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Influence of Process Parameters on Removal of Methylene blue dye from an Aquatic Environment Using Traganum nudatum Roots Treated with Trona as Novel Activator

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Abstract The removal of synthetic cationic dyes, methylene blue, from wastewaters by using *Traganum Nudatum* Roots, TNR, as low cost agriculture material, treated by Trona as novel activator. Parameters control the adsorption capacity of MB were studied. It was found that the maximum adsorption capacity was 339.16 mg MB/g TNR at pH 8.4 and increased with increasing solution pH. The adsorption capacities of MB dye increased with increasing concentration of MB and the maximum adsorption capacity was 292.09 mg MB/g TNR at initial MB concentration of 500mg/L. The MB dye was reached equilibrium within 90 min. The adsorption capacity decreased with increase in adsorbent dose for MB dye and the maximum adsorption capacity was 402.8 mg MB/g TNR at initial TNR dosage of 20 mg. The results indicated that the adsorption capacity increased for both dyes by rising the temperature from 303 K to 323 K, indicating that the adsorption process is an endothermic process and adsorption favorable at high temperature. The findings in this research that TNR treated with Trona as cheap and effective activator can be used to remove MB from aqueous solution and all the parameters studied had a significant effect on removal process.
Keywords: removal, MB dye, *Traganum Nudatum* Roots, Trona, adsorption.

العوامل المؤثرة على ادمصاص صيغة الميثيلين من المائية باستخدام جذور نبات الضمران المنشطة بالطرونا كمنشط خلايا الأوساط

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الملخص تضمن هذا البحث استخدام جذور نبات الضمران كمادة ليست غالية الثمن و المنشطة بالطرونا كمنشط جديد لادمصاص الأصباغ الكاتيونية مثل صبغة المثيلين الأزرق . حيث تم دراسة تأثير العوامل الفيزيائية والكيميائية لازالة صبغة المثلين الازرق بواسطة جذور نبات الضمران. واثبتت الدراسة ان هذه العوامل لها تأثير مباشر علي نسبة الازالة.
الكلمات المفتاحية: الادمصاص، الطرونا، الميثيلين الازرق، نبات الضمران، الازالة .

1. Introduction

The pollution of water by common toxic heavy metals, dyes or pigments is a world-wide environmental matter, which are commonly founded in waste water and [1-3]. Those chemicals, which have been considered as hazardous materials due to none biodegradable and accumulating in living organisms, which causing health problems in human beings, plants and animals [3]. Dyes are ionic aromatic ring compounds, which has strong affinity to interaction with surfaces or fabrics to give a distinct color, including paper, waxes, plastics, cosmetics, textile, hair, food, greases, etc. [4]. Methylene blue, MB, is widely used as cationic and synthetic dye in manufacturing operation in textile industry for dying cottons, silk, nylon, wool, leather, coloring paper, temporary hair colorant, printing calico and etc. [5].

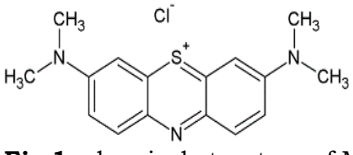

Fig.1: chemical structure of MB dye.

Various techniques are now available to remove toxic dyes from industrial effluents from an aquatic environment [6]. In recent years, the adsorption method has become more popular and preferred over the other methods due to low cost, flexibility, simplicity of design and highly removal capacity [6-9].

Agricultural solid wastes are nonconventional low-cost adsorbents can be used as inexpensive adsorbent such as rice husk, leaves, fibers, seeds, sawdust, roots etc. The utilization of these materials in adsorption process is an efficient, economical method for the removal of contaminants from wastewater [10, 11]. In this research, *Traganum Nudatum* Roots (TNR) activated by Trona was used to remove MB from aqueous solutions. Trona used as pretreatment alkali solution, which classified as a native salt.

2. Material and Methodology

2.1. Materials and Instruments

Tragunum Nadutum roots (TNR) used as adsorbent activated by Trona as native salt was prepared. MB dye was purchased from (Riedel-De Haen Ag). Electronic pH/conductivity meter (Electron

Corporation, USA) and UV-Vis spectrophotometer (Jenway 6305, UK) were used.

2.3. Methodology

2.3.1. Preparation of Adsorbent

TNRs were collected from Samno Village, Albowanise State, and north of Sabha State, Libya. The TNR was washed with plenty of water and socked several times with deionized water to remove surface impurities. The TNRs were dried in an oven at 105°C until a constant weight obtained. The yield was grounded and sieved to obtain a particle size range of 0.125-0.063 mm.

2.3.2. Activation process

40 ml saturated solution of Trona was added to a flask containing 1.0 g of natural TNRs. The mixture was mixed and heated at 100°C for 1 hr. The mixture was filtered by Whatman paper No113. The treated natural TNR washed several times by deionized water to remove the excess of Trona until the risen reaches almost neutral (pH 7). The activated TNRs were dried at 105°C until a constant weight obtained and grounded to desire particle size. The activated TNR was kept in desiccator for further the experiments.

2.3.3. Batch adsorption experiment

For each experiment, 0.01g treated TNR was immersed in 20 ml of known initial concentration (C_0) dye solution at specific temperature. The mixture was agitated at constant speed 250 rpm for a known period to reach equilibrium of the solid solution mixture. After the equilibrium, the mixture were separated by a fast filtration, then the clear supernatant was analyzed by UV-Vis spectrophotometer at wavelength of 662nm for MB dye [12]. The adsorption capacity of treated TNR was calculated by the following equation [13]:

$$q_e = \frac{(C_0 - C_e)\ V}{W} \qquad (1)$$

Where: q_e (mg/g) is the adsorption capacity of adsorbent, C_0 is the initial dye concentration (mg/l), C_e is the equilibrium dye concentration (mg/l), V is the volume of dye solution (l) and w is the adsorbent mass (gm).

3. Results and Discussion

3.1. Effect of initial solution pH

Fig.2 shows the effect of pH on the adsorption capacity of MB dye. The pH of MB dye solutions were adjusted from 3-9 at room temperature, 0.01 g/20 ml of treated TNR, 1hr and initial concentration of MB dye 400 mg/L [14, 15]. It was found that the maximum adsorption capacity was 339.16 mg MB/g TNR at pH 8.4 and increased with increasing solution pH. The lower adsorption capacity of MB dye at acidic medium is probably attributed to the competition of H^+ ions with cation groups of MB dye on the surface for the active sites of the adsorbent and decrease the chances of adsorption of MB dye on the surface [16]. In addition, this could be due to electrostatic repulsive between positively charged dyes and positively charged surface. On the other hand, at higher pH, the adsorption capacity of MB dye increased because the negative surface charge increased and H^+ ions decreased. Therefore, the electrostatic force attraction increases between cationic dye molecules and the surface [17-21].

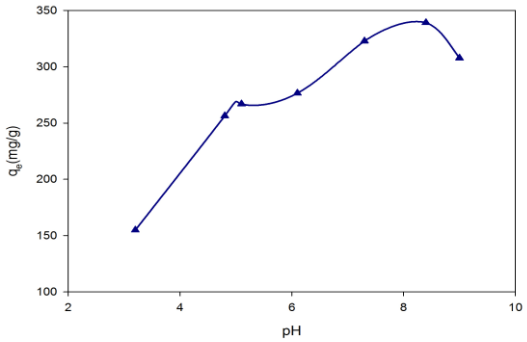

Fig.2: Effect of initial pH on adsorption capacity of MB dye onto treated TNR.

3.2. Effect of initial dyes concentration

The effect of MB dye concentrations on its adsorption capacity was studied at concentrations of 200-600 mg/l at pH 8.4, adsorbent dose 0.01g, contact time 1 hr, 20 ml of dye solution at room temperature. It is observed from Fig.3 that the maximum adsorption capacity was 292.09 mg MB/g TNR at initial MB concentration of 500mg/L and the adsorption capacities of MB dye increased with increasing concentration of MB. This could be due to the increased initial concentration of dye will give the driving force required to overcome the resistance of the mass transfer of dye molecules between adsorbents and dye aqueous solutions [22-24]. It was also observed that, the adsorption capacities of MB dye was higher in case of higher initial concentrations.

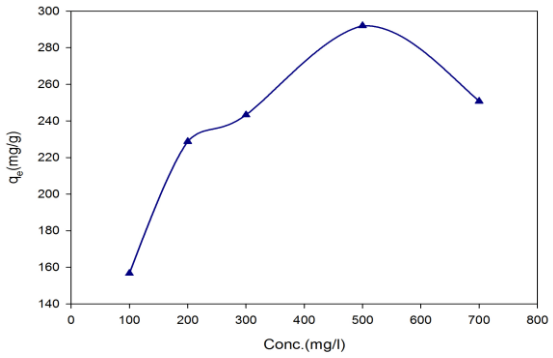

Fig.3: Effect of initial concentration on adsorption of MB dye onto treated TNR.

3.3. Effect of treated TNR dose

Fig.4 shows the effect of adsorbent dose on the adsorption capacity of MB dye onto treated TNR. The doses of treated TNR were varied from 0.01 to 0.07 g and keeping all other experimental parameters were kept constant. It was observed from Fig.4 that the maximum adsorption capacity was 402.8 mg MB/g TNR at initial TNR dosage of 10 mg and the adsorption capacity decreased with increase in adsorbent dose for MB dye. This decrease in amount of adsorbed dye q_e is probably due to overlapping agglomeration of particles and this is resulting in a decrease in a surface area of adsorbent available to the dyes which will increase diffusion bath length [25]

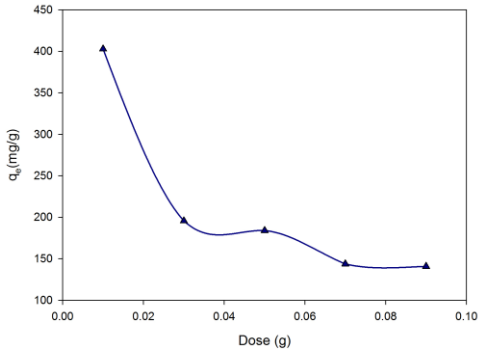

Fig.4: Effect of adsorbent dose on the adsorption capacity of MB dye onto treated TNR.

3.4. Effect of contact time and temperature

Contact time is another important parameter influence in the adsorption process. Fig.5 show the effect of contact time on adsorption capacity of MB dye. The contact time was varied from 0-2 hours and keeping other experimental parameters constant. The MB dye was reached equilibrium in 90 min. It can be observed that the adsorption capacity of MB

dye gradually increase until they reached the equilibrium state. That was attributed to the surface sites of adsorbent. Before the equilibrium time, there were a large numbers of surface sites are available for adsorption during the adsorption process. A further increase in contact time does not increase the adsorption capacity because after equilibrium state most of available active sites were occupied [12, 15, 22]. The equilibrium time, is the amount of the adsorbed molecules of dye from the surface of adsorbent is stay in a state of dynamic equilibrium with the amount of the desorbed dye molecules onto the surface of adsorbent. The amount of dye adsorbed at the equilibrium time reflects the maximum adsorption capacity of the adsorbent under those operating conditions [24].

The effect of different temperatures at 303, 313 and 323 K on the adsorption capacity of treated TNR for the removal MB dye was investigated under the following optimum conditions, 0.01 g of adsorbent dose, 500 mg/l initial concentration, pH 8.4 as shown in Fig.5. The results indicated that the adsorption capacity increased by rising the temperature from 303 K to 323 K, indicating that the adsorption process is an endothermic process and adsorption favorable at high temperature. This effect of temperature may be due to the increase in the movement of molecules of dyes which cause to increase the number of active sites on the surface, increase in the pore volume and porosity of adsorbent [24, 26]. Also, the viscosity of the dye solution decrease with the increase of temperature and then increase the diffusion rate of the dye molecules into the internal pores of the adsorbent [27, 28].

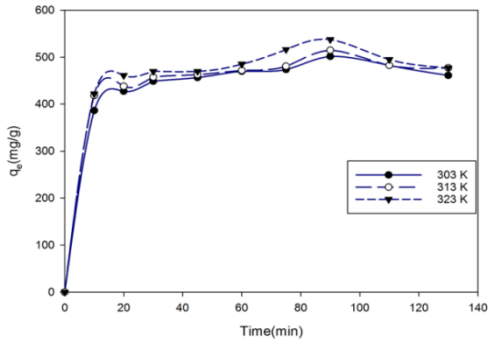

Fig.5: Effect of contact time and temperature on the adsorption capacity of MB dye onto treated TNR.

Conclusion

In this study, the removal of MB dye by treated TNR were investigated. Results showed that the MB dye was highly dependent on initial pH of solution, adsorbent dose, initial concentration of dye, contact time and temperature. It can be concluded that the treated TNR with Trona can be effectively used for the adsorption of basic dyes such as MB dye from aqueous solutions, this adsorbent have a great potential in environmental remediation processes with no economical cost.

Arabic section:

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