

Studying the effect of adding Magnesium oxide-nano to poly hydroxamic acid on the adsorption Isotherms of V^{+5} and Fe^{+3}



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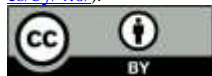
Keywords:

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ABSTRACT

In this study, the free radical mechanism of the copolymerization between styrene and methyl methacrylate was used to synthesize the copolymers (styrene-methyl methacrylate) hydroxamic acid and the copolymer (styrene-acrylic acid) hydroxamic acid. Using a conversion rate of 10%, the molar mixing ratio was 1/1 with a benzoyl peroxide initiator at a temperature of 70 °C. The copolymer (styrene-methyl methacrylate) was prepared and the yielding polymer was characterized using FT-IR and HNMR. Through polymers prepared from poly(styrene-methyl methacrylate) and poly(styrene-acrylic acid); Poly(styrene-methyl methacrylate) hydroxamic acid was prepared, and poly(styrene-acrylic acid) hydroxamic acid was prepared with hydroxylamine hydrochloride. The reaction was carried out in a basic medium (pH = 12), using sodium hydroxide, with thermal reflux for 120 hours at a temperature of (70-80 °C). The yielding compound of poly(styrene-methyl methacrylate) hydroxamic acid was characterized using FT-IR. The adsorption capacity (Q_e) of polyhydroxamic acid for Fe^{+3} , V^{+5} ions was additionally examined in this study, both before and after adding Nano magnesium oxide. The effect of time and pH was also studied, as the adsorption capacity decreases at high or low pH. At pH = 6, the largest amount of adsorption was noted. Polyhydroxamic acid was used to compare the effects of temperature on the ability of these ions to adsorb from their aqueous solutions before and after the addition of Nano magnesium oxide. At two different temperatures, the heat of adsorption (H_e) of poly(styrene-methyl methacrylate) hydroxamic acid was estimated. The ferric ion is adsorbed physically whereas the vanadium ion is adsorbed chemically, based on the values of the adsorption temperature.

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1. INTRODUCTION

A nano-meter is one in a billionth of a meter, hence nanotechnology is the technology used to manipulate and control substances at the nanometer level (1 nanometer = one in the sum of 1 billionth of a meter). Molecules and atoms exist at the nanometer level [1]. As opposed to this, nanotechnology refers to a series of technologies involved in the setup, design, application, and employment of materials, structures, systems, and devices through modifying size and shape on the nanometer level [2].

Numerous aspects of medicinal, industrial and agricultural life as well as transportation, as well as fields like water technology and space research, will be significantly impacted by nanotechnology [3]. Its chemical name, $C_5H_5O_2$, indicates that it is an unsaturated ester. Chemical formal (C_8H_8) Styrene and chemical formal ($C_3H_4O_2$), which are utilized to create resins and polymers, are irritating to human eyes, skin, and mucous membranes. MMA is also utilized in these materials [4]. Methyl methacrylate (MMA) could be converted into the polymer's poly (MMA-ST) and poly (MMA-AA) by a variety of polymerization techniques, including ionic polymerization, radical polymerization, and other techniques. Uses in biomedicine and medicine, especially in metal plating and orthopedics [5].

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These chelated polymers, which have ring

structure and the capability for binding to the metal by no less than one donor atom, are utilized for removing the ions regarding toxic heavy elements from the aqueous solutions, including copper, iron, vanadium, cadmium, as well as other toxic heavy ions. They are amongst significant compounds that are utilized to make stable chelating reagents. In order to allow acid to interact with the metal ion and produce octahedral complex, the HA units are spaced appropriately apart throughout polymer chain [6,7]. Each one of the ligands is associated with a metal ion via the oxygen of carbonyl group which is a component of HA in ligand, and HA loses a proton regarding the hydroxyl group in one of the two ligands (ligand 0,0 Di denate) with a single negative charge. As a result, three acid molecules replace all molecules that were previously attached to metal ion, creating 6 sites of coordination around metal ion's triple positive charges. These coordination sites are equivalent to the three acid molecules' negative charges, which create three 5-membered rings around metal ion [8]. The general formula for HAs is shown below. HAs are derivatives of hydroxylamine molecules, which have hydrogen and nitrogen linked together [9,10]:



Figure 1: general formula of hydroxamic acid

R is an aryl group that has been substituted, saturated or unsaturated alkyl group, or a polymer. No matter what the other parts of the molecule are made of, the active group keeps its properties. The great capacity of HA polymers to adsorb the ions of certain toxic metals distinguishes them from other materials. A few of them represent extremely selective polymers that have been designed to take certain ions out of aqueous solutions. Additionally, HA polymers have higher selectivity than conventional ion exchanger types[11, 12].

Synthetic polymeric ligands are regarded as an efficient adsorbent material for the removal of heavy metals from industrial wastewater, according to recent studies, the most prominent of which is a study conducted by (Rahman et al., 2021)[13]. A free-radical initiation procedure was used to synthesize poly(methyl

acrylate) grafted palm cellulose, which was then followed by an oximation reaction to produce poly(hydroxamic acid) ligands. Finally, the metal analysis findings demonstrated that up to 85–97% of the lead, nickel, and chromium from electroplating effluent could be eliminated. A new polystyrene-poly(hydroxamic acid) interpenetrating network resin was effectively produced via suspension polymerization and interpenetrating network technology in another study by researchers (Cao et al., 2022)[14]. Due to their greater adsorption capacity than other adsorbents, FTIR and XPS analyses further demonstrate that rare earth ions are chemisorbed on the surface of polystyrene-poly(hydroxamic acid) interpenetrating network. This makes it a potential adsorbent for the adsorption of rare earth ions. Researchers (Duan et al., 2023)[15] used column experiments to examine the practical adsorption of poly(2-acrylamide-pentanedihydroxamic acid) resin to heavy metal ions. Overall, the findings showed that the innovative poly(2-acrylamide-pentanedihydroxamic acid) resin has a bright future for the treatment of wastewater containing heavy metals as a green and highly effective adsorbent.

2. MATERIALS AND METHODS

Benzoyl peroxide (B.P), Sodium hydroxide, Methyl metha acrylate, nitrogen gas, styrene Acrylic acid (98% SIGMA-ALDRICH), Hydroxyl amine hydrochloride (99%), Ethanol (99.9%), Benzene (99%), Chloroform (99%), Magnesium oxide_nano (>99), Vanadium (V) Oxide, and Iron(III) Oxide.

Tools and equipment used in this study

Magnetic Hote plate stirrer, Atomic Absorption Spectroscopy (AAS), pH-meter Centrifuge, Electric oven, Shaker water bath, Sensitive Balance, Nuclear magnetic resonance spectroscopy, and Infrared Ultraviolet and visible.

Poly (Styrene –Co-Methyl metha Acrylate) and poly (Styrene-Co-acrylic acid) Preparations

The flask has been closed as well as immersed in a water bath at for a period of 10 mins, at a temperature (70°-80°C) for 1hr with a magnetic stirring after adding purified styrene monomer of 37.40g (40 ml), purified methyl metha acrylate monomer of 37.4g (40ml), and initiator (Benzyl peroxide) of 0.03g to nitrogen gas for 10 mins. In the case when the mixture

becomes more viscous, we remove beaker from water bath, take off the lid, add gasoline for dissolving this polymer, and after that pouring the mixture into a beaker with ethanol ((80ml) for precipitating the polymer. The polymer is after that removed as a white mass, allowed to dry, and examined using infrared spectroscopy and nuclear magnetic resonance to get a diagnosis [21], similarly to prior preparation [16].

Poly (Styrene- Co-Methyl metha Acrylate) ana poly (Styrene-Co-Acrylic acid) hydroxamic acid Preparation

10 g of P (ST-Co-M.M. A) that had been made in advance is dissolved in a chloroform solvent of 70ml, and hydroxyl amine hydrochloride of 10g is added in a 1:10 ratio with ethanol (45ml) and deionized water (5ml). The mix is after that cooled to absolute zero degrees Celsius, and KOH (20g) is dissolved in the smallest amount of deionized water possible to create a solution. After cooling the mixture to 5°C and adding KOH solution and hydroxylamine hydrochloride solution, the mix is filtered, ignoring potassium chloride precipitate and keeping leachate of (NH₂OH). The filter is after that added to a polymer solution, like methacrylate, and the pH is measured; it must be between 12 and 13. The mix is after that placed in a 250 ml circular flask and heated sublimation for 120 hrs. After that, the compound was identified through infrared spectroscopy in the same manner as before poly (ST, Co, AA) HA preparation [17].

Addition of Magnesium oxide nano to polyhydroxamic acid

Polyhydroxyamic acid (PHA) (10g) made from homopolymer (MMA-Co-ST) and P (ST-Co-AA) has been dissolved in chloroform (10ml) before being combined with MgO (10g) nano and allowed to dry.

Studying the Capacity of Poly Hydroxamic Acid Sorption to Heavy Metal Elements

Study of ferric and Vanadium ions' adsorption capacity by the PHA before and after Magnesium oxide – nano addition:

The capacity of the adsorption has been investigated through mixing PHA of (1g) with (50 ml) of a vanadium ions' solution at 350 ppm concentration while continuously shaking the mixture

for 5 hrs at a temperature of 25 Celsius. The filtrate was after that separated from the sediment with the use of a centrifuge. Using the standard absorbance curve, the residual ion concentration in filtrate has been calculated by absorber Atomic and Vis-UV devices. The equilibrium ion concentration was established, and the next equation could be used to obtain the adsorption capacity [18,19].

$$Q_e = \frac{V(C_o - C_e)}{M} \dots \dots \dots (1 - 1)$$

V/ Represents size (50mL)

Co/ Primary focus

Ce/ focus on balance

M/ Weight of adsorbent (1g)

Study of factors that affect Vanadium and ferric ions' adsorption capacity by the PHA before and after adding nano:

Effects of the time on the capacity of adsorption

The impact of time has been investigated by first creating a range of the ferric ion, ferrous ion, and solutions, then combining 50.0ml of (350ppm) with (1g) of the PHA in sealed bottles with constant shaking for various times (1, 2, 3, 4, and 5 hrs). The filtrate is after that separated from the sediment with the use of centrifuge, and Vanadium ions' concentration in filtrate is determined through utilizing atomic adsorption and the UV-Vis's equipment.

Temperature effects on the capacity of adsorption

The impact of the degree of temperature has been investigated through first creating series of the Vanadium and freon ions' solutions, then mixing (50.0ml) of one gram of PHA with (350ppm) of that solution in tight bottles while shaking continuously for 5 hrs at various temperatures (10, 30, 50, and 70) degrees Celsius. After that, using a centrifuge, separate the filtrate from sediment, and calibrate the atomic absorption and (UV-Vis) devices to measure concentration regarding the rest of the ferrous ion in the filtrate.

Effect of acidity function on adsorption capacity

Through creating a variety of Vanadium ion solutions, the impact of acidity function on the

adsorption capacity has been investigated. Ferrous ion solution of 50 ml was then combined with PHA of 1g in tight bottles with a continuous shaking for 5 hrs at (2, 4, 6, 8, 10) pH range. After centrifuging filtrate in order to separate it from sediment, an atomic absorption instrument (UV-Vis) is used to determine how much ferrous ion is still present in filtrate.

3. RESULTS AND DISCUSSION

With the use of FTIR spectroscopy, the resultant polystyrene -CO- methyl metha acrylate has been identified; infrared spectra displayed an absorption band at (1786cm⁻¹) that has been caused by carbonyl group (C=O) vibration. According to figure 18, (2991cm⁻¹) absorption band is caused by (C-H) group absorption, a band at (1440cm⁻¹) is caused by (C-O) group absorption [20], and a band at (1446cm⁻¹) is caused by the absorption of (C=C) group.

Table 1: FTIR spectroscopy of polystyrene -CO- methyl metha acrylate.

Bonds	absorption band
C=O	1786cm ⁻¹
C-H	2991cm ⁻¹
C-O	1440cm ⁻¹
C=C	1446cm ⁻¹

Additionally, poly (styrene -CO- methyl metha acrylate has been identified with utilizing HNMR spectroscopy. NMR spectra of poly (ST-MMA) proton exhibited one signal at chemical displacement (= 3.610) which belonged to methyl group (CH3) ester protons. Medium single methyl group proton signal at (=1.25) and an aromatic ring group proton signal at (=7.63) were both present. Styrene-Co-methyl metha acrylate, the polymer, has been changed into poly hydroxamic acid. As indicated by following equation:

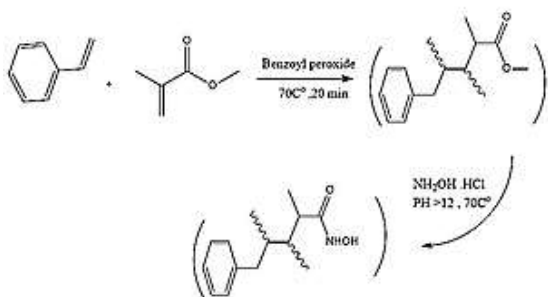


Figure 2: Equation for the formation of polyhydroxamic acid from the copolymer (styrene - methyl methacrylate)

With the use of FT-IR, the compound was identified. The spectra revealed absorption band in (3437cm⁻¹) region because of amide group (N-H) absorption and absorption band in the range (3558cm⁻¹-3618cm⁻¹) because of (O-H) group vibration. As it has been illustrated in Fig. 3, a bundle at (1734cm⁻¹) because of the carbonyl group's adsorption in the HA and a band at (910 cm⁻¹) because of group's absorption. Residual concentration (C_e) related to metal ion in filtrate after PHA treatment was used to determine PHA's adsorption capacity prior to and following the addition of the nano-carbons to the ions of the heavy metal at an equilibrium concentration. The remaining metal ion concentration was determined with the use of UV-Vis's spectroscopy and an atomic absorption instrument. Adsorption capacity (Q) and Equilibrium concentration (C_e) of the metal ions (V⁺⁵, Fe⁺³). In the case of multiple adsorptions, like methyl metha acrylate hydroxyamic acid, where metal ions have been removed from solutions after the addressing of other parameters, impact of treatment duration on the capacity of the process was investigated. As ion solutions were treated with PHA for a duration of (5–1) hrs, this had an impact on the capacity of adsorption from a particular acidic function and temperature. According to table (1,2) and figure (3,4), PHA was most reactive with the investigated ions (V⁺⁵, Fe⁺³) at the longest time of 5 hrs.

Additionally, the values of the equilibrium concentrations (C_e), initial concentrations (C₀), and adsorption capacity were analyzed to determine the temperature impact upon capacity of adsorption regarding multiple ions, like the methyl metha acrylate hydroxamic acid for (V⁺⁵, Fe⁺³) metal ions. Values of (Q) increase with decreasing the degree of the temperature since we observe that the maximum adsorption capacity value takes place at a (10°C) temperature, while values of (Q) decrease with increasing temperature since this causes metal ion separation from the surface of the adsorbent [21], as it can be seen from (table3,4) and (figs 6,7). Through values of equilibrium concentrations (C_e) and initial concentrations (C₀), it was possible to determine the impact of the function of acidity on adsorption capacity of the P (ST-Co-MMA) HA for examined ions V⁺⁵, Fe⁺³ With adsorption capacity (Q), it has been discovered that the capacity of the adsorption is higher at a pH of 6,

whereas the value of (Q) falls at pH levels lower or higher than (6). Which is due to the fact that metal ion in basic media produces precipitating gelatinous molecules. In a metal hydroxide form, yet in acidic medium, metal ions separate from adsorbent material' surface, and this causes (Q) value to reduce. The cause of such reduction is competition between the ions of hydrogen that rises by increasing acidity and metal ions in solution, for binding sites in the PHA present in the polymer, and that causes an increase in acidity to reduce the adsorption capacity. Clausius-Clapeyron equation for the chemical adsorption has been used in order to compute the temperature of the adsorption (H_e) of the PHA of the metal ions. This is listed in table9 [22], which also shows the heat values of the investigated ions' heat prior to and following the addition of MgO nano. The value of metallic ions' adsorption capacity at different temperature levels, such as (T_1 and T_2), can be used to calculate the temperature of the adsorption as equilibrium process, and utilizing the following equation to produce (C_{e1} , C_{e2}) for creating same breakage which is connected to covered surface. [23]

$$\ln \frac{C_{e2}}{C_{e1}} = \frac{H_e}{R} \left(\frac{T_2 - T_1}{T_2 * T_1} \right) \dots \dots (1 - 2)$$

Conclusions

The (Styrene-Co-methyl methacrylate) polymer was created, and the polymer was then used to create PHA. The results show that MgO nano existence increases the capacity of the adsorption of the ferric and vanadium ions, which were measured both prior to and following the addition of the material. The highest value of the adsorption capacity is 5 hrs, and it rises with a reduction in the degree of the temperature and falls with an increase in studied metal ions' temperature since that causes metal ions to separate from the adsorbent material's surface. The capacity of adsorption is higher at the function of acidity (6–8). It was discovered that the adsorption was physical thanks to the heat adsorption values, and it has been discovered as well that heat adsorption values of ions that are investigated by the PHA are larger after the addition of MgO nano than they were before.

Table 2: The effect of time on the ability of poly (ST-CO-M.M.A.) hydroxamic acid to adsorb metal ions.

Metal Ions	Q _e (mg/g)				
	1 hr	2hr	3 hr	4hr	5hr
Fe ⁺³	8.6	10.99	12.2	13.5	15
V ⁺⁵	6.9	10.6	12.1	14.5	14.68

Table 3: The effects of time on the values regarding the metal ion adsorption capacity by PHA with the existence of MgO nano

Metal Ions	Q _e (mg/g)				
	1 hr	2hr	3 hr	4hr	5 hr
Fe ⁺³	10.8	13.91	15.4	16.8	17.5
V ⁺⁵	8.03	13.7	15.3	16.98	17

Table 4: The values of PHA 's metal ion adsorption capability under the impact of temperature

Metal Ions	Q _e (mg/g)			
	T10°C	T30°C	T50°C	T70°C
Fe ⁺³	15	13	12.9	11.1
V ⁺⁵	13.9	10	8.9	5.01

Table 5: The effects of temperature on the values regarding the metal ion adsorption capacity by PHA with the existence of MgO nano

Metal Ions	Q _e (mg/g)			
	T10°C	T30°C	T50°C	T70°C
Fe ⁺³	17	15	14.6	13.03
V ⁺⁵	15.8	12.5	10.1	9.3

Table 6: Impact of pH function values on the values regarding the metal ion adsorption capacity by PHA

Metal Ions	Q _e (mg/g)				
	pH=2	pH=4	pH=6	pH=8	pH10
Fe ⁺³	5	8.3	17.3	14.70	10.54
V ⁺⁵	4.03	7.9	16.08	13.30	10

Table 7: Impact of the pH function with the existence of MgO nano on the values regarding the metal ion adsorption capacity through PHA

Metal Ions	Q _e (mg/g)				
	pH=2	pH=4	pH=6	pH=8	pH=10
Fe ⁺³	7.5	11.9	17.5	15.1	12.8
V ⁺⁵	6.1	8.1	16.5	14.2	13.01

Table 8: Values of heat adsorption for ferric ions and vanadium

Metal Ions	Temperature of Adsorption (Kcal.mol ⁻¹)
Fe ⁺³	60024.3
V ⁺⁵	94323.9

Table 9: Effects of time on the ability of the poly(ST-CO-A.A) HA to adsorb metal ions

Metal Ions	Q _c (mg/g)				
	1hr	2 hr	3 hr	4hr	5hr
Fe ⁺³	6.3	9.27	11.6	12.12	13.03
V ⁺⁵	4.05	5.6	8.3	10.09	12.18

Table 10: The effects of time on the values regarding the metal ion adsorption capacity by PHA with the existence of MgO

Metal Ions	Q _c (mg/g)				
	1 hr	2 hr	3hr	4hr	5 hr
Fe ⁺³	8.9	11.5	13.4	15.53	16.38
V ⁺⁵	7.9	8.99	13.4	14.08	15.82

Table 11: The values regarding PHA 's metal ion adsorption capability under the impact of temperature

Metal Ions	Q _c (mg/g)			
	T 10°C	T 30°C	T 50°C	T 70°C
Fe ⁺³	13.03	11.12	9.8	6.35
V ⁺⁵	12.18	11.9	9.4	5.7

Table 12: The effects of temperature on the values regarding the metal ion adsorption capacity by PHA with the existence of MgO

Metal Ions	Q _c (mg/g)			
	T 10°C	T 30°C	T 50°C	T 70°C
Fe ⁺³	16.38	13.4	12.16	10.2
V ⁺⁵	15.82	13.4	12.1	8.9

Table 13: Impact of pH function values on the values regarding the metal ion adsorption capacity through PHA

Metal Ions	Q _c (mg/g)				
	pH=2	pH=4	pH=6	pH=8	pH=10
Fe ⁺³	6.3	9.27	13.5	11.8	10.95
V ⁺⁵	4.82	7.6	12.81	10.53	8.5

Table 14: Impact of the pH function with the existence of MgO nano on the values regarding the metal ion adsorption capacity through PHA

Metal Ions	Q _c (mg/g)				
	pH=2	pH=4	pH=6	pH=8	pH=10
Fe ⁺³	9.01	11.32	16.43	13.03	12.52
V ⁺⁵	6.03	9.9	14.82	12.05	10.5

Table 15: Values of heat adsorption for ferric ions and vanadium

Metal Ions	Temperature of Adsorption (Kcal.mol ⁻¹)
Fe ⁺³	25724.7
V ⁺⁵	8574.9

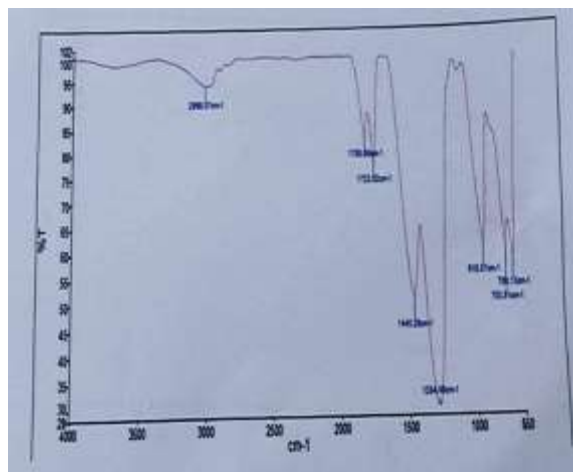


Figure 3: Infrared spectrum regarding Ploy (Styrene-Co-methyl methacrylate) polymer.

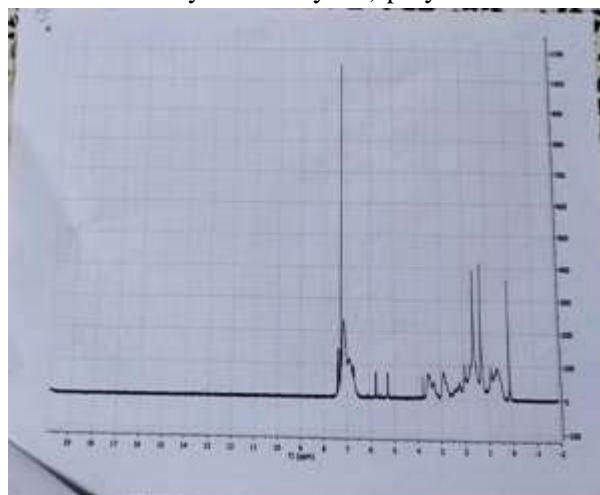


Figure 4: HNMR spectrum regarding Poly (Styrene-Co-methyl methacrylate) polymer

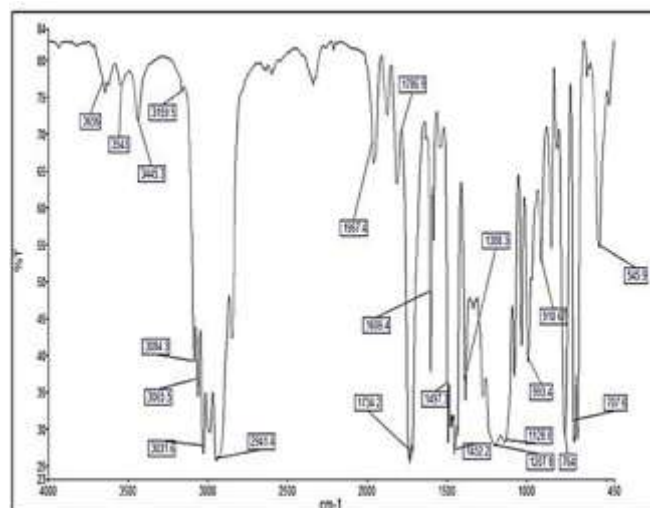


Figure 5: Infrared spectrum of polyhydroxy acid

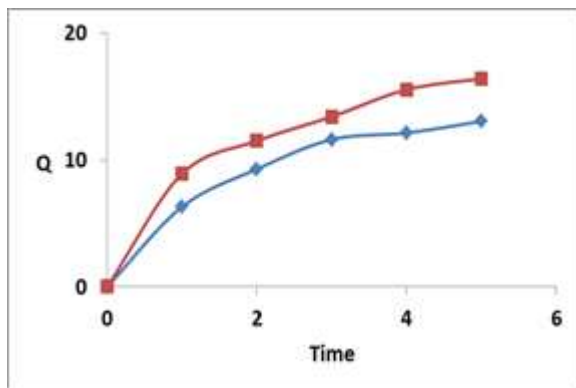


Figure 6: Ferric ion's adsorption capacity by PHA prior to and following MgO nano addition at effects of time

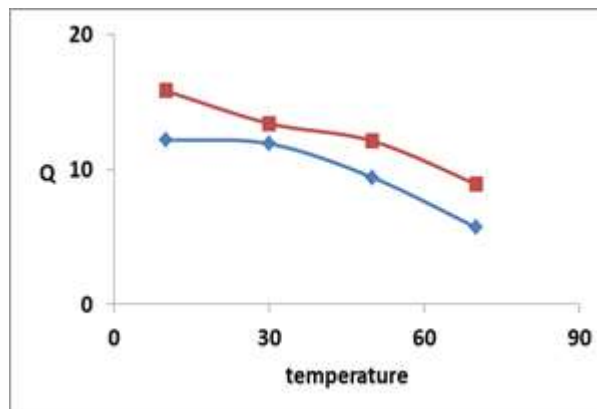


Figure 9: The PHA's ability to adsorb ferric ions prior to and following adding MgO nano under impact of temperature.

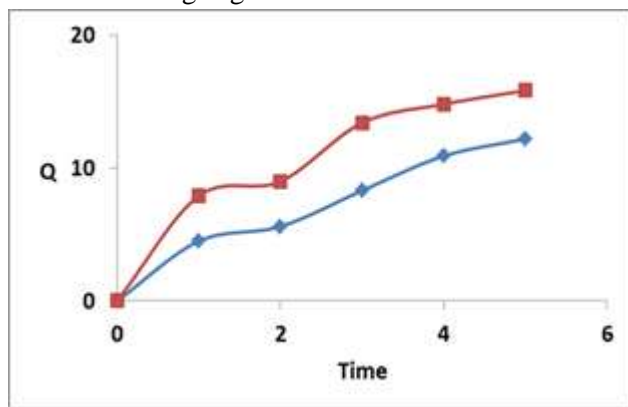


Figure 7: The influence of time on the PHA's ability to adsorb vanadium ions prior to and following the addition of MgO nano.

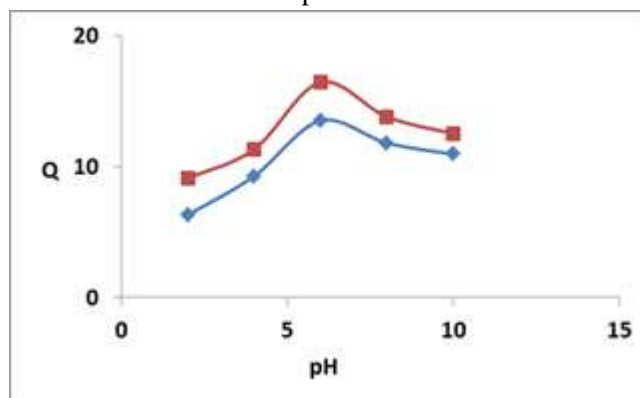


Figure 10: Adsorption capability of ferric ions by PHA prior to and following the addition of MgO nano in the case when the acidity function is changed.

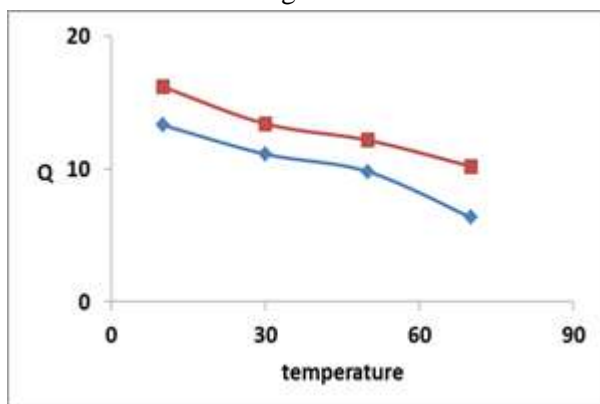


Figure 8: The capacity of PHA to adsorb vanadium ions under the impact of temperature prior to and following adding MgO nano.

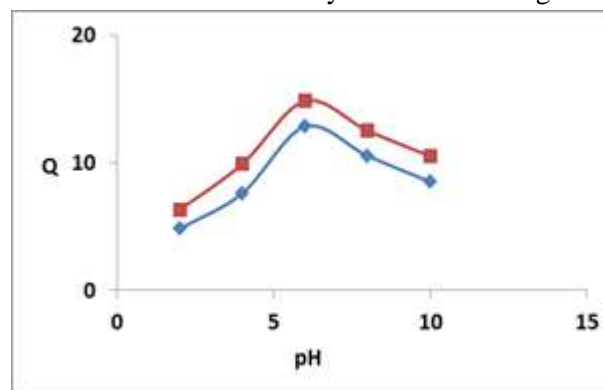


Figure 11: In the case when the acidity function is impacted, the ability of PHA to adsorb vanadium ions prior to and following the addition of MgO nano.

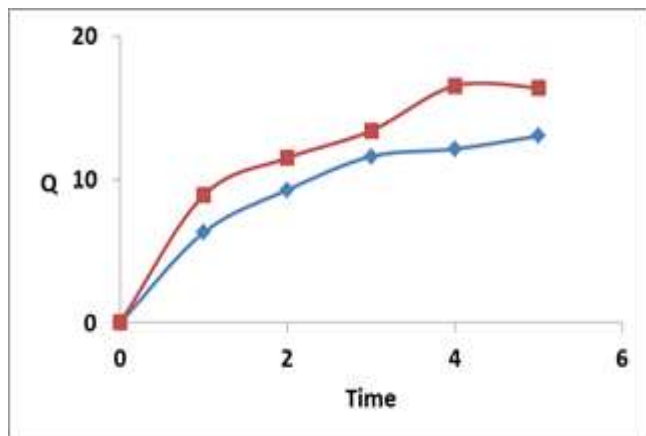


Figure 12: The ability of PHA to bind ferric ions prior to and following MgO nano addition under the impact of the time.

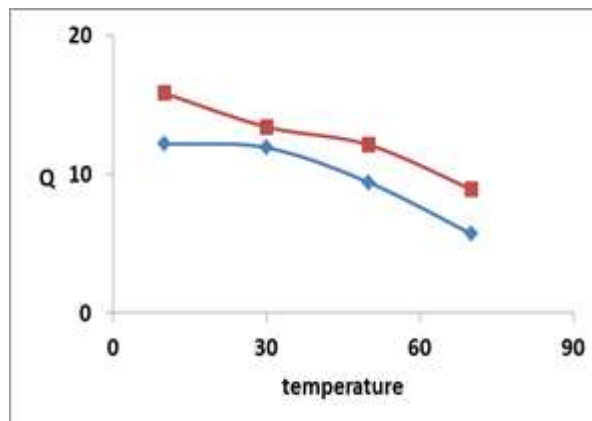


Figure 15: The PHA's ability to adsorb ferric ions prior to and following adding MgO nano under the impact of temperature.

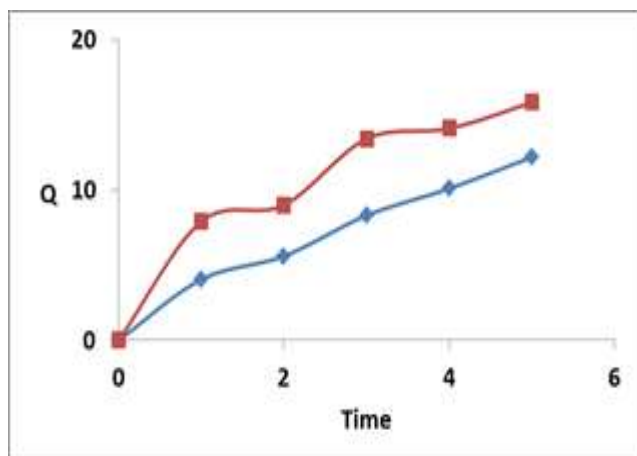


Figure 13: Adsorption capability of Vanadium ions by PHA prior to and following MgO nano addition at the impact of time.

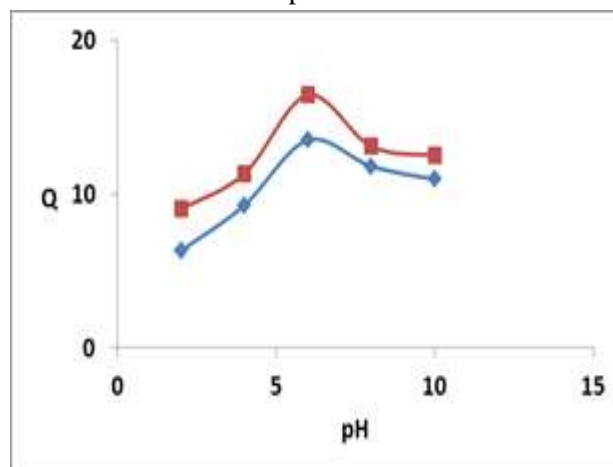


Figure 16: Adsorption capability of ferric ions by PHA prior to and following the addition of MgO nano in the case when acidity function is changed.

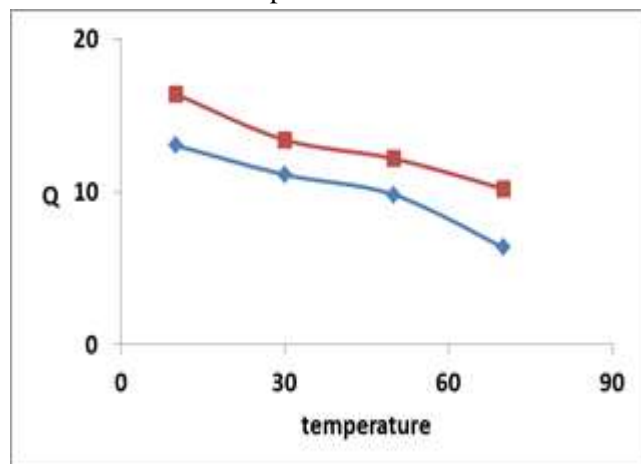


Figure 14: The PHA capacity to adsorb Vanadium ions under the impact of temperature prior to and following adding MgO nano.

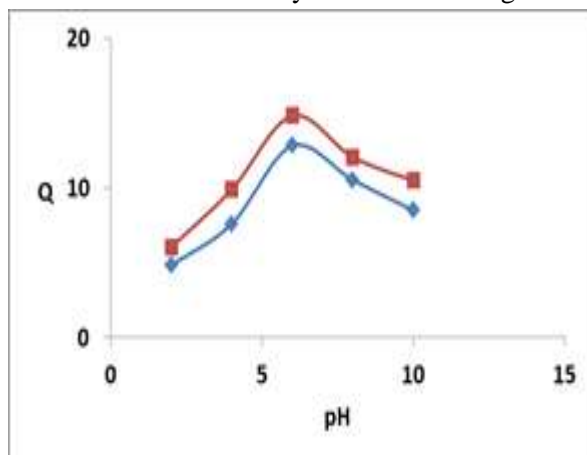


Figure 17: In the case when the acidity function is impacted, the ability of PHA to adsorb Vanadium ions prior to and following the addition of MgO nano.

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إضافة نانو-أوكسيد المغنسيوم إلى حامض البولي هيدروكساميك ودراسة تأثيره على ايزوترم الامتزاز



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الخلاصة:

في هذا البحث تم تحضير البوليمر المشترك (ستايرين - مثل ميثا اكريلات) حامض الهيدروكساميك والبوليمر المشترك (ستايرين - حامض الاكريليك) حامض الهيدروكساميك وباستخدام ميكانيكية الجذور الحرة للبلمره المشتركة بين الستايرين والمثل ميثا اكريلات بنسبة خلط موليه 1/1 بوساطه بادئ بيروكسيد البنزويل وبدرجة حرارة 70°C بنسبه تحويل 10% تم تحضير البوليمر المشترك (ستايرين - مثل ميثا اكريلات) وتشخيص البوليمر الناتج باستخدام طيف الاشعه تحت الحمراء FT-IR وطيف الرنين النووي المغناطيسي (HNMR). ومن خلال البوليمرات المحضره من متعدد (ستايرين - مثل ميثا اكريلات) و متعدد (ستايرين - حامض الاكريليك) تم تحضير متعدد (ستايرين - مثل ميثا اكريلات) حامض الهيدروكساميك و متعدد (ستايرين - حامض الاكريليك) حامض الهيدروكساميك مع هيدروكسيل أمين هيدروكلورايد في وسط قاعدي (pH = 12) باستخدام هيدروكسيد الصوديوم (NaOH) مع اجراء تصعيد حراري لمدته 120 ساعه وبدرجه حرارة (70-80°C). وقد تم تشخيص المركب الناتج لمتعدد (ستايرين - مثل ميثا اكريلات) حامض الهيدروكساميك باستخدام طيف الاشعه تحت الحمراء FT-IR. أيضا في هذا البحث تم دراسة سعة الامتزاز (Q_e) لمتعدد حامض الهيدروكساميك قبل وبعد اضافه اوكسيد المغنسيوم النانوي لايونات (Fe⁺³, V⁺⁵) وكذلك تم دراسة تأثير الزمن والداله الحامضيه حيث تقل سعة الامتزاز عند ارتفاع او انخفاض الاس الهيدروجيني ونجد اعلى قيمه للامتزاز عند pH=6 ودرجة الحرارة على سعة الامتزاز لهذه الأيونات من محاليلها المائيه بوساطه متعدد حامض الهيدروكساميك قبل وبعد اضافه اوكسيد المغنسيوم النانوي ، تم حساب حرارة الامتزاز (H_e) التوصل لمتعدد (ستايرين - مثل ميثا اكريلات) حامض الهيدروكساميك عند درجتين مختلفتين ووفقاً لقيم درجه حرارة الامتزاز فإن امتزاز ايون الحديدك يكون فيزيائياً في حين ان امتزاز ايون الفناديوم كيميائياً.

الكلمات المفتاحية: نانو-أوكسيد المغنسيوم، حامض البولي هيدروكساميك، الامتزاز.