Synthesis, Characterization Of (CD-g-p(SA-MAA) And Adsorptive Removal Of Pb (II) Ions From Aqueous Solution

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Abstract:

The superimposed (CD- g.p(SA-MAA) hydrogel synthesized from *Ceratophyllumdermersum*, sodium alginate, and methyl acrylic acid was prepared in the presence of crosslinking agent (MBA) and potassium persulfate (KPS). The structural and surface characteristics of the prepared surface were studied and diagnosed by means of the field emission scanning electron microscope (FE-SEM) technique.Four main factors were studied including the effect of surface weight, time, shaking speed, and temperatures on the adsorption process of lead ions on the synthesized surface with different weights, times, speeds, and temperatures, respectively. While the current results demonstrate that the best weight was 0.05g, the best time was 120 minutes, and the best shaking speed was 120rpm. As for the effect of temperature, the results show that the process of lead ion adsorption on the adsorbent surface decreases with increasing temperature. The results of the current study also indicate that the removal rate of lead ions on the synthesized surface was 68.5%.

Keywords: **Heavy elements, Lead Pb (II), nano-adsorption, Hydrogel**
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1.Introduction:

One of society's most important problems is water pollution, which results in a change in the physical, chemical, and biological characteristics of water, making it less suitable for natural uses and harming the aquatic environment in many ways, such as by reducing dissolved oxygen, increasing water temperatures, and increasing turbidity [1].

Heavy metals are released into rivers, lakes, and groundwater when they enter the water system through industrial wastewater, acid rain, or soil erosion. While heavy metal pollution in water has an impact on plants, animals, and people depending on the solubility, bioavailability of minerals, carrying capacity of the organism, pH, and presence of some ions that enter with bioavailability. Because they can interact with cellular components and compromise their functions in plants, animals, or people, all heavy metals are considered toxic when they are present in high concentrations [2][3].

The ability of aquatic plants to accumulate these pollutants despite their toxicity comes as a result of their possession of multiple means that enable them to remove their toxicity [4]. The ability of plants to absorb these elements varies greatly depending on the type of plant, genetic makeup, age, and stage of growth of the plant, as well as the type of

2.2 Preparation of the standard solution of Pb (II) ion at a concentration of (200mg/L)

The standard solution for chromium ion Pb (II) was prepared by dissolving 0.5g)) of $Pb(NO_3)_2$ in a small amount of distilled water, and then transferred to the volumetric bottle of (1000 ml) and then we supplemented the volume with distilled water up to the mark.

2.3 Effect of Adsorbent Weight on the Adsorption

The effect of changing the weight of the adsorbent material for the prepared hydrogel superimposed in the adsorption process was studied, as 10 ml of lead ion Pb (II) solution was added with a concentration of 200 mg/L were added to different weights of the Synthesized superimposed (0.1, 0.08, 0.05, 0.03, 0.01, 0.008, 0.005, 0.003, 0.001) and then placed in temperature-controlled shaker devices at a temperature of (20°C), for a period of 120 min, and at a speed of 120 rpm to reach the equilibrium state after filtering with filter paper (0.45 Millipore), after which the adsorption is measured.

2.4 Effect of shaking speed on adsorption

The effect of shake speed was studied using different shaking speeds 100, 110, 120, 130, 140, and 150. We fix the conditions, including the temperature of 20°C, the adsorbent concentration of 200mg/L, the surface weight of 0.05g, and solution volume of 10ml with a change in shaker speed.

2.5 Equilibrium Time of Adsorption Systems

To identify the equilibrium time between the adsorbent surface and the adsorbent, we fix the conditions, including the temperature (20°C), the concentration of the adsorbent (200mg/L), the weight of the adsorbent surface (0.05g), and the volume of the solution (10ml), with a change in the time factor, and then We take (1-180) min for the lead ion Pb (II).

element itself because different elements behave differently [5].

Recently, the removal of heavy metals by nanomaterial for wastewater treatment has been linked to nano-adsorption technology and influencing factors like pH, temperature, adsorbents, adsorption time, ion concentration, and mechanisms [6].

2.Materials and Methods:

2.1The preparation of superimposed (CD-g.p(SA-MAA)

The superimposed (CD- g.p(SA-MAA) was synthesized by preparing a group of solutions and then mixing them. We start by dissolving (0.2g) of ceratophyllum in 10 ml of distilled water, which is placed in an ultrasound device until dissolution, then prepare (SA) by dissolving 1g of it in 20 ml of distilled water, then stirred by a magnetic stirrer at a temperature of 60 for a period of 60 minutes, then 10 ml of MAA is taken, and then we prepare the clamping agent (MBA) by taking an amount (0.1 g) of it and melting it 4 ml of distilled water that dissolves the polymers, then we prepare the starting agent (kps) by taking an amount (0.1g) and dissolving it in 4 ml of distilled water, it works on the formation of free radicals through its interaction with sodium alginate. Then we mix the solutions by adding a solution (CD) to a solution (SA) with continuous stirring and at a temperature of 20C for 30 minutes, then add MAA solution to the formed solution and also with continuous stirring for 15 minutes, followed by adding (KBS) (MBA) Slowly with continuous stirring for a period of 60 minutes, then adding nitrogen gas for a period of two minutes, working to expel oxygen because the reaction of free radicals occurs in the absence of oxygen. The reactant is then dried by a temperature of 70 C for three days, and then ground to obtain a certain weight of the nano-superimposed surface.

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of about (55 nm) prepared particles, and it has a sponge-like structure like a compact network as a result of the strong bonding of the crosslinking agent as well as the presence of ceratophyhm with polymeric chains and their dispersal homogeneously throughout the hydrogel matrix, and this is due to the interfering interaction of the ceratophyhm in the composition of the superimposed due to the functional groups present on the surface of each of the ceratophyhm and the hydrogel (He and Gao, 2010). Also, Figure (2) demonstrate the EDX of the proportions of the elements included in the composition of the superimposed, which shows a clear change in the proportion of the elements that make up the synthesized surface.

2.5 Effect of Temperature on the Adsorption

The effect of temperature on adsorption at different temperatures (30,25,20,15 °C) was studied in the adsorption of lead ion Pb (II) on the surface of the synthesized superimposed, where the effect of each temperature in the process of adsorption of lead Pb (II) was recorded.

3. Results and Discussion:

3.1 Field Emission-Scanning Electron Microscopy (FE-SEM)

By usingField Emission-Scanning Electron Microscopy (FE-SEM), the present study indicated in figure (1) that the surface of the hydrogel is smooth, porous and has a nanostructure, with an average

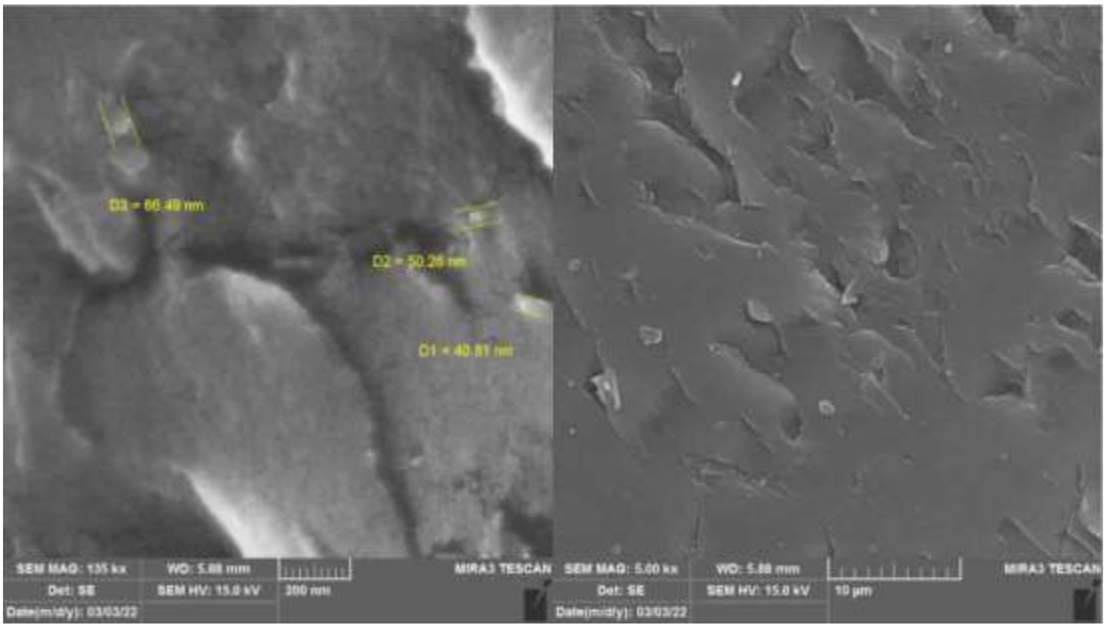

Figure (1): The Field Emission Scanning Electron Microscope (FE-SEM) technique of the synthesized superimposedCD-g-P(SA-MAA) at different magnification powers

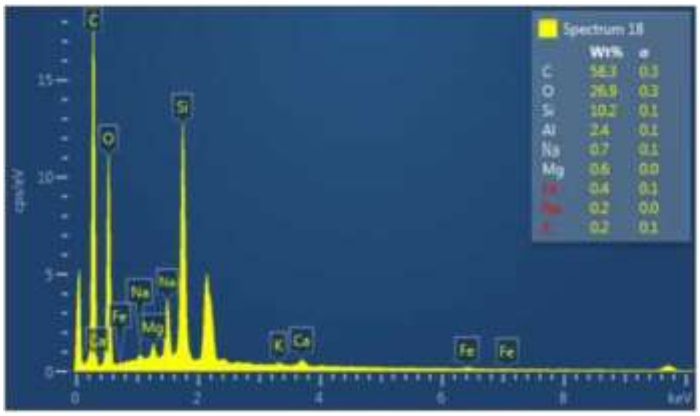

Figure (2): The proportions of the elements in the composition of the synthesized superimposed CD-g-P(SA-MAA)

3.2 Effect of adsorbent Weight on Adsorption:

To study the impact of the adsorbent surface weight on the adsorption process, different weights of the adsorbent material were used on the surface of the synthesized superimposed CD-g-P(SA-MAA) (0.01-0.15g), with a constant concentration of the lead ion Pb (II) and at a temperature of 20°C. The results of the study indicate that the best weight used in this process was 0.05g as explained in table 1.

Table (1): The adsorbent amount value for the lead ion Pb (II) using various weights on the synthesized superimposed CD-g-P(SA-MAA)surface with all other conditions fixed.

C_0 (mg/L)	Adsorbent Weight (g)	CD-g-P(SA-MA)		
		Ce mg /L	Q_e(mg/g)	% Re
200	0.001	45.02105	30.996	77.5
	0.005	37.12632	32.575	81.4
	0.010	29.33684	34.133	85.3
	0.050	29.12632	34.175	85.4
	0.100	28.81053	34.238	85.6
	0.150	28.49474	34.301	85.8

3.3 Effect of Shaking Rate

The results of the current study reveal that the best shaking speed was at 120 rpm. In addition, increasing the shaking speed increases the kinetic energy of the lead ion Pb (II) and adsorbent surface particles, as shown in table (2).

Table (2): The adsorbent amount value for the lead ion Pb (II) using various speeds on the synthesized superimposed CD-g-P(SA-MAA)surface with all other conditions fixed.

C_0 (mg/L)	Speed	CD-g-P(SA-MA)

		***Ce* mg /L**	**Q_e**(mg/g)	**% Re**
200	100	30.81053	33.837	84.594
	110	29.75789	34.048	85.121
	120	29.33684	34.132	85.331
	130	30.91579	33.816	84.542
	140	32.28421	33.543	83.857
	150	32.38947	33.522	83.805

3.4Equilibrium Times

As explained in table 3, the results of this study indicate that the time required to reach the equilibrium state for the adsorption of the lead ion Pb (II) on the surface of the synthesized superimposed CD-g-P(SA-MAA)was 120. These results agreed with the previous study findings done by (Bhattacharyya and Ray, 2015).

Table (3): The adsorbent amount value for the lead ion Pb (II) using various times on the synthesized superimposed CD-g-P(SA-MAA)surface with all other conditions fixed.

C_0 (mg/L)	**Time**	**CD-g-P(SA-MA)**		
		***Ce* mg /L**	**Q_e**(mg/g)	**% Re**
200	1	155.336	8.932	22.331
200	2	145.231	10.953	27.384
200	4	133.863	13.227	33.068
200	6	117.968	16.406	41.015
200	10	115.231	16.953	42.384
200	15	74.6	25.08	62.7
200	30	63.336	27.332	68.331
200	45	41.863	31.627	79.068
200	60	35.442	32.911	82.278

200	90	31.231	33.753	84.384
200	120	29.126	34.174	85.436
200	180	29.021	34.195	85.489

that the amount of adsorption on the surface of the synthesized superimposed CD-g-P(SA-MAA) raised with increasing temperature, which means that the process of removing these ions from the aqueous solution favors higher temperatures.

3.5 Effect of Temperature and Calculation of Thermodynamic Functions of Adsorption Process

Table (4) shows the adsorption of the lead ion Pb (II) from an aqueous solution. While the current study reported

Table (4): The values of the lead ion Pb (II) adsorption on the synthesized superimposed CD-g-P(SA-MAA) surface at different temperatures

	C15°C		**20°C**		**25°C**		**30°C**	
Lead Ion Pb(II)	***Ce (mg/L)***	***Qe (mg/g)***	***Ce (mg/L)***	***Qe (mg/g)***	***Ce (mg/L)***	***Qe (mg/g)***	***Ce (mg/L)***	***Qe (mg/g)***
	1.652	9.669	6.810	8.637	12.073	7.585	7.757	8.448
	3.547	19.290	11.757	17.648	18.810	16.237	18.284	16.343
	9.336	28.132	19.968	26.006	25.021	24.995	37.547	22.490
	17.863	36.427	27.442	34.511	29.336	34.132	56.810	28.637
	22.073	45.585	74.705	35.058	74.389	35.122	99.336	30.132
	26.810	54.637	85.442	42.911	99.863	40.027	125.021	34.995
	44.284	61.143	115.757	46.848	153.336	39.332	174.810	35.037
	80.705	63.858	139.442	52.111	182.494	43.501	205.231	38.953
	131.863	63.627	175.547	54.890	209.863	48.027	219.442	46.111
	156.389	68.722	195.863	60.827	237.757	52.448	260.073	47.985

9860

4. Conclusions and Recommendations:

In this study, we concluded that the use of synthesized hydrogel is an effective absorbent for removing lead ions from the aqueous solution. The results of this study also indicate that the adsorption amount of heavy metal ions increases at 0.05g, time of 120min, and shaking speed of 120rpm, while the amount of adsorption decreases with increasing temperature, and this indicates that the adsorption process is exothermic.

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