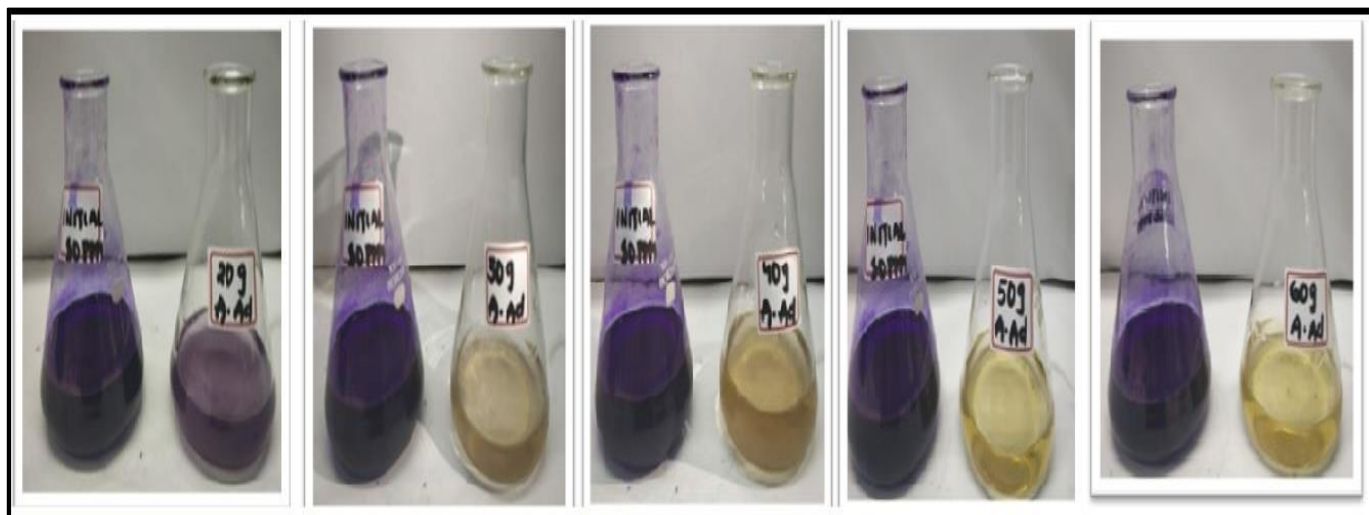
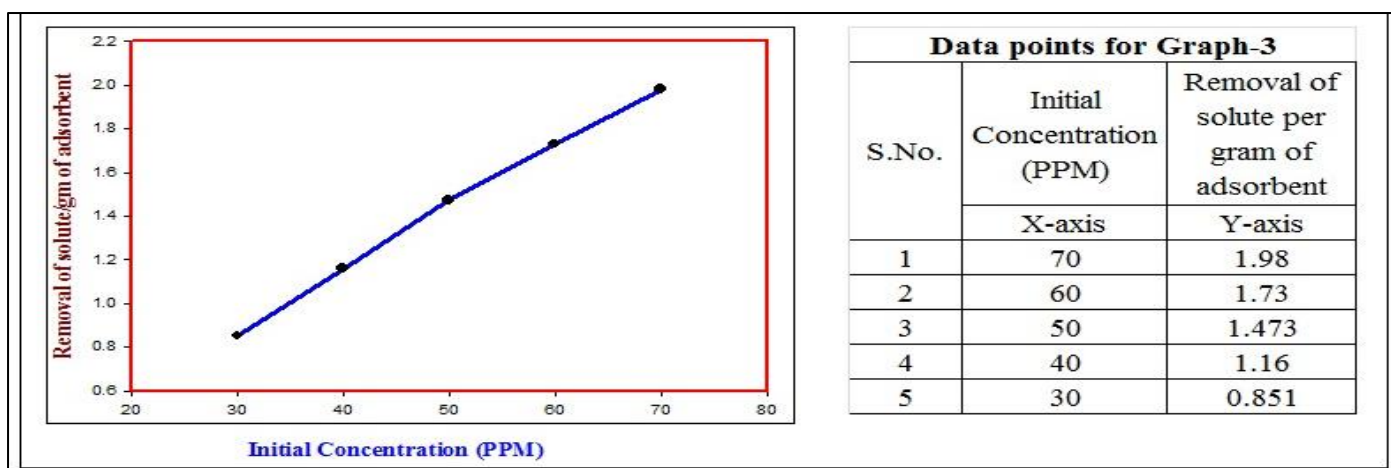


Fig 14: Change in the Color of the Colored Solution before and After Adsorption.

### IX. GRAPHICAL REPRESENTATION FOR THE EFFECT OF INITIAL CONCENTRATION



Graph 3: Effect of Initial Concentration

The driving power for solute transfer (i.e., the transfer of color component to the adsorbent surface) decreases as the starting concentration decreases. As a result, the rate of solute removal decreases per gram of adsorbent.

#### • Precautions

Equipment should be positioned on a level, completely horizontal surface. Glassware has to be handled with care. When handling cuvettes, use tissue paper. Sulfuric acid should be used with caution while cleaning glass. To prevent solution spilling, use Teflon tape. Chromophores display a complementary hue to the one they absorb. As a result, it must be approximated in the suitable spectrum area where it absorbs the most energy. Colorimetric tests are often most sensitive at the absorbance peak of the Chromophores present. Thus, if there is any ambiguity, the absorption maxima should be determined before beginning the experiment. Make that the cuvettes are clean. Fill cuvettes two-thirds full, or up to the triangle mark. The reference cuvette should contain all reagents except the substance being tested at the same concentration as the test cuvette. Glassware used in studies has to be cleaned using distilled water, diluted sulfuric acid, and chromic acid.

### X. CONCLUSIONS AND RESULTS

- By conducting experiment for scheme-1, where When the amount of adsorbent is adjusted while the concentration of the colored solution remains constant, it may be inferred that an increase in adsorbent quantity results in an increase in adsorption efficiency.
- For Scheme-1, It has been shown that 30 grams of adsorbent is the ideal amount to utilize for a colored solution with an 80PPM concentration.
- For Scheme-1, for a rise in the amount of adsorbent above 30gm, it is observed that The adsorption efficiency is unchanged.
- By conducting experiment for scheme-2, where the quantity of adsorbent and initial concentration were kept constant and the temperature of the coloured solution is varying, it can be concluded that, with the rise in the

temperature of the coloured solution, there is a reduction in the adsorption efficiency.

- By conducting experiment for scheme-3, where the quantity of adsorbent is kept constant and the initial concentration of the coloured solution is varying, it can be concluded that, with a reduction in the amount of the initial concentration of the coloured solution, there is a decline in the removal of solute per gram of adsorbent.

### ACKNOWLEDGEMENT

I am writing to express my deepest gratitude to KBVSS Kumar, Asst. Professor, Department of Chemical Engineering, Government Institute of Chemical Engineering for his invaluable support and guidance throughout the development of this work. His expertise and insightful feedback have been instrumental in shaping the quality and depth of this work. I deeply appreciate the time and effort he dedicated to reviewing and providing constructive comments, which have significantly enhanced the overall clarity and rigor of the paper. His mentorship has not only enriched this specific project but has also profoundly influenced my academic growth and research skills. I am truly fortunate to have had the opportunity to learn from him, and I thank him once again for his unwavering support and encouragement.

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