

# Removal of Methylene Blue from an Aqueous Solution using Prepared Activated Carbon from Olive Woods

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**Annotation:** The present study was aimed to remove Methylene Blue dye by adsorption technique using activated carbon as an adsorbent and study some factors, including contact time, adsorbent content, and beginning dye concentration, influence the adsorption process. Production of Activated Carbon (A.C) from Iraqi woods (olive) by cutting the woods to small sizes and the produce charcoal by using heating process and the convert the charcoal into carbon by heating the woods in the furnace with the absence of oxygen at higher temperature (500 c0) the next steps the Activations of carbon prepare the (KOH) solution {(3/1) by weight} and left the Carbon in the (KOH) solutions (24 hours) after 24 hours put the activated carbon in the Electrical furnace with higher temperature to (1hour) to increase the surface area for adsorptions. after the production of activated carbon and prepared methylene blue solutions with different concentrations (20,40,60, 80) ppm put the activated carbon with known weights in the methylene blue solution and mixed them some minutes noticed that the concentrations ppm of methylene blue reduced.

**Keywords:** Activated Carbon, olive, methylene blue, charcoal.

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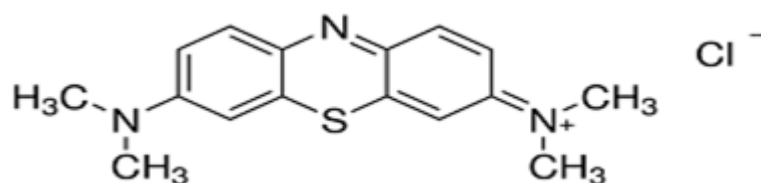
## Introduction

Although dyes have long been employed in the printing, textile, plastic, coloring, paper, cosmetics, medicine, and agri-food industries, the effluents released by these sectors present specific environmental dangers and issues [1]. The usage of synthetic dyes as coloring agents has significantly increased in these industries. When dyes are released into waste streams, their complex aromatic molecular structures and synthetic origin make them inert and challenging to biodegrade [2]. Since some colors and the byproducts of their breakdown may be poisonous and carcinogenic, the removal of synthetic dyes is a major concern. As a result, biodegradation alone cannot be used to treat these dyes [3]. Methylene blue is frequently used as a model compound for eliminating organic impurities and colored substances from aqueous solutions due to its well-known high adsorption onto solids [4]. The colors were removed using standard wastewater treatment methods as carbon adsorption, chemical coagulation, activated ludge, trickling filters, and photo-degradation [5]. Only adsorption was thought to be better than other physicochemical approaches, despite the fact that many others had been tested [6]. Due to its many advantages over other methods, including its cheap cost, availability, profitability, convenience of use, efficiency, and efficacy, the adsorption process is a good method for removing both organic and inorganic contaminants from wastewater [7-9]. Even at low concentrations, this method is similarly effective in removing harmful pollutants and is simple to use [10]. Adsorption is a surface phenomenon by nature, and the special qualities of a specially made sorbent substance have a significant impact on how well it works. Physical adsorption, which involves just modest intermolecular interactions, and chemisorption, which involves the sorbate molecule and the adsorbent surface forming a chemical connection, are two types of adsorption processes [11]. It was discovered that the adsorption efficiency on the activated carbon surface rises as the temperature rises, proving that the reaction is endothermic [12]. The density functional density theory (DFT) method was used to study the adsorption of hydrogen molecule (H<sub>2</sub>) on the large unit cell (1 × 3 × 3) of pure graphene, graphene doped with boron atoms, and graphene adsorbed with lithium atoms using first principle calculations [13]. The most widely used adsorbents for removing harmful substances from water are activated carbons because of their high surface area, porous structure, high adsorption capacity, unique surface reactivity, good corrosion resistance, inert nature, and stability across a broad pH range [14]. Since activated carbon is relatively inexpensive, readily available, easy to construct, highly effective, simple to use, biodegradable, and capable of treating dyes, it has been developed [15]. condensed types According to research, the adsorption effectiveness on the surface of activated carbon rises as the temperature rises, suggesting that the reaction is endothermic [16]. Physical activation or chemical activation are the two most frequent methods used to prepare activated carbon. For the elimination of several organic and inorganic pollutants, activated carbon is the most widely used adsorbent [17]. The two stages of carbonization and activation make up the creation of activated carbon [18]. In this study, produce charcoal by using heating process and then convert the charcoal into carbon by heating the woods in the furnace with the absence of oxygen at higher temperature (500 c<sup>0</sup>), the next steps the Activations of carbon prepare the (KOH) solution (3/1) by weight and left the Carbon in the (KOH) solutions (24 hours) after 24 hours put the activated carbon in the Electrical furnace with higher temperature to (1 hour) to increase the surface area for adsorptions. In the present study, detailed are carried out to remove this dye by adsorption technique using activated carbon as an adsorbent. Numerous factors, including contact time, adsorbent content, and beginning dye concentration, influence the adsorption process.

## Materials and Method:

### Adsorbate

Methylene blue (MB), a cationic dye, was employed as a very pure adsorbate in this investigation. The molecular weight of this substance is 319.85 g/mol, and its formula is C<sub>16</sub>H<sub>18</sub>N<sub>3</sub>SCl. Fig. 1 depicts the chemical structure of MB. All of the solutions and reagents were prepared using double-distilled water.



**Figure (1): The molecular structure for methylene blue [19]**

### Raw materials for production activated carbon

Activated Carbon can be produced from a wide variety of carbonaceous raw materials including:

Lignite Coal, Bituminous Coal, Coconut Shells, Wood, Peat Olive Pits, etc. The features and performance of the AC are greatly influenced by the raw material selection, as different raw materials result in ACs with varying surface areas, total pore volumes, pore radiuses, and pore volume distributions [20].

**Table (1): Properties of carbon**

Carbon Type	Total Pore Volume (ml/g)	Mean Pore radius (Angstroms)	Surface Area (m <sup>2</sup> /g)
Coconut Shell	0.5 – 0.6	10 – 11	1000-1100
Peat	0.6 – 0.7	11 – 12	1000-1275
Bituminous Coal	0.6 – 0.7	12 – 14	1000-1150
Bituminous Coal	0.7 – 0.8	14 – 16	900-1050
Lignite Coal	0.9 – 1.0	29 – 32	900-1050
23 – 26	1.1 – 1.2	Peat	600-675
22 – 26	1.4 – 1.8	Wood	1200-1600

### Design of Carbonization Box

- ✓ type of used metal is stainless steel (304)
- ✓ we cut the metal in industrial place to optimum sizes for our procedure
- ✓ the dimensions of the box is 25 cm length, 16 cm width and the height 25 cm
- ✓ we welding the plate by welden welding for many layers to prevent leakage of nitrogen gas from the carbonization box
- ✓ one side of the box was contained a hole with moving cap to insert and outlet the charcoal
- ✓ two sides of the box contained two valves one of them to insert the nitrogen gas and the other to reject the air from the box.

### Carbonization of Charcoal

Put the charcoal in the carbonization box, Passes the nitrogen gas to remove the oxygen from the carbonization box and prevent oxygen enter to the box, put the box with the charcoal inside the electrical furnace at temperature of 450C<sup>o</sup> for time range from (30\_60)min. After this time take out the box from the electrical furnace

### Activation of carbon

crushing the carbon to be in powder shape and prepared KOH solution, the mixing the solution for few minutes, and put the powdered activated carbon in the KOH solution for 24 hours, then wash the solution with distilled water (2 to 3) times and filtered the solution with filter paper till get PH of the solution is (7). After washing of activating carbon we dried in the drying furnace, then put it in the Ceramic crucible that tolerate temperature of(800C<sup>o</sup>) and been introduced to an electric furnace on temperature of (600C<sup>o</sup>) for an hour to remove any volatile organic component and oily materials that make the black color appears whiten the washing process.

### Preparation of methylene blue solutions

Preparation of aqueous solution of concentrations (20,40,60,80) ppm or (20,40 ,60 ,80) mg/l. prepared additional solutions to make the curve more accurate, so prepared them by the (dilution formula).

**Table (2): weight of methylene blue**

Concentration (ppm)	Wt. (methylene blue) mg/ml
20	5/250
40	10/250
60	15/250
80	20/250

### Adsorption of methylene blue by activating carbon

After absorbing the methylene blue, filtered the solution with the filter paper to remove the carbon Remains from the solution. Finally, measured the absorbent of this obtained solution in the spectrometer device, Table 3 and 4.

#### 1. First sample

**Table 3 adsorption of first sample**

Conc. ppm	Wt. of adsorbent (A.C) (gm)	Duration of contact (min)
20	0.5	10
40	0.5	15
60	0.5	20
80	0.5	25

#### 2. Second sample

**Table 4 adsorption of second sample**

Conc. ppm	Wt. of adsorbent (A.C) (gm)	Duration of contact (min)
20	0.5	15
40	1	20
60	1.5	25
80	2	30

### Result:

#### Sample (1)

In the first sample we set the weight of activated carbon on 0.5 gm. for all aqueous solution of methylene blue (20,40,60,80) ppm with variation the contact time between aqueous solution and activated carbon and the activated carbon adsorbs the 20 ppm aqueous solution with high efficiency because its saturated with methylene blue Either the other solutions adsorbs lower than 20 ppm because of over saturation phenomena which caused to not removed the color completely, Table 5 & 6, figures 5&6.

**Table (5): the result for sample1**

PPM	Weigh of A.C (gm)	Absorbents before A.C	Absorbents after A.C	Contact Time (min)
20	0.5	1.755	0.138	10
40	0.5	1.870	1.476	15
60	0.5	1.874	1.531	20
80	0.5	1.880	1.578	30

**Table (6): the concentration (ppm) of MB for first sample**

PPM before using A.C	PPM after using A.C
20	1.3
40	8.4
60	9.1
80	9.6



Figure (3): methylene solution before (A) and after (B) Activated carbon

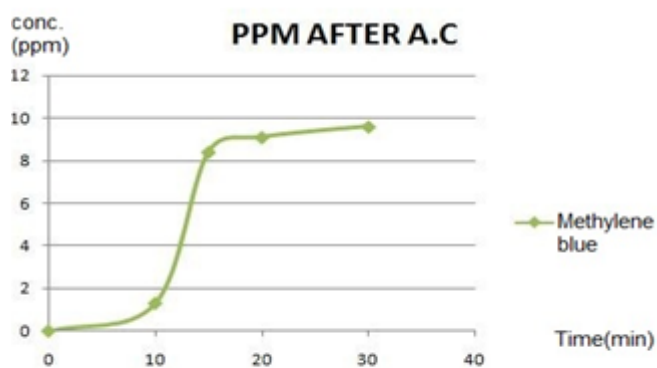


Figure (4): first sample after AC.

In the second sample change the weight of activated carbon between (0.5 to 2) gm. and change the time of contact between solutions and activated carbon which caused to remove the color after filtration, Table 7 & 8 and figures 5&6.

**Table (7) result for second sample**

PPM	Weight A.C (gm)	Absorbents Before A.C	Absorbents After A.C	Contact Time (min)
20	0.5	1.755	0.068	15
40	1	1.870	0.099	20
60	1.5	1.874	0.149	25
80	2	1.880	0.211	35

**Table (8): the concentration (ppm) of MB for second sample**

PPM before Using A.C	PPM after Using A.C
20	0.5
40	0.9
60	1.2
80	1.5



Figure (5): methylene solution before and after Activated carbon for sample 2.

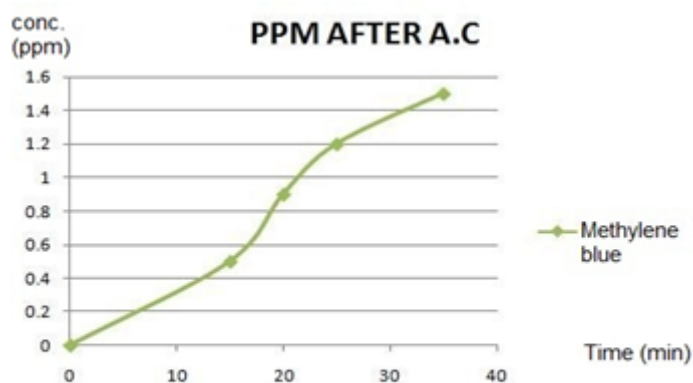


Figure (6): second sample after AC.

One of the main elements influencing the removal yield is the concentration of the adsorbent. The MB removal yield may drop if the adsorbent concentration is too low; conversely, flocculation may happen if the adsorbent concentration is too high. Both have a detrimental effect on adsorption [21, 22]. The impact of adsorbent concentration on MB's adsorption efficiency and capacity was investigated. Tables 5-8 show that while the amount adsorbed reduces with increasing mass, the adsorption efficiency increases as the amount of adsorbent increases. The increased surface area and quantity of active sites accessible for methylene blue fixation may be the cause of this. This is comparable to research published by Mehta et al. [24] and Jain et al. [23]. The primary factor that negatively impacts the adsorbent's capacity to adsorb is time. Tables 5 and 7 demonstrated that the rate of MB dye elimination increased with time, reaching a specific point and then falling off. Activated carbon was able to remove more than 90% when the time was changed from 15 to 20 minutes, and it stayed constant for another 35 minutes. This showed that the MB dye molecules first adsorbed on the pores before diffusing on the surface. Once the surface was completely covered, no more adsorption occurred and stayed constant. For this analysis, the ideal contact time [25].

## Conclusion

In the first sample we noticed that with increasing the contact time between aqueous solution and activated carbon the adsorption increases and we noticed that the activated carbon adsorbs the 20 ppm aqueous solution more effectively because of its saturation with methylene blue, Either the other solutions adsorbs lower than the 20 ppm solution because of over saturation phenomena which caused to not removed the color completely. In the second sample we noticed that with increasing the weight of activated carbon and time of contact the surface area increase which cause to adsorption increases. Activated carbon (A.C) adsorbs methylene blue dye with high efficiency. When the surface area increases the adsorbents increase, and activated carbon can be produced from available trees such as olive trees.

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