Synthesis and Characterization of Nano-composite co-polymer: Adsorption and Removal Studies of vitamin B12 from Aqueous Solutions

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Abstract

Background: Nano-composite polymer from Nano graft co-polymer that has the ability to absorb, but not dissolve in, water at physiological conditions (pH, temperature, mass of adsorbent). research the adsorption systems of drug (vitamin B12 drug) on selected surfaces (Nano-composite co-polymer) at variable conditions of pH and temperature. Methods: The UV-Visible spectrometer was used to conduct the adsorption experiments. FTIR (Fourier transform infrared spectrometer) and AFM were used to study the chemical structures of polymers. Results: When the adsorption phenomenon was investigated at different temperatures (10, 20, 35 and 55 oC), it was found that the degree of adsorption of vitamin B12 drug on Nano-composite co-polymer was increased with temperature increase. The amounts of drug that were adsorbed on the Nano-composite co-polymer surface at different pH, were in the following order: 11, 6, 4, 2 and successful removal at pH 11.

Keyword: Nano –composite, Graft- co- polymer, Nano graft co-polymer, Isotherm, adsorption.

1. Introduction

Evolution and developed countries are confronted with ecological problems as a result of fleet urbanization, climate change, and an excess of solid waste production, which has resulted in a rise in the flow of toxins (dyes, pharmaceuticals, heavy metals, phenol, and so on) into clean water [1, 2]. Also in minute quantities, these pollutants pose significant risks to living organisms and human health. To reach environmental sustainability, new innovative water expertise are needed for effectively addressing global water pollution problems[3]. Numerous traditional wastewater treatment strategies rely on chemical consumption and the production of harmful byproducts that are hazardous to the environment. The current requirement is for the implementation of a technology that does not generate dangerous
chemicals, decreases energy usage and curing costs, and offers oblique emission control strategies. Nanotechnology is one of the methods used to eliminate pollutants.

Nanotechnology, as a potent technology of the twenty-first century, satisfies all of the conditions necessary for the advancement of science and technology. Additionally, nanotechnology contributes to the long-term growth of a variety of social cultures.[4, 5] Numerous methods are essential for the treatment of contaminants, including adsorption, ion exchange, chemical precipitation, membrane-based filtration, photo oxidation, evaporation, solvent extraction, and reverse osmosis[6, 7].

2. Experimental Part

Synthesis of Nano-Composite polymer

Hydrothermal polymerization was used to create nano-composite polymers. (1) Approximately 50 ml (C₂H₅OH), was applied to a 100 ml beaker, followed by the addition of distilled water and (two gram) “Nano graft co-polymer” and (one gram) Activated Carbon, then, The mix was closely stirred for one hour at hydrothermal 160 C°, heating was stopped after 24 hours. Allow 24 hours for the mixture to dry.

Scheme (1) : preparation Nano-composite polymer

Preparation of calibration curve

A 1000 mg/L stock solution was prepared by dissolve (1 gm) from (vitamin B12 drug) in (1 L) double distilled water. Concentrated working solutions. The cumulative absorbance (max) of a model drug (vitamin B12 drug) dissolved in aqueous media was determined to be 530nm. This wavelength was used to create standard curves for (vitamin B12 drug) in the range of 5 - 50 ppm, which is within the range of Beer-applicability. Lambert's law's (Figure 1).
Table (1): Statistical of calibration curve for different concentration of (vitamin B12 drug )

| Parameters                  | Proposed Method V12         |
|-----------------------------|----------------------------|
| λmax (nm)                   | 530                        |
| Beer’s law limit (mg/L)     | 5–50                       |
| Regression equation         | (Y = m X + C)              |
|                             | Y=0.021664X+(0.06506)      |
| Slope (m)                   | 0.02166                    |
| Intercept (C)               | 0.06506                    |
| Correlation coefficient (r^2)| 0.99036                    |
| Color                       | Red                        |

**Determination the adsorption isotherm**

0.05 g of the “nano composite polymer” was combined with 100 mL solutions containing drug concentrations ranging from 5 to 50 parts per million. The mixtures were shaken for 24 hours and centrifuged for 10 minutes at 3500 rpm. The concentration of the drug in the suspensions was then measured using spectrophotometry. The sum of drug adsorbed was determined using the equation below:

The amount of compound adsorbed (q_e) was estimated using the equation below[113].
Where \( q_e \) denotes the quantity adsorbed (mg), \( m \) denotes the weight of the adsorbent (g), \( C_0 \) denotes the initial concentration (mg/L), and \( C_e \) denotes the equilibrium concentration (mg/L). And the percentage removed was calculated as follows:

\[
(\text{E\%}) = \frac{C_0 - C_e}{C_0} \times 100
\]

### Effect of Different Parameters on Adsorption Process

#### Influence of drug conc.

Approximately 0.05 g of “nano composite polymer” was applied to 100 mL of (vitamin B12 drug conc. mg(5,10,20,30,40, and 50 mg/L) using a water-bath shaker for a 24 hour contact time at a steady agitation speed of 120 rpm.

#### Influence of pH of solution

The effect of the solution pH was determined by agitating 50 mg of polymer Nano composite and 100 mL of (vitamin B12) drug concentration (20 mg/L in a water-bath shaker at a temperature of 20 C°. The experiment was carried out at various pH values ranging from 3 to 11. Agitation was maintained at a steady speed of 120 rpm for the duration of the 24 hour contact period. Adjusting the pH with a few drops of diluted 0.1 N sodium hydroxide or 0.1 N hydrochloric acid and measuring with a pH meter.

#### Effect of mass dosage

The effect of mass dosage was investigated by agitating various masses (0.05, 0.1, 0.15, 0.2, and 0.25) of Nano composite polymer and 100 mL of (vitamin B12 drug) concentration (20 mg.L-1) in a shaker water bath at a temperature of 20 C°. The experiment was carried out at a pH of 6. Agitation was maintained at a steady speed of 120 rpm for the duration of the 24 hour contact period.

#### Effect of solution temp.

This parameter was studied by using solutions at various temp.(10 ,20 ,35 , and 50 C°) with a mass dosage of 50 mg of “Nano-composite polymer” and 100 mL of (vitamin B12 drug) concentration (20 mg.L-1), in a shaker water bath set to 20 C°. The experiment was carried out at a pH of 6. Agitation was maintained at a steady speed of 120 rpm for the duration of the 24 hour contact period.

### 3.Results and Discussion

#### Effect of pH

Process of adsorption molecules is affected by pH, probably because of the effect of pH on the surface properties of the molecules of the adsorbents [8], and the ionization, color and structural stability of the absorbent material depends on the pH [9]. The effect of pH on the
absorption of drug (vitamin B12) was studied on the surface of the Nano-composite polymer in the pH range (3,4,8,11) at a conc. of (20 mg L\(^{-1}\)). The results showed that adsorption efficiency and removal percentage increased by The increasing in pH is due to the increased concentration of negative hydroxyl ions (OH), which in turn increases the hydrostatic attraction between the adsorbed molecules and the surface and also increases the hydrogen bonds between them in addition Increasing the efficiency of adsorption with the increase of the acidic function can be explained by the fact that the increase of the acidic function leads to an increase in the efficiency of the acidic groups present in the synthesis of the absorbent material. In addition, the effect of Vandervals forces and electrostatic attraction forces between the adsorption and adsorption sites on the surface\[10\].

Figure (2): Influence of pH on the adsorption capacity and primary percentage removal

**Effect the mass of Nano–composite polymer**

This research was done to investigate the effect of polymer Nano–composite dose on the vitamin B12 removal (adsorption) at 20\(^\circ\)C. Fig. (3), exhibits that the removal % of vitamin B12 increased by an rise in the polymer Nano–composite dose (0.01–0.25g). It is evident that via raising the adsorbent mass the quantity of adsorbed vitamin B12 rises but adsorption power, the quantity adsorbed per unit mass, decreases. Increasing the amount of the adsorbent with constant concentration of the adsorbent content increases the effective un-saturated sites [11, 12].
Figure (3): Effect the mass of Nano–composite polymer

**Effect of initial vitamin B12 conc.**
The amount of (vitamin B12) adsorbed (q_e mg/g) and the amount of (vitamin B12) removed (R percent ) versus the primary concentration C_o under various experimental conditions. As shown in Fig. (4), the amount of drug adsorbed varies with primary drug concentration and increases with increasing primary drug concentration, but the removal percentage also decreases with increasing primary drug concentration. This is because increasing primary drug conc. rises the number of collisions between drug ions and the polymer nanocomposite, which improves the adsorbed amount. The effect of primary concentration drug on the efficiency of polymer nano–composite has been found to be significant for the basic drug. [2, 13-16].

Figure (4): The Effect of initial drug (vitamin B12) concentration
Effect of the temp.

The effect of temperature solution was studied via agitating of variants temperatures solution (10, 20, 35, and 50°C) containing 0.05 g of “polymer nano-composite” and 100 mL of vitamin B12 conc. (20ppm) in a water-bath shaker set to 20°C. The experiment was carried out at a pH of 6. Agitation was maintained at a constant pace for the duration of the communication period, 24 hours. Temperature has a significant effect on the adsorption process since changes in temperature result in changes in the adsorbent's equilibrium efficiency for adsorption of a specific adsorbent [16, 17]. The absorption of drug decreases as temperature increases, suggesting that the adsorption reaction is exothermic, while temperature increases suggest that the adsorption reaction is endo-thermic. As the temperature rose, the physical bonding between the organic complexes (including the drug) and the adsorbent's active sites decreased. Besides a decrease in the degree of freedom of adsorbed species and a decrease in available adsorption active sites [18, 19].

Fig. (5): Influence of the temp. on adsorption effecency and removal percentage

4.Conclusion

- The Nano – composite polymer appeared of the highest activity in the adsorption from a solution of the drug.
- The removal percentage of drug was depending on the pH and temperature of the solution.
- Adsorption efficiency and removal percentage increased by the increasing in pH.

5.References

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