Removal of nitrate ions from water in optimal conditions by nano-particles of zero valent iron magnetic

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Abstract: As the world's population growth and industrial development, water pollution has become one of the most fundamental problems in the world. Water quality has a significant impact on human health. Normally all metals, with different concentrations, are found in nature. One of the most important risks that threaten natural ecosystems, are water and soil pollution by heavy metals and toxic. Nitrate is one of the most common chemical contaminant for waters all over the world. Increase of nitrate in water, leading to various diseases and water becoming unusable. For this purpose, a simple spectrophotometer method for the removal of nitrate ions from water has been suggested. In this way, magnetic nanoparticles of zero-valent iron were used as adsorbent. To optimize the method, the effect of various parameters including pH, contact time, solution temperature, and amount of adsorbent, concentration of nitrate was determined. Nitrate concentrations in this study were performed at 275 nm with a spectrophotometer. Based on the results of this study found that the percentage of nitrate removal by zero magnetic iron nano-particles on 95.6 percent.

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Introduction:

Water is important sources of uptake the essential material by body of human, but its quality has a great impact on human health. Toxic pollutants and heavy infiltration of water are causing human health and disease organisms. Nitrate is the most important water contaminants that cause water pollution and water quality will be reduced. Nitrate contamination of surface water and groundwater in many parts of the world leads to environmental problems [1]. Nitrate toxicity is mainly due to the wide spread among the major pollutants of groundwater resources is considered. [2]

Combined nitrate is colorless, odorless and tasteless, which surrounds the earth environment around us. Biological reduction of nitrate to nitrite in the body can lead to illness in children aged less than six months is metoglobin disease. [3.4] Zero-valent iron nanoparticles, a high capacity for recovery of pH and nitrate removal from water resources and environment play a role in the removal of these ions. Iron zero by taking oxygen from nitrate to reach higher capacities and the nitrogen gas is converted to iron precipitation. Some studies have shown that pregnant women who drink water with high nitrate concentrations have been used; the incidence of malformations in infants at high risk of miscarriage, and decreased oxygen delivery to the baby through the mother's blood is effective and in case of water with high nitrate concentration is about 29 ppm to 75 percent increased risk of miscarriage in pregnant women and may increase the risk of bladder cancer in women [5]. Due to the small size of the iron nanoparticles, atomic and molecular structure and unique mechanical features, have special magnetic and optical [6]. Zero-valent metals in polluted water are factors for reform, among these metals, the use of zero-valent iron (NZVI) due to the abundance of cheap, non-toxic and capable of rapid response and high efficiency in the analysis of priority pollutants [7]. Schoemen et al. showed in a study on water, iron-containing compound is a method for nitrate removal. In this study it was found that the particle size is smaller and therefore much more reactive nanoparticles with nitrate ion removal rate are increased [8]. Huang and colleagues showed in a study of zero-valent iron nitrate removal at pH equal 4 was over 90% [9, 10]. Many contaminants are dissolved in water and separate them from the waters requires sophisticated and expensive technologies such as reverse osmosis is the use of large-scale purification of the volume of water, the government does not cost anything. Statistical analysis shows that the mean apparent consumption in developed countries is 300 liters per person per day. According to the importance of safe drinking water and the effects of high concentrations of nitrate, it is necessary to do this research. Consumption of contaminated water, the ions are toxic and can cause various diseases. This is true in the case of drinking water and food seems to be necessary and appropriate. The aim of this study was to investigate the removal of nitrate ions from water using zero-valent iron Nan particles.

Equipments

7230G Model UV-Vis spectrophotometer
PH meter model Metrohm-827

Properties of Nanoparticles

Magnetic nanoparticles of zero-valent iron made in this study have a purity of 95%, the size of nanoparticles and 8-18 nm, 59-79 m2g-specific surface shape is spherical.

The optimal absorption conditions for the removal of nitrate ion

All chemicals used in making the measurements and the purity were 99%, Merck, Germany; deionizer water with a conductivity of less than 0.055 of the solution was used. High purity potassium nitrate 99.9% of Merck was used. There are different ways to measure nitrate in samples that can be measured, chromatography and paleography cited. In this method, nitrate measurements were performed using a spectrophotometer model TG90+, Methods This was done in the first 100 mL solution of 20 mg of nitrate per liter, with the absorbent was used to optimize the parameters, the nitrate adsorption on the adsorbent before and after contact with the adsorbent filtrate was read by a machine. And finally nitrate concentration before and after exposure was calculated according to the following formula [11].

$$\%E=\frac{C0-C}{C0}\times 100$$

C_o: initial concentration of nitrate

C: concentration after contact with the adsorbent

When iron FeO nanoparticles on water containing nitrite and nitrate ions is granted, according to the following reactions of divalent iron or nitrogen to ammonia gas. Gases are released into the environment and the use of water treatment processes can be removed [12].

$$2No_3^- + 5Fe^O + 6H_2O \rightarrow 5Fe^{2+} + N_2{}^+ + 12OH^-$$

$$No_3^- + 4Fe^O + 7H_2O \rightarrow 4Fe^{2+} + NH_4 + 10OH^-$$

Parameters of effective sorbent for the removal of nitrate ions

Investigation the pH effect

One of the main parameters controlling the pH of the reaction of nitrate ion is removed. For determining the pH of the reaction of nitrate by zero-valent iron is related to the following factors are considered.

1 - Being directly involved in ion H^+

2- H+ ions on the absorption of iron nitrate levels affect the active sites

3 - How to make a large extent influenced by the solution pH [13].

The pH of the medium was changed in the range between 2 to 8. Thus, 100 ml of nitric acid concentration of 20 milligrams per liter at 35 ° C during 46 min exposure to 1.2 mg of nanoparticles was placed. The result is shown in Figure 1. Nitrate removal rate increased with increasing pH to 3 and then nitrate removal rate decreases. Iron oxides are positively charged at low pH, such as nitrates better absorb negative ions in high pH can cause adsorption of cations [14, 15]. The maximum percentage removal of nitrate ion concentration was obtained for the adsorbent 3 = pH choleric acid to adjust the pH of it 0.1 M was selected. Figure (1)

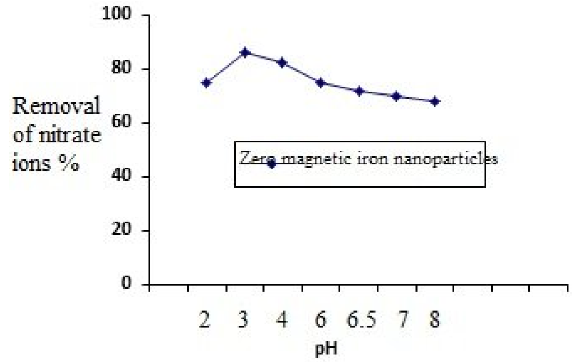

Figure 1 - Effect of pH solution

Amount of adsorbent

Zero-valent iron as an electron donor element can be directly caused by the nitrate removal, for this purpose, the amount of adsorbent was used to remove nitrate ions [16]. In each experiment, 100 ml of sample solution containing Liter pH= 3, concentration of 20 mg l, for 35 min with different amounts of nanoparticles was placed in contact with the results is given in Figure 2. This study showed that the nitrate removal efficiency increased absorption of soluble nitrate ion removal rate increases and then decreases. Zero-valent iron nanoparticles nitrate removal efficiency increases with increasing amount of adsorbent that can be liberated because the location is on the nanoparticle surface. Under the curve values for changes in Catchy Contact nitrate solution to remove most of the nitrate ion absorption 1.2 g, respectively (Figure 2).

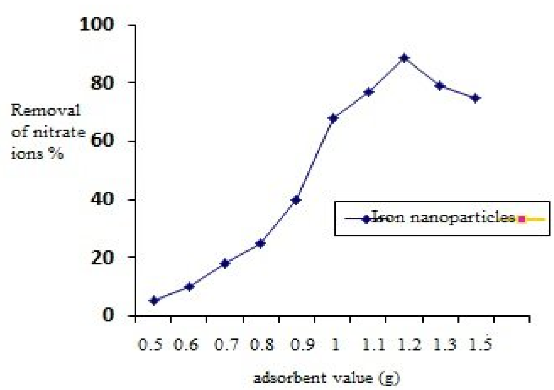

Figure 2 - The amount of adsorbent

Contact time of the adsorbent

For the time variation of the nitrate solution with an absorbent in each test sample with a concentration of 20 mg to 100 mg liter pH=3, in contact with 1.2 gram of nanoparticles at 50-10 min were placed. The absorption maximum of the curve changes with time reducing nitrate nitrate solution for 46 minutes was the adsorbent. Nitrate ion removal rate initially increased and then reached its highest removal rate at 46 minutes. Figure (3)

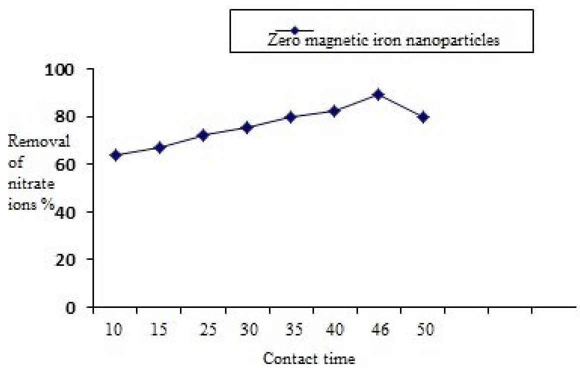

Figure 3 - Evaluation of sorbent contact time

Evaluation Solution Temperature

After testing the optimized conditions, the temperature change curve with the absorption maximum of nitrate removal by nitrate absorber temperature of 35 ° C, respectively. Up to temperatures up to 35 ° C, the percentage removal of nitrate ions with zero-valent iron nanoparticles increased. At temperatures above 35 ° C, the percentage concentration remained stable. According to the results, the removal of nitrate ions at the constant temperature of 35 ° C and reached its maximum value and then remains constant removal rate. Figure 4

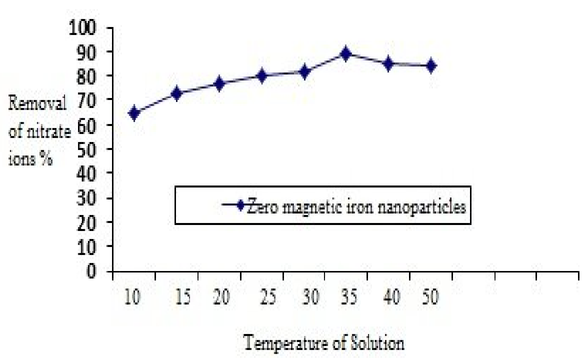

Figure 4: Evaluation Solution Temperature

Concentration of nitrate in contact with the adsorbent

Iron nanoparticles increases with increasing concentration and solution ionic strength nitrate removal rate increases. According to studies carried out in various concentration of nitrate solution with the highest efficiency absorbent absorbent concentration is 20,000 ug/ml. The results show that the sorbent sorbent performance in all areas of fairly high concentrations of nitrate removal was investigated. Low concentrations of nitrate ion, nitrate ion transport in the nanoparticles can be done more efficiently. Figure (5)

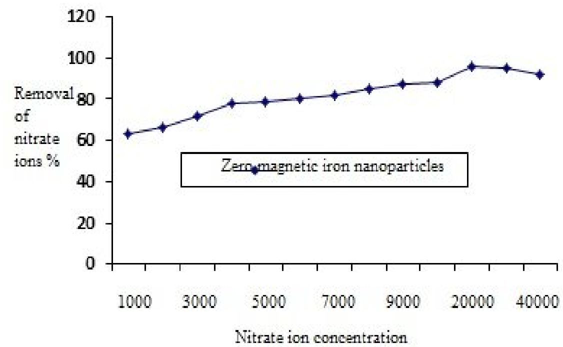

Figure 5 - Evaluation of the nitrate solution

Recovery nanoparticles used in the experiments

Zero-valent iron nanoparticles in a magnetic recovery, gradually adding 2 ml of nitric acid used 5/0 M, the pH was lowered to 3 ranges. With this method, about 89% of the particles were retrieved and re-usable. To do this, after comparing the results of the initial nanoparticles were recovered and nitrate uptake, nanoparticles have been used in the recovery of approximately 89%.

Experiment findings:

PH plays a major role in removing nitrates. At pH lower than 4 nitrate removal is easily done. These results corresponded well with the results of Choe et al [17]. Not favorable for nitrate reduction in alkaline conditions because of the high pH will precipitate iron hydroxide [18]. Eskaman and colleagues in a study in South Africa, using iron nanoparticles for the removal of nitrate ions have the finer particles are more efficient and the removal rate [19].

Conclusion:

Nitrate is a major disruption in the supply of oxygen to the body cells, especially for children and pregnant women is associated with morbidity. Nitrate increases the risk of cancer, especially in children have lower infant's body is causing a serious disturbance. Nitrate is water soluble contaminants by conventional wastewater treatment or chlorination is not available. One of the best methods for nitrate purification, reverse osmosis, but today's high efficiency in the removal of heavy metals and toxic are nanoparticles. Zero-valent iron nanoparticles, a high potential for nitrate removal from water sources are revival. In this study, 20 mg of iron nanoparticles Brlytr zero concentration, temperature 35 ° C and 46 min to remove pH =3 above 6/95% of the nitrate solution is capable of. The benefits of this approach can be used by a high percentage of nanoparticles recovered, relatively low cost, ease of procedure, much less catchy and at ambient temperature, contact time, low efficiency of the system, use this method to remove nitrate pollution of drinking water, single-beam spectrophotometer, using simple and inexpensive devices that are available in many laboratories can be introduces.

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