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Research Article

Synthesis of Acrylic Acid Polymer Hydrogel Nano Fe_3O_4 to Remove Ammonia from Sugarcane Field Waste

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Ammonia is the most essential hydrogenated nitrogen composition that can cause problems when it enters the environment. One of the most important natural and synthetic adsorbents is hydrogels, which can reduce the economic costs of treating industrial effluents and minimize the concentration of ammonia in the drainage of sugarcane fields. In this study, carrageenan, which is a type of polysaccharide, and acrylic acid were used to prepare nanomagnetic hydrogels. Also, the effect of pH, concentration, and temperature on the amount of ammonia adsorption was analyzed by the spectrophotometer, and finally, the adsorption property of the hydrogel was analyzed by the scanning electron microscope (SEM). The results of scanning electron microscopy show that there are holes in the hydrogel surface that increase the rate of adsorption. Experimental data from the spectrophotometer show that the rate of ammonia adsorption increases by about 50% over 80 minutes as its concentration in the effluent increases. The inflation rate of these hydrogels was selected to be 991.52 (mg/g) under optimal conditions, and the nanomagnetic hydrogel adsorption capacity remained constant at a pH range of 4 to 9, while when the pH was below four or above 9, the capacity of adsorption shows a slight decrease. Adsorption by acrylic hydrogels is significant. There is an issue that by modifying the acrylic compounds in the production of the hydrogel, it is possible to absorb the heavy elements or colors in the best way and also to achieve high efficiency. Also, by increasing the amount of adsorbent nanomagnetic hydrogel up to 40 mg led to the adsorption of 89.16%, 32.50%, and 31.11% of ammonia in three pools of the test site, respectively. The results also show that the use of iron oxide nanoparticles in the hydrogel substrate has increased thermal stability by thermogravimetric analysis (TGA) which shows that at 650 degrees centigrade, kappa-carrageenan, hydrogels, and nanomagnetic hydrogels have a weight loss of 72.66%, 58.79%, and 52.39%, respectively. Studies have shown that the kappa-carrageenan-based hydrogel nanocomposite is more cost-effective, while it is more efficient at absorbing NH_4^+. Therefore, this adsorbent can be a promising material in terms of economic as well as its effectiveness in eliminating ammonia from sewage. Investigations were performed for ammonia desorption and the reusability of nanomagnetic hydrogels. Also, the rate of ammonia adsorption by nanomagnetic hydrogels after 6 cycles of recovery cycle using NaCl can be about 43% of the initial rate. All statistical studies were performed by Minitab software version 18 and considering p value = 0.05.

1. Introduction

Pollution of water resources with various organic and inorganic pollutants is one of the biggest challenges of today. These pollutions pose a severe threat to human health and the lives of plants and animals. The surface adsorption process of pollutants is one of the most well-known and widely used processes. In the process of surface adsorption, which is in the category of physical separation methods, the various pollutants in the effluent are absorbed by the physical or chemical interactions with the functional groups present at the adsorbent surface. In this process, high-porosity adsorbents such as activated carbon, polymeric adsorbents, and agricultural wastes are used. The use of adsorbents has been taken into consideration for reasons such as unique physical and chemical properties, high specific surface area, porous and modifiable structure, selective performance, and effective removal of pollutants. Highly water-soluble ammonia is an alkali with a distinctive and disgusting smell that can cause extensive damage throughout the breathing passage [1].

Nitrate is usually formed in nature as a product of nitrogen denitrification and is highly soluble in water, inactive, and nonreactive. Chemical fertilizers and other nitrogen-containing wastes decompose and are converted to nitrate and nitrite by further oxidation of ammonia. Nitrate is present in the air, water, and food and is synthesized by plants into organic compounds. Nitrate is one of the factors that, when combined with moisture, it produces nitric acid. Although inactive, it decreases microbially to nitrogen (N) gas and nitrogen monoxide. Nanomaterials have significant catalytic properties due to their surface properties. In the process of reducing nitrate, ammonia, nitrogen gas (N_2), nitrite (NO), and ammonium (NH) are formed [2].

There are several common methods for removing nitrate from effluents, including adsorption methods, ion exchange processes, electrochemical methods, reverse osmosis, biological methods, and chemical methods. However, these techniques have several limitations. One of the limitations of adsorption-based techniques is the changing conditions of the aquatic environment, which challenges the choice of high-efficiency adsorbent material that is suitable for different environmental conditions. Estimation of adsorption efficiency, adsorption resilience for multiple uses, and adsorption recycling with adsorbed nitrate are among the limitations of conventional adsorption-based techniques. In the ion exchange method, there are limitations, such as applying previous and subsequent treatments [3].

Carrageenan solutions' strength to become a gel decreases at pH below 4.3. Carrageenan gels are stable at room temperature and dissolve at temperatures of 5–20 degrees above the gelling temperature, and the system recreates the gel by cooling it [4]. Potassium ions increase the gelling temperature, and calcium ions increase the hardness of carrageenans. Carrageenans are purified by alcohol deposition by a drying process. The alcohols used in the treatment include methanol, ethanol, and isopropanol [5].

Hydrogels are a three-dimensional and flexible polymeric network that can absorb large amounts of water in the swollen state due to a large number of hydrophilic groups. In the field of water and wastewater treatment, hydrogels show significant performance in absorbing various types of nonorganic pollutants (such as heavy metals such as chromium and arsenic) as well as organic pollutants (such as toxic dyes). Also, compared to conventional adsorbents, hydrogels have a higher adsorption capacity [6, 7].

In spite of the fact that lately numerous examinations on hydrogel nanocomposite used to expel different contaminants from the earth have been directed, the quantity of such investigates is exceptionally restricted. Hydrogel nanocomposite is one of the ease nanomaterials which have properties, for example, being nonpoisonous and earth benevolent, having explicit surface territory, and it likewise has high adsorption limit [8, 9].

Various methods of free radical polymerization, such as bulk, suspension, emulsion, and solution polymerization, are used to make hydrogels. Nanocomposites such as polymers, graphene-based nanocomposites, and magnetic polymers have been widely used to treat and remove pollutants. Nanocomposites contain a combination of nanomaterials that increase the adsorption capacity of nitrate. Nitrate adsorption efficiency was measured in nanocomposites (44.98%), and nitrate removal efficiency was observed 21.98% in bulk form composites.

In the present work, synthesis of the acrylic acid polymer hydrogel nano Fe_3O_4 was used to remove ammonium and exploited as an adsorbent for rapid removal of ammonium ion. The pH and temperature effect, ammonia concentration, desorption, and reusability were investigated and evaluated. The preparation method was relatively simple, and this technique is classified as an environmentally friendly process.

2. Materials and Methods

2.1. Materials. In this study, κ-carrageenan (Sigma-Aldrich, owned by Merck KGaA, Saint Louis, Germany), acrylic acid (AA, $C_3H_5O_2$, chemically pure, Merck KGaA, Darmstadt, Germany), ammonium persulfate (APS, $(NH_4)_2S_2O_8$, analytical grade, Merck KGaA, Darmstadt, Germany), sodium hydroxide (NaOH, chemically pure, Merck KGaA, Darmstadt, Germany), sodium chloride (NaCl, chemically pure, Merck KGaA, Darmstadt, Germany), charcoal activated (C, analytical grade, Merck KGaA, Darmstadt, Germany), iron (II) chloride and iron (III) chloride ($FeCl_2$, $FeCl_3$, analytical grade, Merck KGaA, Darmstadt, Germany), N, N′-methylenebisacrylamide (MBA, Sigma-Aldrich, owned by Merck KGaA, Saint Louis, Germany), ethylenediaminetetraacetic acid (EDTA, Sigma-Aldrich, owned by Merck KGaA, Saint Louis, Germany), and ethanol (C_2H_5OH, 96% by volume, Nasr Khoramabad, Iran).

2.2. Methods. In this study, carrageenan, a type of polysaccharide, was used to make hydrogels. Partial acrylic acid, which was partially neutralized with sodium hydroxide, as a monomer, ammonium persulfate as the initiator of the reaction, and methylene bisacrylamide as the networking agent were used. Initially, ammonium persulfate is converted to anion-radical sulfate by heat, which in turn reacts with kappa-carrageenan to form a large radical. Hydrogel network structure is created by the reaction of these radical deposits with the cross-linker of methylene, bisacrylamide, and acrylic acid monomer. A coprecipitation method was used to produce nanomagnetic hydrogels. In this method, two- and three-capacity chloride iron was used, and after uploading these nanoparticles on the desired hydrogel for 24 hours, it was transferred to the oven (Hastaramteb RS232) for drying, and then the nanomagnetic hydrogel was prepared for use in the treatment of the intended effluents.

The electron microscope used for this project is of Mira III type and is from the Tescan Company. This device is of field emission type, with an enormous chamber and high vacuum velocity. Other devices used in the study included Eutech's pH 510 which is a pH meter determining whether the substance was acidic or alkaline, and Rayleigh's UV-9200 spectrophotometer is a device for measuring the amount of a substance based on its electromagnetic adsorption. To play out the tests, a column was used by placing glass wool at the end and using dry hydrogels and inserting effluent from the top and removing the treated effluent from the end of the experiment. In a study to remove ammonia from effluent, a column with 2.5 cm in diameter was used [10]. Therefore, in this study, the column was prepared with the following specifications and kept constant at all stages of the experiment, except when changes were made to the column according to the experimental conditions.

The column had a diameter of 3 cm, and a length of 50 cm, and the average rate of effluent outflow from the column was 80 drops per minute and was performed at room temperature (25 degrees centigrade). To determine the equilibrium swell rate of the synthesized hydrogels, 0.1 g of dry hydrogel was added to 250 ml of distilled water to complete the swelling of the gels. After that, the swollen hydrogels were put in a mesh filter, and the equilibrium swell rate was calculated with the following equation, and the results were written (Table 1):

$$Es = \frac{(w_2 - w_1)}{w_1}. \tag{1}$$

To make polymer hydrogels, 1 gr of carrageenan and 4 ml of acrylic acid were used. 0.1 g of ammonium persulfate was used as the heat initiator of the reaction, and 0.1 g of methylene bisacrylamide was used as the cross-linker. First, the carrageenan is dissolved in a certain amount of boiled distilled water. Then, it is placed in a heater (Alfa HS860) at 80°C and stirred with a mechanical mixer (IKA R1381) at 180 rpm to obtain a uniform solution. Then, 0.1 g of ammonium persulfate, dissolved in 5 ml of cold distilled water, is added to it. The solution is stirred with a mechanical mixer for 2 to 5 minutes. Then, 4 ml of acrylic acid with 0.70 g of sodium hydroxide dissolved in 5 ml of boiled and cold distilled water is added to the reaction vessel and mixed with a mechanical mixer for 1 minute to create a uniform solution and neutralize acrylic acid. In the next step, 0.1 g of methylene bis acrylamide dissolved in 5 ml of cold distilled water is added to the reaction vessel, and 0.2 g of activated carbon is added to the reaction mixture. Performing the reaction by incubation continued for 30 minutes using a mechanical mixer. Next, the formed gel is removed from the heater and immersed in 100 ml of 96 degrees ethanol to dry completely. After being cut into pieces, these dried gels are placed on a Petri dish and then placed in an oven with a 50°C temperature for 20 hours to dry completely.

2.3. Preparation of Control and Main Effluent. According to the analysis received from the Etminanazma Gostaran Joonob Company, the control effluent was made from the main effluent extracted from the main drainage, the drainage effluent of the fields, and the water of the fish pool with the number of elements and ammonia. This analysis includes pH, levels of metal ions such as calcium and magnesium, and nonmetallic ones such as PO_4, SO_4, and NH_3 (Tables 2 and 3).

3. Result and Discussion

Study of the passage of control effluent from the column 9.5 g of the synthesized magnetic hydrogel was placed inside the column, 100 ml of the manufactured effluent was passed, and its eluted detergent, which was the liquid leaving the column, was collected. After calibrating the spectrophotometer, the passed effluent was transferred to a 5 cc cell to use the spectrophotometer, and the adsorption rate is measured at the same wavelength as before. According to the constant conditions of the effluent test, 80 drops per minute were passed with the length and diameter of the expressed column. The amount of adsorption by the UV device with a wavelength of 213 nm before passing the column for the control effluent was 0.184 ABS, and after passing through the effluent, it was 1.47 ABS (Table 4).

3.1. Investigating the Effect of pH on Ammonia Adsorption. To investigate the effect of pH on the adsorption value, the effluent of the collection pool, the main drainage, and the inlet pool with pH values of 7.1, 7.8, and 7.9, respectively, in contact with 4.4 g of an adsorbent for 6 minutes at a medium speed which is about 70 rpm was mixed (Table 5). The resulting residual solution was then smoothed, and the residual ammonia concentration in the solution was measured using a spectrophotometer with a wavelength of 213 nanometers (Table 5).

3.2. Investigating the Effect of Temperature on the Amount of Ammonia Adsorption. To study the effect of temperature on the adsorption of ammonia in effluents at a wavelength of 213 nm at an ambient temperature (25 degrees centigrade), at first, it is was 1.12 at the ambient temperature. Then, at temperatures of 15, 30, 40, 50, 60, 70, 85, and 95 degrees centigrade from the effluent, it was measured by atomic adsorption device. The adsorption rate of ammonia in the main drainage effluent at a wavelength of 213 nm at ambient temperature was 0.1 ABS and 1.8 ABS, and after passing the effluent through the column, it was 1.8 ABS (Table 6). The effect of temperature on the adsorption of ammonia in the effluent of the collection pool was also calculated (Table 7).

3.3. The Effect of Ammonia Concentration on the Amount of Adsorption on the Synthesized Hydrogel. The effluents were prepared with concentrations of 20, 30, 50, 60, and 80 mg/l of ammonia at an optimal pH of 6. Then, 0.04 g of the nanomagnetic hydrogel adsorbent was added to the column, and after passing the effluents, the amount of effluent ammonia adsorption collected at their outlet was measured using a spectrophotometer at a wavelength of 213 nm

Table 1: Results of hydrogel preparation.

Test name	Carrageenan weight (g)	The total volume of the solution (ml)	Swell rate (g/g)	Gelling time (min)
A	1	40	153	4
B	1	50	520.41	4.5
C	1	60	632.72	5
D	1	70	991.52	11

Table 2: Analysis of the main drainage effluent, by the Etminanazma Gostaran Joonob Company.

Row	Measured parameter	Test result	Unit
1	Total hardness	1600	mg/I $CaCO_3$
2	Ca (mg/I $CaCO_3$)	343.6	mg/I $CaCO_3$
3	Mg (mg/I $CaCO_3$)	304.89	mg/I $CaCO_3$
4	EC	11780	μS/cm
5	PH	7.82	-
6	PO_4	0.08	mg/L
7	SO_4	113	mg/L
8	NO_3	0.9	mg/L
9	NH_3	4.36	mg/L
10	NO_2	0.273	mg/L
11	F	0.64	mg/L

Table 3: Ammonia analysis of the three effluents intended by the Etminanazma Gostaran Joonob Company.

Row	Measured parameter	Results of field drainage water test	Result of the main drainage water test	Result of fish pool water test	Unit	Test method
1	NH_3	6.70	5.39	6.56	mg/L	4500-C

Table 4: ammonia adsorption rate from control effluent at wavelengths less than 213 nm.

Wavelength (nm)	Adsorption rate (ABS)
188	1.790 1.789 1.792
190	1.930 1.933 1.928
192	1.729 1.730 1.727
194	1.578 1.573 1.576
196	1.434 1.436 1.433
198	1.235 1.240 1.230
200	1.045 1.070 1.055
213	1.470 1.473 1.475

(Table 8). Studies on the results show that the adsorption of NH_4^+ by nanomagnetic hydrogels increases because the initial concentration increases at a constant rate. It can be interpreted as the fact that increasing the initial concentration of ammonia increases the driving force of mass transfer, and therefore, the probability of collision between ammonium ions in high concentrations of effluent ammonia and adsorbent surface increases. As the concentration of ammonia increases, the amount of adsorption increases.

3.4. Studying Scanning Electron Microscope (SEM) Images. According to the images of the electron microscope, it can be said that the existence of a large number of cavities and pores and perfectly regular shape and uniform particle size indicate the high potential of this hydrogel in absorbing water and intended effluent. These cavities are a factor in the excellent adsorption rate (Figure 1).

3.5. Investigating the Thermal Stability of Hydrogels Synthesized by Thermogravimetric Analysis (TGA). Figure 2 shows the thermal decomposition by thermogravimetric analysis (TGA) of kappa-carrageenan, kappa-carrageenan-based hydrogel, and acrylic acid and nanomagnetic hydrogel. Loss of water leads to a reduction in initial weight to about 130 degrees centigrade temperature. Thus, it has been

Table 5: Effect of changing pH of effluents on the adsorption capacity of synthesized nanomagnetic hydrogels.

pH	Control effluent	Collection pool effluent	Main drainage effluent	Inlet pool effluent
	Adsorption capacity (ABS)			
2	1.15	0.98	1.20	1.23
2.45	1.2	1.1	1.22	1.18
3.81	1.32	1.26	1.30	1.33
4.35	1.75	1.62	1.72	1.81
5.56	1.84	1.68	1.8	1.85
5.98	1.82	1.70	1.82	1.88
7.44	1.79	1.65	1.79	1.86
8.25	1.76	1.63	1.77	1.84
9.0	1.69	1.61	1.75	1.82
9.86	1.66	1.59	1.73	1.80

Table 6: Investigation of the effect of temperature on the amount of ammonia adsorption in the main drainage effluent.

Temperature (°C)	Adsorption rate (ABS)
15	1.603
	1.601
	1.595
30	2.194
	1.997
	2.127
40	2.037
	1.198
	2.135
50	1.994
	1.987
	2.103
60	1.893
	1.921
	1.741
70	2.062
	1.984
	1.981
85	1.092
	1.074
	1.082
95	1.840
	1.854
	1.902

Table 7: Investigating the effect of temperature on the amount of ammonia adsorption in collection pool effluent.

Temperature (°C)	Adsorption rate (ABS)
15	1.596
	1.602
	1.591
30	1.732
	1.736
	1.729
40	1.803
	1.810
	1.812
50	1.854
	1.859
	1.848
60	1.835
	1.839
	1.841
70	2.002
	2.104
	2.098
85	1.161
	2.158
	1.167
95	2.186
	2.179
	2.191

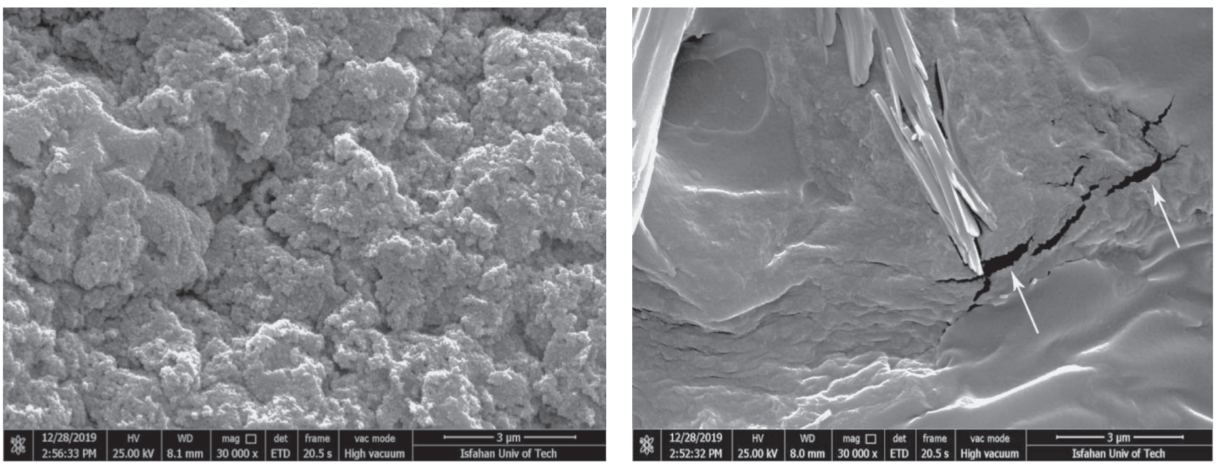
shown that kappa-carrageenan-synthesized hydrogel is more stable than the original polysaccharide, possibly due to its network structure and the presence of acrylic acid in the hydrogel [11]. The results also show that the use of iron oxide nanoparticles in the hydrogel substrate has increased thermal stability. At 650 degrees centigrade, kappa-carrageenan, hydrogels, and nanomagnetic hydrogels have a weight loss of 72.66%, 58.79%, and 52.39%, respectively.

3.6. Statistical Analysis. Data analysis by the regression method (p value = 0.05) is shown in the trend line for different effluents. Given that the p value in all effluents was less than 0.05, so the hypothesis of the relationship between pH and adsorption rate is significant and all data were in the predictable range and also about 95% of ammonia is absorbed in the temperature range of 10 to 20 degrees centigrade and a pH of 7 to 8.5. At pH values below 9, in most cases, the revitalized nitrogen is ionized as ammonia (Figure 3).

Data analysis by the ANOVA method (p value = 0.05) shows that the maximum adsorption occurs at 30 degrees centigrade and the adsorption rate is approximately the same at 40, 60, and 95 degrees centigrade. Moreover, the adsorption rate in the range of 30 to 70 degrees centigrade is associated with minor changes. According to Figure 4 and the results of the study, the adsorption capacity increases slightly with increasing effluent temperature. The slight increase in the amount absorbed on the hydrogel on increasing the temperature may be due to the increase in the level of hydrogel

Table 8: The effect of effluent ammonia concentration on the adsorption capacity of synthesized nanomagnetic hydrogels.

Density (mg/L)	Control effluent	Collection pool effluent	Main drainage effluent	Inlet pool effluent
	Adsorption capacity (ABS)			
10	1.62	1.23	1.66	1.35
20	1.83	1.31	1.87	1.41
30	2.04	1.97	2.01	1.87
40	2.28	2.12	2.32	2.02
50	2.41	2.45	2.48	2.38
60	2.63	2.76	2.69	2.46
70	2.86	2.94	2.97	2.85
80	3.12	3.05	3.06	3.10
90	3.31	3.12	3.38	3.15
100	3.54	3.28	3.60	3.21



(a) (b)

Figure 1: Image of the scanning electron microscope. (a) Synthesized hydrogel in the swollen state with 30 thousand times magnification. (b) Synthesized hydrogel in the dry state with 30 thousand times magnification.

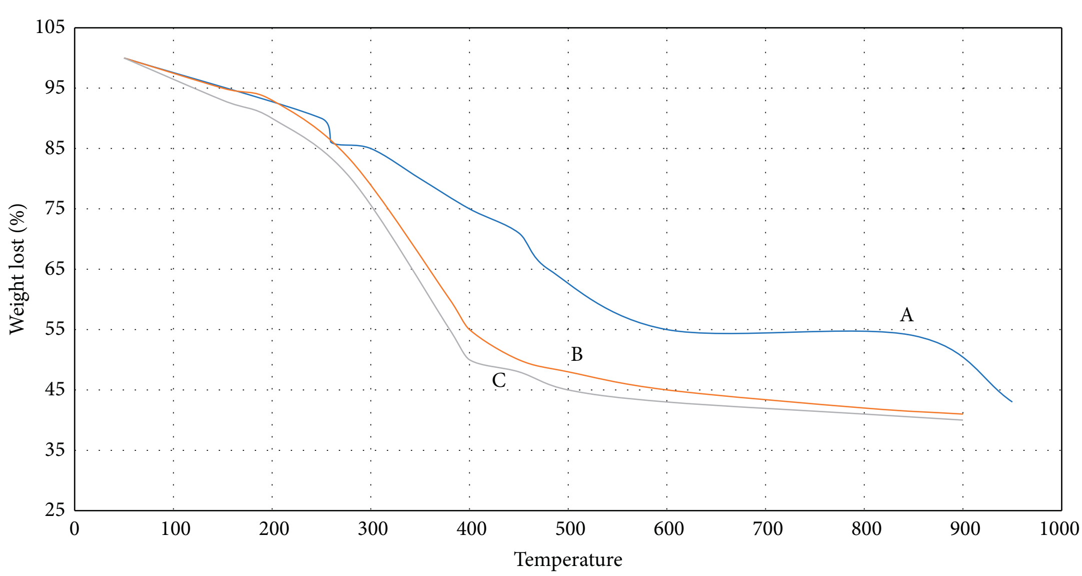


Figure 2: TGA diagram. (A) Synthetic magnetic hydrogel based on acrylic acid and kappa-carrageenan. (B) Synthesized hydrogel based on acrylic acid and kappa-carrageenan. (C) Kappa-carrageenan.

adsorption, as well as the increase in the chemical adsorbents between the increased level of hydrogel and NH_4^+ ions. Chemical adsorption is possible on a wide range of temperatures, so the adsorption of NH_4^+ on hydrogel nanocomposites mainly depends on chemical adsorption, which is confirmed by the study of Ju et al. and this study's teammates.

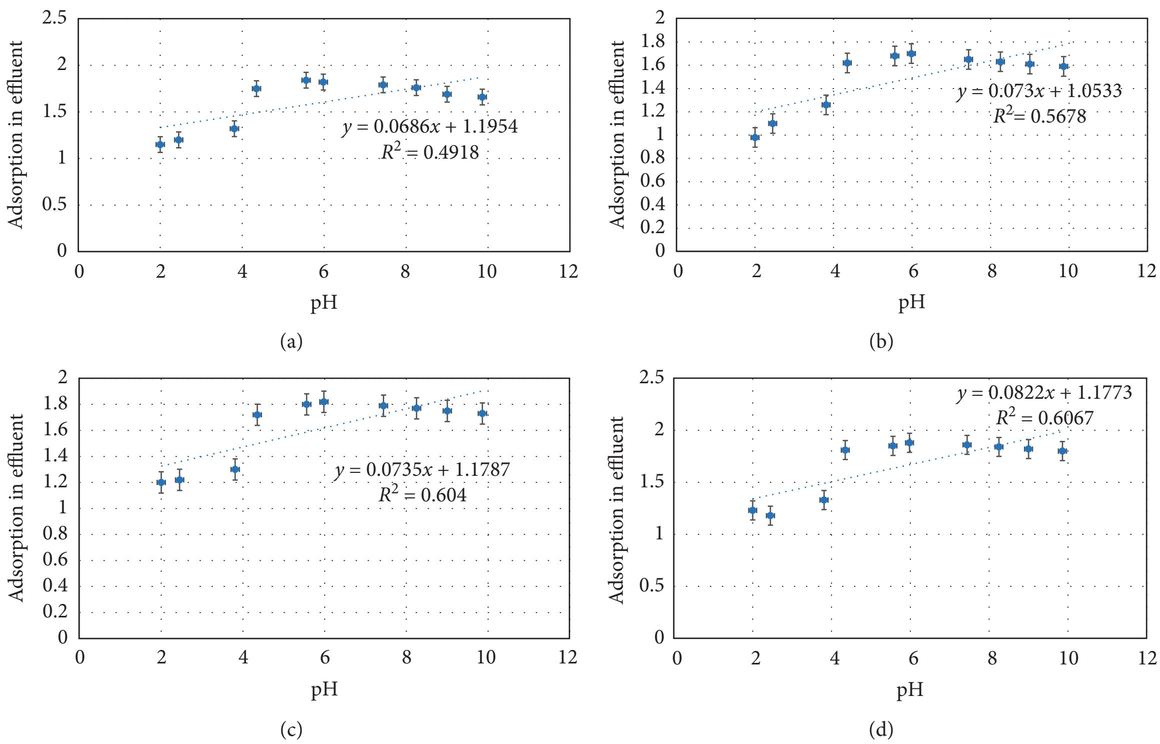


FIGURE 3: The trend line for data on the effect of pH on adsorption in effluent: (a) main drain, (b) control, (c) collection pool, and (d) inlet pool.

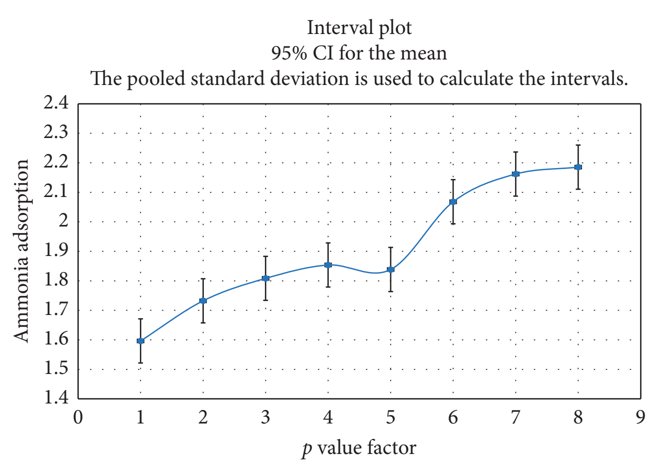


FIGURE 4: Investigating the effect of temperature on the amount of ammonia adsorption in the effluent.

Data analysis by the regression method (p value = 0.05) in Figure 5 for different effluents shows the best-given passage line. Given that the p value in all effluents is less than 0.05, so the hypothesis of the relationship between concentration and adsorption rate is significant and all data are predictable in the predictable range. In fact, as the concentration of ammonia increases, more NH_4^+ ions become available to active sites of nanomagnetic hydrogels.

3.7. Investigating the Effect of Nanomagnetic Hydrogel Adsorption on Ammonia Adsorption. The weight of the adsorbent is an important factor in the efficiency of adsorption and the rate of adsorption of ammonia. The results show that the removal of ammonium ions increases with the weight of the adsorbent, while the adsorbed amount increases nonlinearly with the adsorption concentration. Increasing the adsorption efficiency with adsorbent weight may be attributed to the higher level and availability of more vacant

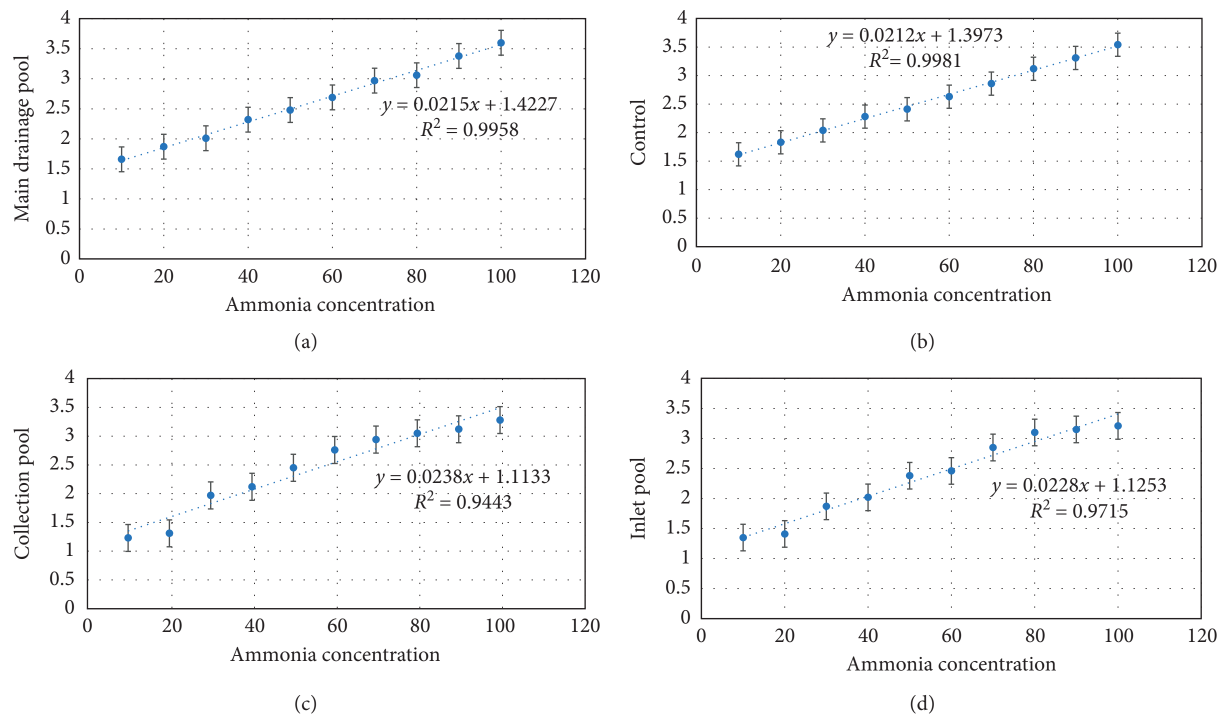


Figure 5: The trend line for data on the effect of changes in ammonia concentration on adsorption in effluent: (a) main drainage, (b) control, (c) collection pool, and (d) inlet pool in effluents.

adsorption sites. However, by increasing more amount of nanomagnetic hydrogel adsorbent, the adsorption capacity in all samples begins to decrease. The rapid adsorption of ammonia in the least amount of adsorbent can be attributed to the high adsorption level of the adsorbent. Since the number of active sites for adsorption in any adsorption system is definite and limited, by increasing more amount of adsorption, fewer places get occupied on the adsorbent surface, and thus, a decrease in adsorption process is observed (Table 9).

Šimková and Ghasemzadeh [12] removed methyl purple dye from aqueous solutions using nanomagnetic hydrogels based on kappa-carrageenan and acrylic acid in optimal condition, time of 60 minutes, and pH equal to 8 and initial concentration of 10 ppm with 86% efficiency.

The authors in [13], through the synthesis of iron magnetic nanocomposite hydrogel based on xanthan gum, measured the release rate of diclofenac in it. This hydrogel does not react between 5 and 11 pH and has the best release conditions at pH equal to 8. In [14], the authors removed 190.5 mg/g of Cd (II) ions of polluted sources from hydrogel nanocomposites based on alginate, carbon nanotubes, and acrylamide comonomers in optimal conditions of 88% gel and 440 equilibrium swell.

Khan and Lo [4], through synthesizing γ-Fe_2O_3 nanomagnetic hydrogel, removed aromatic pollutants from effluent at the rate of 833.3 mg/g. Shahrooie et al. [15], through synthesizing nanocomposite hydrogel based on starch and polyvinyl alcohol and using boehmite mineral, managed to remove 9% of ammonia in effluent within 3 hours of contact time. Gholami et al. [16], through synthesizing nanocomposite hydrogel κ-carrageenan-g-poly (methacrylic acid) and iron oxide nanoparticles, removed 28.24 mg. g^{-1} crystal violet from intended effluent within 15 minutes of contact time.

Zhu et al. [17], using polyvinyl alcohol and HKUST-1 membrane to a polymeric hydrogel at 120 degrees centigrade and 12 hours, achieved a combination that was able to eliminate ionic dyes in optimal condition up to 44.97%.

Pooresmaeil et al. [18], using polyacrylic acid nanocomposite hydrogels and synthesis of soluble magnetic nanoparticles, led to the removal of methyl blue pigment at a rate of 507.7 mg. g^{-1}. Mahdavinia et al. [19] used nanocomposite hydrogel polyvinyl alcohol and kappa-carrageenan and iron oxide nanoparticles at pH 2 to 10 to remove cationic dyes from the solutions. Additionally, In [2], evacuation of responsive blue 29 dyes with chitosan and altered chitosan with Cu buildings from the fluid arrangement was researched in a cluster adsorption framework as for the adjustments in the contact time, pH of the arrangement, and chitosan dose. Adsorption isotherms of the dye onto chitosan were likewise considered. The outcomes uncovered that the adsorption limit of chitosan with Cu edifices is lower than that of chitosan without Cu buildings. Likewise, the impact of H_2O_2 on adsorption, when we utilized chitosan without Cu edifices, is increasingly extensive. The outcomes likewise showed that the adsorption limit of responsive blue 29 dyes on chitosan was higher at lower pHs.

Table 9: Effect of nanomagnetic hydrogel adsorption on ammonia adsorption.

The amount of adsorbent (mg)	Adsorption percentage in control effluent	Percentage of main drainage	Percentage of the collection pool	Percentage of inlet pool
10	21.86	60.04	17.01	21.25
20	34.27	74.43	30.05	26.51
30	36.13	87.34	31.12	28.04
40	37.37	89.16	32.50	31.11

Wang et al. [20] synthesized carboxymethyl chitosan hydrogel based on polyacrylic acid and led to the removal of 237.6 mg/g of NH_4^+ ion in 15 minutes from effluent. Zheng et al. [21], through the synthesis of chitosan composite hydrogel and polyacrylic acid, could remove 78.23 mg. g^{-1} of nitrate at a pH of 4 to 8 and contact time of 30 min. Also, in another study in 2012, they were able to achieve a 30% elimination efficiency for effluent-based ammonia by synthesizing hydrogel polyacrylic acid and biotite mineral ores and a contact time of 15 minutes.

Bezbaruah et al. [22] removed 50 to 73% of nitrate in effluent within 2 hours using the synthesis of calcium alginate hydrogels and zero iron nanoparticles. Huang et al. [23] achieved a superabsorbent by synthesizing polyacrylic acid nanocomposite hydrogel and acrylamide copolymer and graphene oxide.

4. Conclusion

In this study, the effects of adsorption parameters, such as adsorbent dosage, ammonia concentration, pH and temperature effect, desorption, and reusability were studied. The results showed that these adsorbent have high efficiency in the removal of ammonia from waste water. The results of the scanning electron microscope show that there are holes in the hydrogel surface that increase the adsorption rate of this hydrogel. Synthetic nanomagnetic hydrogels have gradually replaced natural hydrogels due to their long service life, high water adsorption capacity, and high strength. Experimental data from the spectrophotometer show that the rate of ammonia adsorption increases by about 50% over 80 minutes as its concentration in the effluent increases. The swelling rate of these hydrogels was selected to be 991.52 (mg/g) under optimal conditions, and the nanomagnetic hydrogel adsorption capacity remained constant at a pH range of 4 to 9, while when the pH was below four or above 9, the capacity of adsorption shows a slight decrease. Adsorption by acrylic hydrogels is significant. Researchers have suggested that by modifying acrylic compounds to produce hydrogels, they can better absorb heavy elements or dyes and achieve high efficiency. Therefore, studies have shown that the kappa-carrageenan-based hydrogel nanocomposite is more cost-effective, while it is more efficient at absorbing NH_4^+. Therefore, this adsorbent can be a promising material in terms of economic as well as its effectiveness in removing ammonia from wastewater.

Data Availability

All data are available for further dissemination of science and knowledge.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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