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Maxilon Blue 5G Removal by Bimetallic Pt/Co Loaded on GO Material under Ultrasonic Conditions from Aquatic Medium

Mehmet Harbi ÇALIMLI[1*]

ABSTRACT: Bimetallic Pt/Co loaded on GO adsorbance was produced following a series of simple hydrothermal methods. The produced bimetallic Pt/Co loaded GO material was used in the maxilon blue 5G removal (MB 5G) and investigated its adsorption studies. The adsorption studies on removal of MB 5G using the bimetallic Pt/Co loaded on GO material were carried out performing different experimental conditions like ultrasonic irradiation time (1-120 min), temperature (24-55 ^{o}C), initial MB 5G concentration ($0.7.10^{-5}$- $1.5.10^{-5}$ M), and pH (4- 10) to detect optimum removal conditions. The reaction kinetics were investigated by pairing the so-called first-order pseudo-second-order and intraparticle diffusion in the adsorption process study. In addition, enthalpy, entropy and Gibbs free energy, and thermodynamic activation functions were investigated in order to understand the adsorption mechanism. These data showed that the bimetallic Pt/Co loaded on GO material can be used as an effective nano adsorbent for the removal of MB 5G as an organic pollutant in an aquatic medium.

Keywords: Bimetallic, adsorption, removal, kinetic, Maxilon Blue 5G

Su Ortamından Ultrasonik Koşullar Altında GO Malzemesine Yüklenen Bimetalik Pt / Co ile Maxilon Blue 5G Kaldırma

ÖZET: Bimetalik Pt/Co'nin GO üzerine yüklenmiş adsorbent bir seri hidrotermal metod ile sentezlendi. Elde edilen adsorbance maxilon blue 5G (MB 5G)'inin giderilmesinde kullanıldı ve adsorbsiyon çalışmaları incelendi. MB 5G'inin Pt/Co yüklü GO material ile yapılan adsorbsiyon çalışmaları farklı deneysel durumlarda olan ultrasonic ışıma zamanı (1-120 min), sıcaklık (24-55 ^{o}C), başlangıç MB 5G konstrasyonu ($0.7.10^{-5}$- $1.5.10^{-5}$ M), ve pH (4- 10) gibi deneysel koşullar altında yapıldı. Kinetik reaksiyonlar birinci dereceden, ikinci dereceden ve intrapartikül düfüzyonu metodları ile incelendi. Buna ilaveten, entalpi, entropi, Gibbs serbest enerjisi ve termodinamik aktivasyon fonksiyoları aktivasyon mekanizmasını tespit etmek için incelendi. Elde edilen sonuçlar ile bimetallik Pt/Co'nin GO üzerine yüklenmiş adsorbent MB 5G organik boyasının giderilmesinde etkin bir şekilde kullanılabileceği sonucuna varıldı.

Anahtar Kelimeler: Bimetalik, adsorpsiyon, uzaklaştırma, kinetik, Maxilon Blue 5G

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INTRODUCTION

Dyestuffs are used in different areas such as textile, leather, paper, and plastic and are given to the environment as wastewater (Chiou et al., 2004). It is not easy to remove dye-containing wastewater from the environment. Because these dyes gain a stable structure as a result of interaction with light, heat and oxidizing agents and become resistant (Crini, 2006). However, waste dyes contain many toxic materials in their structure(Yener et al., 2006). When the textile industry is compared for both volumetric discharge and other different reasons, it is thought that the waste water is very polluted (Singh et al., 2003). Different technological application processes are used to deal with such problems (Banat et al., 1996; Choy et al., 1999). Chemical oxidation, membrane filtration, biological degradation, separation and adsorption techniques are the most preferred treatment process systems for dye removal (Yenisoy-Karakaş et al., 2004). In this study, the adsorption technique was preferred under ultrasonic process conditions for dye removal. This processing method was effective in its use because it is easy to apply, very fast, and cost-effective (Zhang et al., 2013). Adsorption process technique, efficiency changes depending on the physical and chemical properties of the adsorbent (Yagub et al., 2014; Yenisoy-Karakaş et al., 2004). So far, different composite materials like krill clay, polymer based composites, diatomite, graphene oxide, chitosan and green clay (M. H. Çalımlı, 2020; Mehmet Harbi Çalımlı et al., 2018; Demirbaş et al., 2019, 2016; Nas et al., 2017; Şen et al., 2018) have been applied to remove organic base pollutants like dyes from aquatic environments. In recent studies, nanoparticles produced using polymer, carbon, different metals as new sorbents are highly preferred (Mittal et al., 2014; R. Wu et al., 2014). Since discovered, graphene oxide (GO) was applied in many different areas like high-quality electronics, magnetic, thermal and optical (Batra et al., 2015; Fonseca et al., 2015; Z. Liu et al., 2008). Because, it has extraordinary properties such as (Novoselov et al., 2004; Roy-Mayhew et al., 2014; W. Zhao et al., 2015). In addition, graphene material has a strong interest in many areas such as battery and sensor, electrochemistry, supercapacitor technology and adsorption process applications (Feng et al., 2015; Y. Liu et al., 2011; Song et al., 2016; Teixeira et al., 2016). Graphene material has been widely produced as a catalyst support in works involving metal alloys such as Co, Ni, Cr and Fe (Haldorai et al., 2014; Hernández-Fernández et al., 2007; Koffi et al., 2005; Lai et al., 2010; S. H. Liu et al., 2011; Shen et al., 2010; J. Zhao et al., 2011). Herein, we synthesized bimetallic Pt/Co loaded on GO material to remove MB 5G dye. The data obtained showed that bimetallic Pt/Co loaded on GO material can be effective in MB 5G removal under ultrasonic conditions from the aqueous medium. As stated in the literature, MB 5G is mixed with natural resources as a result of use in industrial activities. This paint is highly damaging to the aquatic environment and aquatic life. For the first time in our study, Bimetallic Pt / Co Loaded on GO material was used to remove MB 5G dye. With this study, the optimum conditions were determined and experimental findings were made about what conditions should be created for the removal of MB 5G dye.

MATERIAL AND METHODS

Chemical material

$PtCl_4$ (99%), $CoCl_2$> 99%, MG 5G dyestuff, ethanol, superhydride and graphite chemicals were obtained from Sigma Aldrich. All chemicals are analytical grade and were used in runs without any purification process. All glassware used in the study was cleaned using distilled water and ethanol.

Preparation and characterization of bimetallic Pt/Co loaded GO material

For bimetallic Pt/Co loaded GO material synthesis, $CoCl_2$ and $PtCl_4$ are used as precursors, and 0.25 mmol of each taken and solved in 5 ml deionized water. This mixture was mixed in an ultrasonic

bath for 10 minutes. Afterward, the required GO has added the resulting mixture. The mixture was stirred for 2 h. Then, ethanol and super hydride were added to the resulting slurry. Upon being the visible brownish color of the solution, (that shows reduction completion of metal ions to metallic state), the formed solid sample was filtered. The solid sample was washed with copious amounts of distilled water (3x10 mL), rinsed using ethanol. Afterward, this solid sample was dried in an oven at 80 ° C.

Adsorption experimental prosedure

Adsorption experiments carried out include various parameters. These are a total of 6 parameters: different temperature, pH, adsorbent concentration, MB 5G concentration, H_2O_2 amount and ultrasonic power effect. A typical experimental procedure performed is as follows. Sorption kinetics studies were carried out in a 250 mL glass Erlenmeyer in an ultrasonic bath. The deionized water was used in the preparation of the dye solution samples used. The mechanism used in experimental adsorption studies was arranged according to a line on the ultrasonic device. It was subjected to the interaction between the dye and the magnetic nanoparticle for about 15 minutes for the balance of adsorption-desorption. To undergo the adsorption experiments, çömmen kinetic parameters including ultrasonic power of 400 (W) US force, $1.0x10^{-5}$M, 303 K, pH 9, and adsorbent dose (0.0020 g). It was taken at certain time intervals during the experimental work to analyze the 3ml sample. Samples were centrifuged. Absorbance peak changes in the range of 200-900 nm were tested on the sample with a UV-Vis spectrophotometer (Perkin Elmer Lambda 750). The dye removal efficiency was determined by using the data and using the equation given below(M. Alkan et al., 2008).

$$q_t=(C_0-C_t).V/m \quad (1)$$

Where; The terms C_o and C_t ($mol.L^{-1}$) describe the liquid phase concentrations at initial and any time, respectively; qt ($mmol^{-1}$) describes the amount of dyestuff adsorbed per unit mass of the supporting nanoparticle at a given time. The m indicates the mass of the supporting nanoparticles in solution (g).

RESULTS AND DISCUSSION

Adsorption effect on removal of MB 5G in ultrasonic process conditions

The adsorption interaction between MB 5G and bimetallic Pt/Co loaded GO material was tested using the bimetallic Pt/Co loaded GO adsorbent, ultrasonic wavelength, dye concentrations, H_2O_2 concentration, temperatures and pH parameters. The Analysis datas reflected in Figure 1.

The examined of sorption effect of MB 5G concentration and bimetallic Pt/Co loaded GO material concentration

The adsorbent concentration parameter test is one of the most important analyzes in dye removal in an aqueous solution environment. In the adsorption process study, it was determined that the maximum dye removal activity was reached by using 30 mg bimetallic Pt/Co loaded GO absorbance (approximately 84.6% yield). The analysis data in Figure 1 (a) are reflected. It can express this situation as a result of the increase in the number of active areas due to the increase in surface area(Çiçek et al., 2007). It was determined that the amount of adsorbent used above this value had a negative effect on the amount of dyestuff. This can be expressed as a result of the active sites on the adsorbent surface overlapping each other during the process. Also, the increased amount of adsorbent can have a negative effect on OH radicals such as scavenging function that may be caused the reduction of removal dye (Sen et al., 2018). One of the other important parameters in adsorption studies is the amount of dye concentration. In this study, the amount of MB 5G Concentration was tested in the range of 24-52 mg. In the adsorption mechanisms, it was determined that the dye concentration contributed significantly to

the mass transfer resistance between liquid and solid (Savk et al., 2019). In some paper, it was stated that some intermediate molecules formed after the adsorption of MB 5G with OH radicals cause a negative environment of resistance in dye efficacy (Dindarsafa et al., 2017).

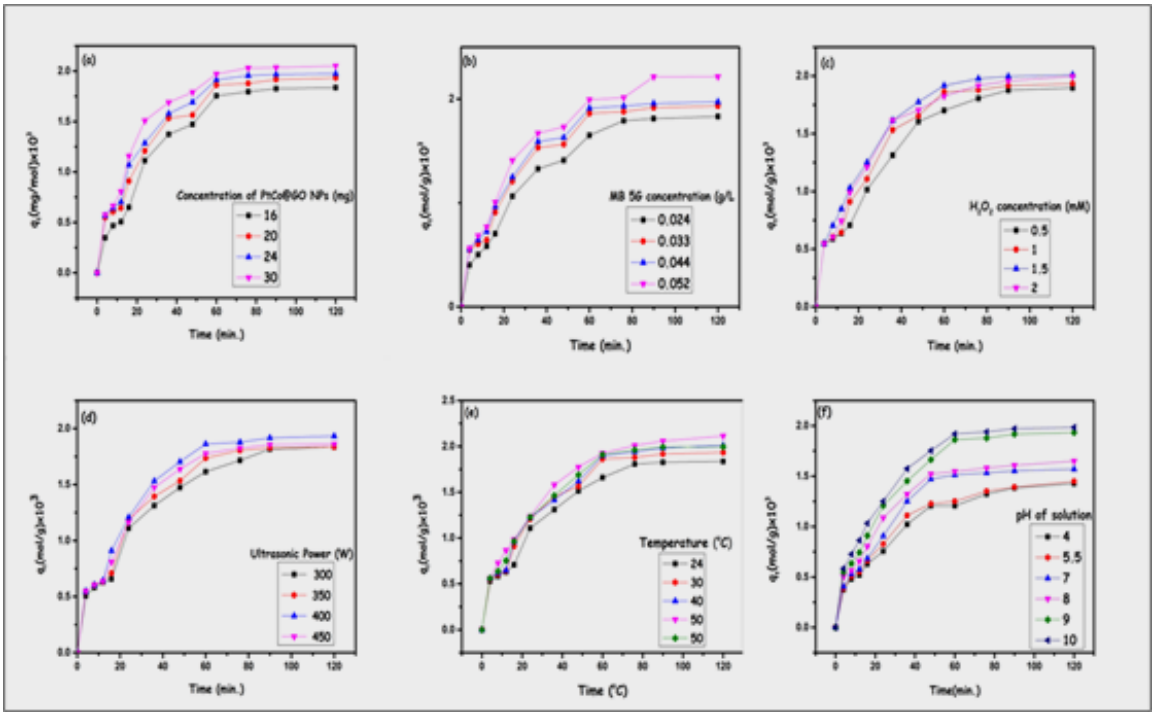

Figure 1. Experimental results of MB 5G removal using bimetallic Pt/Co loaded GO materials at different experimental conditions of (a) Bimetallic Pt/Co loaded GO materials concentrations, (b) MB 5G con., (c) Ultrasonic wave., (d) H_2O_2 conc., (e) Temp., (f) pH.

The sorption effects of temperatures, and pH on the removal of MB 5G

To detect the effects of temperature, five experiments in the range of 24-55 ^oC given in Figure 1e. It was determined that the amount of the adsorbed dye increased in parallel with the increasing temperature and the optimum temperature value was determined as 50 ^oC. The temperature increase of the process medium to the environment leads to increased movement of dye molecules. In this case, the dyestuff used in the study can be explained by providing sufficient energy for the active areas on the surface to interact (Aksu et al., 2000). The increase in the temperature of the environment can cause the pore size of the adsorbent particle to change. This can create a positive synergistic effect in dye removal due to the increase in diffusion rate between the adsorbent and the dye (Khataee et al., 2016). The highest adsorption performance (qm) was detected to be approximately 1150.7 mg g^{-1} at 50 ^oC. In addition, the adsoption perfomance of the as-synthesed bimetallic Pt/Co loaded GO material used in this study was compared with other studies in Table 1. As seen the adsorption performance is good when compared the other materials tested in the different dystaffs. Another parameters is pH, and the pH factor is very important in dye removal in adsorption process mechanisms. pH value caused the changing charges of adsorbents and the surface charges effect the effectivness of adsorption perfomance. The experments results conducted at different pH values are given Figure 1f. In adsorption studies, the pH value of the iso electric point of the adsorbent material has an extremely important effect. In addition, the fact that the MB 5G dye is a cationic dye creates an important effect. A percent dye removal of 64.3% was obtained at pH values of 4. This is result of a reflection resulting from competition between proton ions

for MB 5G and adsorption sites (Khataee et al., 2015). However, increasing the pH of the medium resulted in a high dye removal efficiency of 86.2%. It may be explained by the increased interaction of the binding site and its functional groups as a result of enhancing surface area of adsorbent (Mahir Alkan et al., 2005; V. Yönten et al., 2020; Vahap Yönten et al., 2020). In addition, it has made a positive contribution to the increase of OH radical functions in the environment and to increase the removal of dyestuff. This associated with the increasing the numbers of OH radicals orginated from H_2O_2 (Nasuha et al., 2010). As a result, it was observed that the pH factor was extremely effective in MB 5G removal (Figure 5f).

Table1. Comparation adsorption performans of bimetallic Pt/Co loaded on GO materials to some adsorbents tested on the removal different dystuffs.

Adsorbents	Adsorption perfomance, mg/g	Reference
Activated carbon nanotubes	399	(Ma et al., 2012)
Nano-Fe_3O_4	93.08	(Iram et al., 2010)
Chitosan–graphite oxide	64.935	(Zolgharnein et al., 2015)
Grafted polyacrylamide on SiO2 nanocomposites	378	(Qin et al., 2015)
Turkish Green Clay	195.74	(W. Zhao et al., 2015)
Graphene	153.85	(T. Liu et al., 2012)
Fe_3O_4/porous graphene	460	(Ghorai et al., 2014)
Pt-Co@GO	1150.7	This study

The sorption effect of H_2O_2 cons, and ultrasonic iridations on MB 5G removal

In the ultrasonic process environment, H_2O_2 molecule is an effective factor in dye removal. In ultrasonic systems, it has been observed that H_2O_2 concentration has a positive effect on dye removal in active OH radical increase (Vadivelan et al., 2005). The results showed that the MB 5G removal efficiency was observed to be most efficient in the presence of a 1.5 M H_2O_2 concentration (Figure 1c). This can be expressed as a result of the increase in the release of OH by interacting with the H_2O_2 molecule, the propagating waves in processes operating with ultrasonic systems. When the H_2O_2 concentration exceeded this value, a noticeable reduction in dye removal efficiency was obtained. As understood in equations (2) and (3), the being of excessive amount of H_2O_2 in the reaction medium lead to undesirable consequences such as the scavenging effect of OH radicals (Bagal et al., 2013).

$$H_2O_2 + {}^{\bullet}OH \rightarrow H_2O + HO_2^{\bullet} \quad (2)$$

$$HO_2^{\bullet} + {}^{\bullet}OH \rightarrow H_2O + O_2 \quad (3)$$

Ultrasonic power effect is another important factor in dye removal systems. (Figure 5d). The increase of ultrasound power effect creates a synergistic effect if dissolution turbans in the adsorption medium. This synergistic effect is positively reflected on the move rate of both reactive radical elements and the dye in the reaction environment(Bae et al., 2013; Q. Wu et al., 2016).

The comparison of some parameters investigated and their re-usability efficiency

Experimental studies to compare MB 5G removal at different parameter conditions are given in Figure 6a. As indicated in Figure 2a (A), the effect of MB 5G dye removal on ultrasonic and H_2O_2, respectively, was tested. As a result of the analysis, the efficiency of dye removal was obtained at approximately 3.25% and 5.64%. In this case, the conversion coefficient of H_2O_2 molecules to free OH radicals during the Adsorption process is a result of the reflection (as in equation 6) of the death of the OH radical process. Another reason is that US / Pt/Co loaded on GO / H_2O_2 further increases the surface area by increasing interaction with ultrasonic waves in the presence of process conditions. thus, it

provides a positive synergistic effect to the removal of dyestuffs(Xu et al., 2012). The stability of the adsorbent used in dye removal using the adsorption method is an important factor in testing the reusability effect (Huang et al., 2014). Five consecutive sample studies were performed on the reusability of magnetic Pt/Co loaded on GO adsorbents in the presence of constant conditions (Figure 2b). As shown in Figure 2b, the nano-adsorbent activity showed that it maintained its activity at approximately 60.2% after five consecutive experiments. These data showed that Pt/Co loaded on GO adsorbent can be used as an important promoter in dye removal. Figure 2c shows the variation of the first and last absorption peaks due to the interaction between the Pt/Co loaded on GO and MB 5G in 120 min.

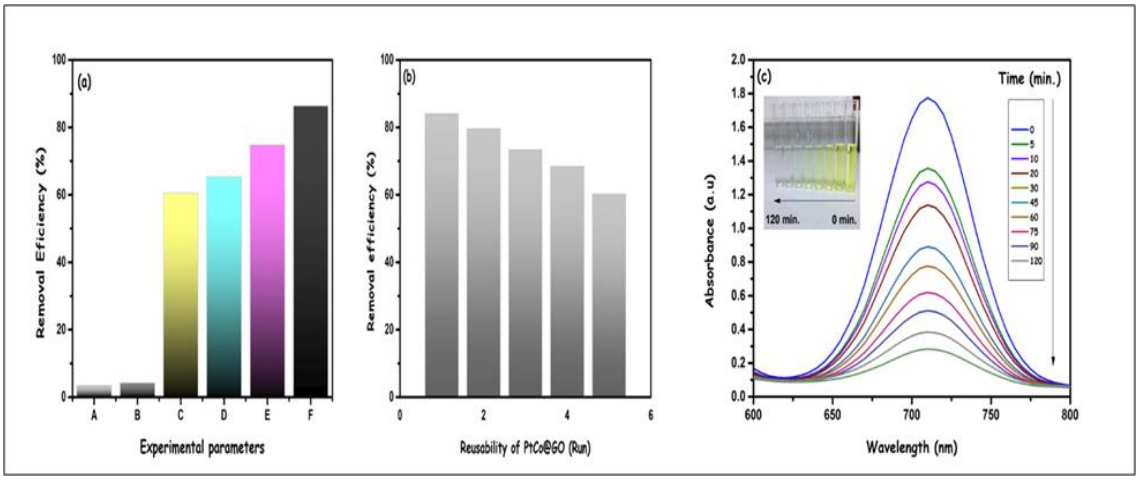

Figure 2. (a) The removal MB 5G results tested at different conditions using bimetallic Pt/Co loaded on GO adsorbents; Ultrasonic iridation (A), cons of H_2O_2 (B), cons. of bimetallic Pt/Co loaded on GO (C), Adsorbent /H_2O_2 (D), adsorbent /Ultrasonic iridation (E), Pt-Co@GO / Ultrasonic iridation /H_2O_2 (F). (b) recycle of adsorbent in the MB 5G solution. (c) Absorbance: MB 5G at 300-500 nm.

Adsorption kinetic parameters

Kinetic data are valuable to interpret the adsorption method for determination removal pullutans in water sources. By determinations kinetic data, explaining of the mechanism of adsorption at different kinetic studies begin easier (Huang et al., 2014). In order to understand the reaction state of MB 5G dye removal in the wastewater environment, the so-called first-order kinetic model and the so-called second-order kinetic model and intra-particle diffusion model analyzes were investigated. In the calculations, the equaitons (7-11) given below were used to interpret the mechanism of adsorpiton MB 5G tested in thi study (Khataee et al., 2017).

$$\ln(q_e-q_t) = \ln q_e - k_i t \quad (4)$$

$$\frac{t}{qe} = \frac{1}{k_2 q_e^2} + \frac{1}{q_e} t \quad (5)$$

$$t_{1/2} = \frac{1}{k_2 q_e} \quad (6)$$

$$h = k_2 q_e \quad (7)$$

$$q_t = k_{int} t_{1/2} + C \quad (8)$$

Where; t and ki explain the time and adsorption rate constant, respectively. The qe and qt quantities describe the amount of the dye (mol.g-1) in the initial and final state, respectively. The data obtained from the kinetic analysis are reflected in Table 1. The 2, 4, and 5 kinetic inequalities are preferred to

investigate whether the adsorption mechanism is either first-order or second-order, respectively (Hassani et al., 2015). Equations 6 and 11 are preferred to test the half-life of the adsorption process and the initial rate of intra-particle diffusion, respectively(Chen et al., 2014). The expression k_{int} (mg (g $min^{-1/2}$) -1 in Table 3 explains the intra-particle diffusion rate constant.

Table 2. Kinetic data of magnetic based bimetallic Pt/Co loaded on GO of the MB 5G adsorption.

T/K	Pt-Co@GO dosage ($mg.L^1$)	PH	US power (W)	MB 5G $mg.L^{-1}$	[H_2O_2] (mM)	Pseudo second-order R^2	q_e (cal.) ($mg.g^{-1}$) 10^3	q_e (exp.) ($mg.g^{-1}$).10^3	k_2 (g.mg min^{-1}) 10^{11}	R^2	h(mol $min^{-1}g^{-1}$)	$t_{1/2}$ (min)
297	20	9	400	33	1	0.59	2.29	2.28	1.52	0.99	3.46	0.288
303	20	9	400	33	1	0.78	2.43	2.44	1.62	0.99	3.95	0.253
313	20	9	400	33	1	0.89	2.39	2.38	1.83	0.99	3.87	0.257
323	20	9	400	33	1	0.70	2.65	2.65	1.5	0.99	3.98	0.251
333	20	9	400	33	1	0.76	2.37	2.37	2.23	0.99	5.28	0.189
303	20	4	400	33	1	0.74	1.71	1.72	2.51	0.99	4.32	0.231
303	20	5.5	400	33	1	0.81	1.71	1.72	2.72	0.99	4.67	0.214
303	20	7	400	33	1	0.85	1.82	1.82	3.51	0.99	6.38	0.156
303	20	8	400	33	1	0.89	2.03	2.03	2.11	0.99	4.28	0.233
303	20	10	400	33	1	0.90	2.37	2.38	2.32	0.99	5.52	0.181
303	20	9	400	24	1	0.82	2.45	2.45	1.20	0.99	2.94	0.340
303	20	9	400	44	1	0.73	2.23	2.24	3.36	0.99	7.52	0.132
303	20	9	400	52	1	0.71	2.96	2.95	1.13	0.99	3.34	0.299
303	16	9	400	33	1	0.86	2.3	2.29	1.84	0.99	4.21	0.237
303	24	9	400	33	1	0.75	2.44	2.45	1.82	0.99	4.45	0.224
303	30	9	400	33	1	0.84	2.36	2.36	2.85	0.99	6.72	0.148
303	20	9	300	33	1	0.91	2.28	2.29	1.65	0.99	3.77	0.265
303	20	9	350	33	1	0.74	2.27	2.27	1.88	0.99	4.26	0.234
303	20	9	450	33	1	0.82	2.3	2.29	1.89	0.99	4.32	0.231
303	20	9	400	33	0,5	0.75	2.38	2.37	1.72	0.99	4.07	0.245
303	20	9	400	33	1.5	0.86	2.43	2.44	1.93	0.99	4.70	0.212
303	20	9	400	33	2	0.91	2.40	2.41	1.84	0.99	4.43	0.225

Table 3. The kinetic results for mechanisim of MB 5G adsorption using bimetallic Pt/Co loaded on GO adsorbents from aquatic solution.

			Mass transfer			Intraparticle diffusion			
T/K	**Pt-Co@GO $mg.L^{-1}$**	**pH**	**US power (W)**	**[H2O2] (mM)**	**MB 5G $mg.L^{-1}$**	**kint,1 $mg.g^{-1}$ $min^{-1/2}$**	**R_1^2**	**kint,2 $mg.g^{-1}$ min^{-1}**	**R_2^2**
298	20	9	400	1	33	2.189	0.94	0.0535	0.84
303	20	9	400	1	33	2.282	0.92	0.0452	0.87
308	20	9	400	1	33	2.345	0.99	0.0243	0.95
318	32	9	400	1	33	2.533	0.93	0.0248	0.92
328	20	9	400	1	33	2.465	0.96	0.0203	0.94
303	20	4	400	1	33	2.189	0.91	0.0535	0.99
303	20	5.5	400	1	33	1.854	0.98	0.0532	0.99
303	20	7	400	1	33	2.429	0.92	0.0248	0.91
303	20	8	400	1	33	2.447	0.99	0.0294	0.92
303	20	10	400	1	33	2.657	0.94	0.0432	0.98
303	20	9	400	1	24	1.983	0.93	0.0256	0.97
303	20	9	400	1	44	2.433	0.94	0.0244	0.92
303	20	9	400	1	52	2.641	0.99	0.0365	0.96
303	16	9	400	1	33	2.237	0.98	0.0379	0.97
303	24	9	400	1	33	2.331	0.99	0.0287	0.98
303	30	9	400	1	33	2.454	0.93	0.0341	0.99
303	20	9	300	1	33	2.348	0.98	0.0364	0.98
303	20	9	350	1	33	2.379	0.99	0.0356	0.98
303	20	9	450	1	33	2.562	0.97	0.0324	0.95
303	20	9	400	0,5	33	2.142	0.97	0.0453	0.96
303	20	9	400	1.5	33	2.346	0.92	0.0265	0.98
303	20	9	400	2	33	2.423	096	0.0234	0.94

Thermodinamic values of MB 5G adsorption using bimetallic Pt/Co loaded on GO adsorbent

The constants of rate the adsoption of MB 5G are referenced using Arrhenius Equation 9. In this equation, the A and T quantities represent the Arrhenius constant and temperature independent of temperature. As indicated in Figure 3a, the activation energy was determined to be 9.55. So, the adsorption mechanism of MB 5G using bimetallic Pt/Co loaded on GO adsorbent showed that it is physically occurring. Because the activation energy (5-40 kJ / mol) explains that the adsorption process proceeds physically. However, if it is above this value, the reaction mechanism shows that it proceeds chemically(Akova et al., 2000; Doğan et al., 2003). Other thermodynamic activation functions such as enthalpy (ΔH °), entropy (ΔS °) and Gibbs free energy (ΔG °) were determined using Eyring equation (10) and equation (11)(Kannan et al., 2001).

$$lnk_2 = lnA - \frac{Ea}{R.T} \quad (9)$$

$$ln(k_2/T) = ln\,(\text{kb}/h) + \frac{\Delta S}{R} - \frac{\Delta H}{RT} \quad (10)$$

In equation 10, the change in Gibbs energy from the slope 1 / T versus ln (k_2 / T) was determined to be + 12.71 kJ / mol at 303 K. These results show that the mechanism does not automatically proceed and the process is carried out by transferring energy from an external source. In addition, the standard enthalpy change value was determined as 6.93 kJ / mol. This implies that the adsorption mechanism takes place endothermicly(Figure 3b).

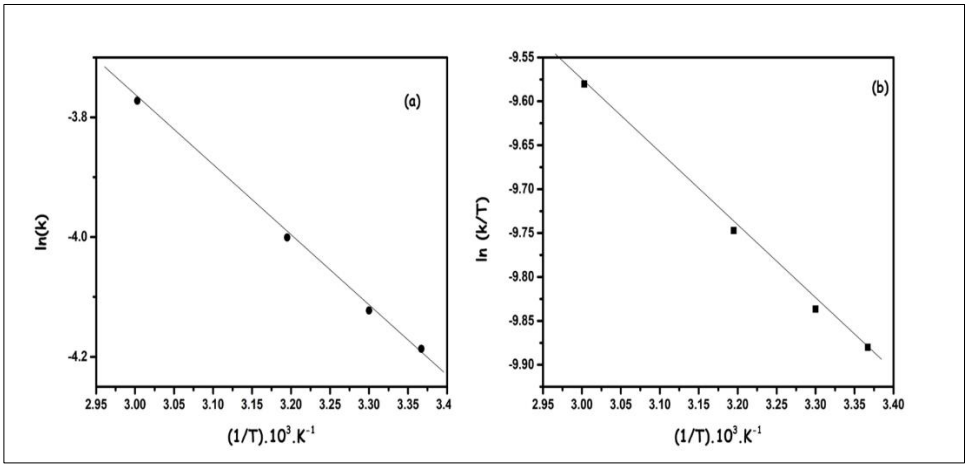

Figure 3. (a) Arrhenius plot and (b) thermodynamic function

CONCLUSION

In this work, the bimetallic Pt/Co loaded on GO material was produced following a series of simple hydrothermal methods. It was performed in the presence of a number of experimental parameters including the effect of pH, contact time, H_2O_2, initial MB 5G dye concentration and temperatures. The most suitable parameters were determined as given below. 30 mg adsorbent amount, 0.052 g / L MB 5G amount, 1.5 mM H_2O_2 concentration, 400 W ultrasonic power, 50 ^oC temperature and 10 pH. At the end of 120 minutes reaction time, 86.4% dye removal efficiency was obtained in the presence of pH 10. The studied determined that O_2 radicals have a synergistic effect on MB 5G dye removal. The kinetics data obtained in the MB 5G adsorption using bimetallic Pt/Co loaded on GO materials were used and adsorption data such as entropy (ΔS *), Gibbs free energy (ΔG *) and activation energy (Ea) were obtained. The data obtained showed that it was understood that the adsorption reaction mechanism did not occur spontaneously and that the process was an endothermic event. The maximum adsorption

capacity (qm) of bimetallic Pt/Co loaded on GO material for maxilon blue 5G was found to be 1150.7 mg g^{-1}. These data showed that bimetallic Pt/Co loaded on GO material proved to be as an effective nano adsorbent as an alternative adsorbent for organic dye removal like MB 5G.

Conflict of Interest

I declare that there is no conflict of interest during the planning, execution and writing of the article.

Author's Contiıbutions

I hereby declare that the planning, execution and writing of the article was done by me as the sole author of the article.

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