International Journal of Recent Trends in Science And Technology, P-ISSN 2277-2812 E-ISSN 2249-8109
Special Issue, ACAEE: 2018 pp 59-61

Original Research Article

Preparation of zero valent iron nanoparticles by using different salts of iron

Hemeshvari Dadhore[1*], Charanjit Kaur[2], Sarita Shrivastava[3], Ranjeeta Choudhary[4]

[1]Department of Chemistry Government P. G. College Bareli, Raisen-464668, Madhya Pradesh, INDIA.
[2]Department of Chemistry, Sant Hirdaram Girls College, Bhopal-462030, Madhya Pradesh, INDIA.
[3,4]Department of Chemistry, Institute for Excellence in Higher Education, Bhopal-462016, Madhya Pradesh, INDIA.
Email: hchem_88@yahoo.com

Abstract

Zero valent iron nanoparticle (nZVI) is becoming an increasingly popular choice for the treatment of contaminated water as iron is inexpensive, non-toxic and environmentally compatible. Nanoparticles are attractive for remediation of various contaminants because of their unique physiochemical properties, especially its high surface area over iron filings. In the present study we have prepared nano Zero valent iron (nZVI) using different salts of iron like ferrous sulphate, anhydrous ferric chloride and ferrous ammonium sulphate. These salts are treated with sodium borohydride and Kaolinite in different concentration. The physical properties of the salts thus formed were studied.

Key Words: Nanotechnology, environmental remediation, nZVI, nanoparticles etc.

[*]**Address for Correspondence:**
Dr. Hemeshvari Dadhore, Department of Chemistry Government P. G. College Bareli, Raisen-464668, Madhya Pradesh, INDIA.
Email: hchem_88@yahoo.com

Access this article online

Quick Response Code:

Website: www.statperson.com

Accessed Date: 26 March 2018

INTRODUCTION

Nanotechnology is an emerging science with wide applications in the remediation of environmental pollutants. In recent years, a great deal of attention has been focused on the synthesis and application of nanostructure materials as adsorbents. Nano particles have high catalytic activity because of their small size (1-100 nm). They are also used as catalyst to remove toxic and harmful substances from water, soil, air etc. Iron metal is one of the very promising material for synthesis of nanoparticle because it is cheap, easily available and has higher surface area. In the present study attempts were made to synthesize nano Zero valent iron (nZVI) using different salts of iron. Zero valent iron nano particles is very promising material and plays a very important role in environmental remediation. Heavy metals such as Cr, Cu, Ni, Co, Pb, As, Cd etc. can be removed easily from contaminated water using nZVI[1]. Zero valent iron is a strong reducer, it has been used to remove several contaminants[2,3]. Water pollution is one of the biggest environmental problems in many countries. It mainly arises due to overpopulation and waste water released from household, industries and agriculture water bodies. These effluents typically contain high concentrations of organic and inorganic chemicals such as organic solvents, heavy metals, pesticides, dyes etc[4]. The contaminants have serious impact on environment and public health. Therefore waste water released from household, industries and agriculture processes must be treated properly prior to their release into the environment. There are several waste water treatment techniques including physical, chemical or biological processes i.e. coagulation, flocculation, adsorption, reverse osmosis, activated sludge and so on. These techniques are costly as well as less effective whereas the use of zero valent iron as reactive medium for waste water treatment is one of the most promising techniques because the iron metal is of low cost, easy to obtain, has good effectiveness and it has great ability of the degrading contaminants. In addition, iron particles from filings can be used as zero valent iron.[5,6]. Significant progress has been made in research and development of iron nanoparticles for wastewater treatment. Several

recent studies have reported on the wastewater treatment using nano zero valent iron[7-9].

METHODS AND MATERIALS

Different salts of iron such as ferrous sulphate ($FeSO_4.7H_2O$), anhydrous ferric chloride ($FeCl_3$), and ferrous ammonium sulphate [$(NH_4)_2$. $Fe(SO_4)_2.6H_2O$] along with Sodium borohydrate ($NaBH_4$) and Kaolinite are used for the synthesis of Zero valent iron nano particles (nZVI). Following methods were used for their synthesis:

Synthesis of nZVI by $FeSO_4.7H_2O$ (1M) and $NaBH_4$ (1M): For the synthesis of nZVI, Dissolve 8.3406g $FeSO_4.7H_2O$ in 24ml ethanol and add 6ml distilled water. Also prepare sodium borohydride solution by dissolving 3.7830g $NaBH_4$ in 100 ml distilled water. Fill sodium borohydride solution in burette. Keep ferrous sulphate solution on magnetic stirrer with hot plate at 30^0C. Now add 90ml sodium borohydride solution in ferrous sulphate solution drop by drop with constant stirring. Black coloured particles are formed. Filter these particles using Whattman filter paper No.1 and wash it twice with ethanol. Dry it overnight at 50^0C in hot air oven. Brown colour particles are obtained. Weight it.

Synthesis of nZVI by Anhydrous $FeCl_3$ (1M) and $NaBH_4$ (1M): Dissolve 4.8660g ferric chloride ($FeCl_3$) in 24ml ethanol and add 6ml distilled water. Also prepare sodium borohydride solution by dissolving 3.7830g $NaBH_4$ in 100 ml distilled water. Fill sodium borohydride solution in burette. Keep ferric chloride solution on magnetic stirrer at 30^0C. Now add $NaBH_4$ solution drop by drop in ferric chloride solution with constant stirring. Black coloured particles are formed. Filter these particles using Whattman filter paper No.1 and wash it twice with ethanol. Dry it overnight at 50^0C in hot air oven. Weight it.

Synthesis of nZVI by $FeSO_4.7H_2O$ (1M) and $NaBH_4$ (1M) and Kaolinite: Dissolve 8.3406g $FeSO_4.7H_2O$ in 24ml ethanol and add 6ml distilled water. Now add 1.50g Kaolinite in this solution. Also prepare sodium borohydride solution by dissolving 3.7830g $NaBH_4$ in 100 ml distilled water. Fill sodium borohydride solution in burette. Keep ferrous sulphate solution on magnetic stirrer with hot plate at 30^0C. Now add 90ml sodium borohydride solution in ferrous sulphate solution drop by drop with constant stirring. Black coloured particles are formed. Filter these particles using Whattman filter paper No.1 and wash it twice with 25ml ethanol. Dry it overnight at 50^0C in hot air oven. Yellowish brown particles are obtained. Weight it.

Synthesis of nZVI by $(NH_4)_2Fe(SO_4)_2.6H_2O$ (1M) and $NaBH_4$ (1M): Dissolve 11.76g ferrous ammonium sulphate in 24ml ethanol and add 6ml distilled water. Also prepare sodium borohydride solution by dissolving 3.7830g $NaBH_4$ in 100 ml distilled water. Fill sodium borohydride solution in burette. Keep ferrous ammonium sulphate solution on magnetic stirrer. Now add 90ml sodium borohydride solution in ferrous ammonium sulphate solution drop by drop with constant stirring. Brown coloured particles are formed. Filter these particles using Whattman filter paper No.1 and wash it with ethanol. Dry it overnight at 50^0C in hot air oven. Brown particles are obtained. Weight it.

Synthesis of nZVI by Anhydrous $FeCl_3$ (0.1M) and $NaBH_4$ (0.5M): Dissolve 1.622g ferric chloride ($FeCl_3$) in 100ml distilled water. Also prepare sodium borohydride solution by dissolving 1.8915g $NaBH_4$ in 100 ml distilled water. Mix both the solutions. Black coloured particles are formed. Filter these particles using Whattman filter paper No.1 and wash it with 20ml distilled water and 20ml ethanol three times. Black coloured particles so obtained are stored in ethanol overnight and dried in dessicator.

RESULTS AND DISCUSSION

In the present study attempts were made to prepare Zero valent iron nanoparticle (nZVI) by using different salts of iron. The zero valent iron nanoparticle so obtained differ from one another in their colour and yield. The results so obtained are tabulated in table 1.

Table 1: Results of Synthesis of various nano zero valent iron

Sr. No.	Sample	Colour	Yield (in g)
1	A	Light Brown	3.73
2	B	Blackish Brown	2.89
3	C	Yellowish Brown	6.30
4	D	Brown	5.69
5	E	Black	2.28

CONCLUSION

In this study it can be concluded that nZVI has been successfully synthesized in the laboratory using different salts of iron, sodium borohydride and kaolinite. Maximum yield was given by sample C and it was obtained when nZVI were synthesized by using ferrous sulphate, sodium borohydride and kaolinite. Zero valent iron can be used to remove waste water pollutants such as heavy metals, pesticides, dyes etc. because the iron metal is of low cost, easy to obtain and has good effectiveness.

ACKNOWLEDGMENTS

I would like to express my gratitude and indebtness to Dr. haranjit Kaur (Principal, Sant Hirdaram Girls College, Bhopal M.P.) for her constant support. I would like to thank Dr. Sarita Shrivastava (Prof., Deptt. Of Chemistry IEHE, Bhopal M.P.) for her help. I am extremely

delighted to express my deep sense of gratitude to Dr. Ranjeeta Choudhary (Asst. Prof., Deptt. Of Chemistry IEHE, Bhopal M.P.) and Dr. Jagdish Pataiya for their valuable suggestions, great support and constant encouragement during the period of this work. I am also very thankful to Sant Hirdaram Girls College Management for providing laboratory facilities.

REFERENCES

1. Hua M., Zhang S., Pan P., Zhang W., Lv L., Zhang Q. (2012) Heavy metal removal from water/wastewater by nanosized metal oxides: A review, Journal of Hazardous Materials, 317-331.
2. Gayathri G., Utkarsh M., Suresh G. (2012) Application of Nanomaterials for the Removal of Pollutants from Effluent Streams, Nanoscience and Nanotechnology-Asia, 2, 140-150.
3. Singh S., Barick KC., Bahadur D.,(2011) Surface engineered magnetic nanoparticles for removal of toxic metal ions and bacterial pathogens, Journal of Hazardous Materials 192, 1539- 1547.
4. National Research Council. (1994) Alternatives for Ground Water Cleanup, Committee on Ground water Cleanup Alternatives. National Academy press, Washington, D.C.
5. Palaharn, W. and Junyapoon, S. (2004) Discoloration of Reactive Blue 5 in Aqueous Solution by Waste Iron Particles, 1st KMITL International Conference on Integration of Science and Technology for Sustainable Development, Bangkok, Thailand, 25-26 August 2004, Vol.1, pp. 217-220.
6. Lee T., Lim H., Lee Y. and Park J-W. (2003) Use of water Iron Metal for Removal of Cr (VI) from water, Chemosphere, 53, 479-485.
7. Uzum C, Shahwan T, Eroglu AE, Lieberwirth I, Scott TB, Hallam KR. (2008) Chem. Eng. J., 144(2), 213-220.
8. Wang CB, Zhang WX. (1997) Environ. Sci. Technol., 31(7), 2154–2156.
9. Shultz MD, Reveles JU, Khanna SN, Carpenter EE. (2007) J. Am. Chem. Soc., 129(9), 2482-2487.

Source of Support: None Declared
Conflict of Interest: None Declared