Green Synthesis of Alginate Encapsulated Iron Nanoparticles for Decolorization of Dye

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Abstract— The synthesis of iron nanoparticles (Fe NPs) using green tea leaves has been found to be eco friendly (green synthesis) compared to conventional method which uses chemicals. The green tea extract acts as both reducing and capping agent during the synthesis procedure. The iron nanoparticles formed was used for removal of both organic and inorganic pollutants (dyes) from aqueous solutions. The formed Iron nanoparticles were used as catalyst for degradation of dye. Iron nanoparticles contains iron oxides and zero valent iron (ZVI), which can be used as FENTON-like catalyst, where Fenton is used for degradation of aqueous organic solutes. Iron nanoparticles encapsulated with alginate beads were used for degradation of acid and basic dye. The different parameters such as effect of concentration, pH, dosage and ionic strength of the dye were discussed. The result suggests that the iron nanoparticles were more efficient in decolorization of acidic than basic dye.

Keywords— Iron nanoparticles, alginate beads, acid and basic dye.

I. INTRODUCTION

Nanoparticles and their applications have gained much importance in recent decades. The properties of bulk materials changed when brought to the nano range. A nano particle has at least one of its dimensions less than 100 nm, but new applications use particles in the range of few hundred nanometers.

The transition from microparticles to nanoparticles can lead to a number of changes in physical properties. Two major factors are the increase in surface area, and the size of the particle moving into the realm where quantum effects predominate.

High surface area is a critical factor in determining the catalytic activity and properties such as increased strength and/or increased chemical/heat resistance.

Zero-valent iron has been used to remediate groundwater by construction of a permeable reactive barrier of zero-valent iron to intercept and dechlorinate chlorinated hydrocarbons such as trichloroethylene in groundwater plumes.

The use of nanoscale zero-valent iron (NZVI) instead of using micro/macro-scale Fe (zero-valent iron) materials could potentially eliminate the need for using PRBs and be more effective in both cost and contaminant remediation. Iron nanoparticle is used for removal of organic and inorganic pollutants from aqueous solutions. Iron nanoparticle contains iron oxides and zero valent iron (ZVI), which can be used as FENTON-like catalyst. Fenton's reagent is a solution of hydrogen peroxide and an iron catalyst which is used to oxidize contaminants in water. Fenton's reagent can be used to destroy organic compounds such as trichloroethylene and tetrachloroethylene.

In green synthesis method the green tea extracts was used for synthesis of Iron nanoparticles. Polyphenols were used as reducing and capping agents.Iron nanoparticles which were synthesized using green tea extract were less susceptible to oxidation and stable. Iron nanoparticles formed were encapsulated with alginate beads to provide resistance to changes in pH or temperature.

The synthesized Iron nanoparticles encapsulated with alginate beads are used for degradation of acidic and basic dye. The different parameters such as effect of concentration, pH, dosage and ionic strength of Iron encapsulated alginate beads on the dye have been discussed in detail.

II. EXPERIMENTAL

MATERIAL USED:
Ferric chloride
Green tea extract
Sodium alginate
Calcium chloride
Acid dye (textile dye)
Basic dye (methylene green)
Distilled water
III. METHOD

Preparation of green tea extract
For preparing the extract, 6 g of green tea leaves were added in 100 ml of distilled water and the beaker was kept in water bath at 60°C for 20 minutes. Then it was filtered and the green tea extract is obtained.

Preparation of Iron Nano Particle
0.1 M of Ferric chloride was added to 100 ml of distilled water. To this green tea extract was added in the ratio of 2:3. The mixture was stirred for 5 minutes in magnetic stirrer. Hence, the nanoparticles were formed.

Preparation of Alginate Beads
Preparation of Alginate Beads:
3% of calcium chloride solution was prepared and refrigerated. 2g of sodium alginate and 20ml of iron nanoparticle was added to 80ml distilled water. This mixture was added drop by drop to calcium chloride solution. Due to the cross-linking between sodium alginate and calcium chloride, iron nanoparticles encapsulated within alginate beads.

Preparation of Dye
1 g of dye was added in 100 ml of distilled water and used.

IV. RESULTS AND DISCUSSION

4.1.1 SEM:

The SEM image fig (4.1) shows that iron nanoparticles have even size distribution and are monodisperse. The average grain boundary size is 250nm.

4.1.2 EDX:

From the fig (4.3) EDX spectroscopy shows that compound Fe and Cl are present.

4.1.3 FTIR:

The SEM image fig (4.1) shows that iron nanoparticles have even size distribution and are monodisperse. The average grain boundary size is 250nm.
The fig(4.4) shows the compounds present by FTIR. $1554.38\text{-amine (n-h bend)}$, $1401.52\text{-carboxylic acid(OH)}$, $1236.45\text{-carboxylic acid(c-o stretch)}$, $1633.58\text{-imines}$, $3122\text{-amines (n-H stretch)}$, $1067.03\text{-carboxylic acid(C-O)}$. These peaks confirm the presence of iron nanoparticle.

4.2 Acid dye

4.2.1 Effect of concentration:

![Figure 4.5](image)

From the graph shows the effect of concentration on efficiency.

4.2.2 Effect of pH:

![Figure 4.6](image)

The graph shows the effect of pH on efficiency.

4.2.3 Effect of dosage:

![Figure 4.7](image)

The graph shows the effect of dosage on efficiency.

4.2.4 Effect of ionic strength:

![Figure 4.8](image)

The graph shows the effect of ionic strength on efficiency.
4.3 Basic dye

4.3.1 Effect of concentration

![Graph showing the effect of concentration on efficiency.](image)

Figure 4.9
The graph shows the effect of concentration on efficiency.

4.3.2 Effect of pH

![Graph showing the effect of pH on efficiency.](image)

Figure 4.10
The graph shows the effect of pH on efficiency.

4.3.3 Effect of dosage

![Graph showing the effect of dosage on efficiency.](image)

Figure 4.11
The graph shows the effect of dosage on efficiency.

4.3.4 Effect of ionic strength

![Graph showing the effect of ionic strength on efficiency.](image)

Figure 4.12
The graph shows the effect of ionic strength on efficiency.
Summary

4.4 Acid vs. Basic

4.4.1 Effect of Concentration:

The graph shows the effect of concentration on efficiency.

4.4.2 Effect of pH:

The graph shows the effect of pH on efficiency.

4.4.3 Effect of Dosage:

The graph shows the effect of dosage on efficiency.

4.4.4 Effect of Ionic Strength:

The graph shows the effect of ionic strength on efficiency.

REFERENCES