ISSN (online): 2250-141X
Vol. 5 Issue 3, October 2015

EXISTENCE OF NANOTECHNOLOGY IN WATER TREATMENT

Mohan Kantharia[1]*, Pankaj Kumar Mishra [2],Jyoti Mishra[3], Priyanka Sharma[4], Akhilesh Udeniyan[5], Ranjeet Kumar Brajpuriya[6]

1. Dept. of Civil Engineering, Amity School of Engineering & Technology, Amity University Madhya Pradesh, Gwalior, India
2. Dept. of Applied Physics, Amity School of Engineering & Technology, Amity University Madhya Pradesh, Gwalior, India
4. Dept. of Physics, Mewar University, Chittorgarh, Rajasthan, India
5. Department of Process, Riverina Oils and Bio Energy Pty. Ltd. Wagga, NSW, Australia
6. Amity Institute of Nanotechnology, Amity University Haryana,Panchgaon,Manesar,Gurgaon,India

Abstract: *Water is most essential need of human life as well as commercially. Water contamination is one of the major issues which the world is facing today. Nanotechnology has great potential in advancement of water purification to improve the treatment efficiency by which human can properly get the quality water supply. The high surface areas of nanomaterials upgrade membrane technologies and the catalytic properties of some nanomaterials have potential to detach contaminates from water. Nano-filtration techniques are now widely used to remove cations, natural organic matter, biological contaminants, organic pollutants, nitrates and arsenic from groundwater and surface water. This study aims to provide review of the elevation of nanotechnology in water purification in this paper. Nanotechnology is able to treat water for daily use and industrial purposes which is the high-priority of eco-friendly system.*

Keywords*:* Nanotechnology, Water contamination, Water treatment, Nano-filtration.

Introduction

The grand challenge of 21st century is to provide clean and affordable water for human being and their needs. Nanotechnology is the field of applied science whose theme is the control of matter on an atomic and molecular scale. Currently the human society is facing a tremendous pollution in ground water and surface water. The available supplies of fresh water are decreasing due to population growth, extended droughts. Water being a prime natural resource, a basic human need, its use needs appropriate planning, development and management. The nano-scale materials have unique properties like extremely high surface area, high absorbing, interacting and reacting capabilities due to their extremely small size, that build them faster, lighter, stronger and more efficient as well as creating new classes of materials. In water research, nanotechnology is applied to develop more cost-effective and high performance water treatment systems, as well as to provide instant and continuous ways to monitor water quality[1,2].

One or more substances have built up in water to such an extent that they cause problems for animals and people are called water contamination. An agency identified that the largest pollutants sources for rivers, lakes and estuaries. Contaminants from these sources include pesticides, metals, nitrates, solvents and others wastes. Contamination is even more persistent in ground water due to lake of biological degradation. Natural phenomena such as volcanoes, algae blooms, storms, and earthquakes also cause major changes in water quality and the ecological status of water. In industrialized nations, water contamination is much less common than in third world and developing countries. That's because sophisticated water purification systems are in place to clean waste materials from the water, disinfect it using chemicals, and then purify it so that it is safe for consumption [3, 4].

Methodology

Since water treatment by using nanoparticles has high technology demand, its usage cost should be managed according to existing competition in market *(Crane et al., 2012)*[14]. In terms of wastewater treatment, nanotechnology is applicable in detection and removal of various pollutants. Heavy metal pollution poses as a serious threat to environments because it is toxic to living organisms, including human, and not

ISSN (online): 2250-141X
Vol. 5 Issue 3, October 2015

biodegradable[5]. Various methods are used to resolve or greatly diminish problems involving water quality in natural environment[6,7].

1. Nanosensors

Nanosensors are any biological, chemical, or surgical sensory points used to convey information about nanoparticles to the macroscopic world. Nanosensors for the detection of contaminants and pathogens can improve health, maintain a safe food and water supply and allow for the use of otherwise unusable water sources[8].

2. Nanosorbents

Nanosorbents have very high and specific capacity having wide application in water purification, re-mediation and treatment process. Carbon based nanosorvents have high specific surface area, excellent chemical resistance, mechanical strength and good adsorption capacity which treats water containing nickel ions. Re-generable polymeric Nano-sorbents treat organic and inorganic contaminants in waste water. Nano-clays residue Hydrocarbons dyes and phosphorous from water[9].

3. Nanocatalysts

Nano-catalysts increases catalytic activity at the surface due to its special properties with higher surface area. It enhances the reactivity and degradation of contaminants. The commonly catalyst nanoparticles are semiconductor materials zero- valence metal and bi- metallic nanoparticles for degradation of environmental contaminants[10].

4. Reverse Osmosis

RO is a physical process that uses osmosis phenomenon, i.e. the osmotic pressure difference between the salt water and the pure water to remove salts from water. In this process , a pressure greater than the osmotic pressure it applied on salt water to reverse the flow , which results in fresh water passing through the synthetic membrane pores separated from the salt and a concentrated salt solution is retained for the disposal[11].

5. Thin Film Nanocomposites

TFN membranes are developed for incorporative nano- materials into the active layers of thin film composite (TFC) membranes via doping in the casting solution or surface modification .Nano materials that have been researched for such applications include nano-zeolites, nano- Ag, nano-TiO2 and CNTs[12].

6. Nanofiltration

Nanofiltration (NF) membrane works similar to reverse osmosis except that with NF, less pressure if needed because of larger membrane pore size. NF can remove some total dissolved solids, but is often used to partially soften water and is successful at removing solids, as well as dissolved organic carbons [13].

Table 1: water treatment equipment demand (million dollars) 2013 by the Freedonia group, Inc.

Items	Year 2007	Year 2012	Year 2017
Municipal	3630	4610	5950
Manufacturing	1818	2350	3150
Commercial & Residential	1076	1110	1520
Resource Extraction	618	973	1470
Power Generation	525	588	690
Other Markets	93	129	230

Graphical representation of fig.1(below) results the high evolution in terms of demand and needs of nanomaterials in water and waste water treatment in various fields with respect to time. The collected data are showing the growing demand of the water treatment equipments with five years interval as from 2007 to 2017[Table 1]. The municipal field's demand has improved tremendously as compared to the other mentioned fields. In this sequence the manufacturing field is second highest which has developed with nanotechnology in the evolution of water treatment [14-16].

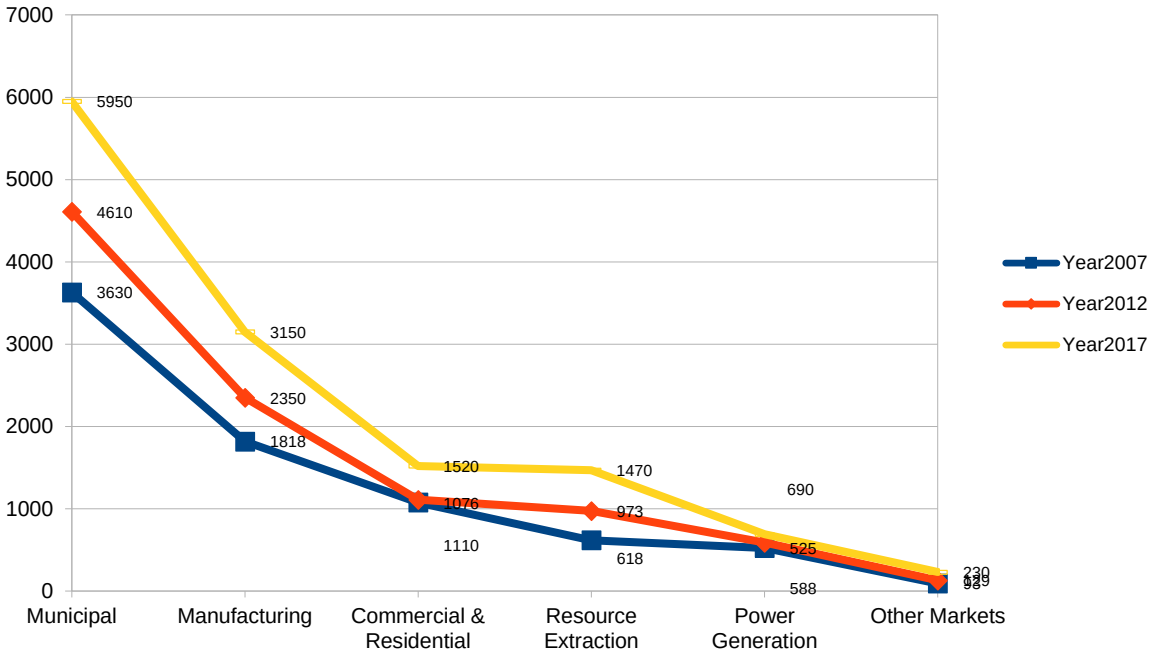
Conclusion

Nanotechnology for water and wastewater treatment is gaining momentum globally. Although many Nanotechnologies highlighted in this review are still in the laboratory research stage, some have made their way to pilot testing or even commercialization. On the basis of study we have

ISSN (online): 2250-141X
Vol. 5 Issue 3, October 2015

concluded that the impact and applications of nanotechnology is quite addressing for the treatment of waste water and raw water. The unique properties of nanomaterial can be revolutionary in the treatment of waste water in upcoming trends due to their convergence in present methods. The nanotechnology review is not only happening in a single stage but also all the stages like not in laboratory level, pilot testing and commercialisation stages. It has been cleared that nanotechnology holds an immense potential to be developed into a very patent water treatment tool of 21st century.

Fig. 1 Schematic of Water treatment equipment demand in million dollars by the Freedonia Group



References

I. Prachi[1], Pranjali Gautam[1], Deepa madathil[1], A.N. Brijesh Nair[2], 1 School of Bio Sciences and Technology, 2 School of Mechanical and building sciences, VIT University Vellore, Tamilnadu, India, Vol.5, No.5, pp2303-2308, 2013.

II. Pankaj K. Tyagi, Ravikant Singh, Smriti Vats, Dharmendra Kumar and Shruti Tyagi, International Conference on Nanotechnology and Chemicak Engineering, Bangkok, Dec 2012.

III. N.C. Mueller, B. Nowack, "Nanotechnology development for the Environment sector", *report of the observatory* NANO 2009.

IV. S.D. Mamadou, N. Savage, "Nanoparticles and water quality", J. Nano. Res. 7: 325-330, 2005.

V. D.K. Tiwari, J. Behari and P. Sen, Applications of Nanoparticles in Waste Water Treatment", World Applied Sciences Journal, 3(3), 417-433, 2008.

VI. Gao W., Majumdar M., Alemany L.B., Narayanan T.N., Ibarra M.A., Pradhan B.K., Ajayan P.M., Engineered Graphite Oxide Materials for application in water purification, ACS Applied Materials and Interfaces 3(6), 1821-1826, 2011.

VII. Carrado K.A. And Komadel P., 5(2), pp111-116, 2009.

VIII. Dr. Mona B. Mohamed, Director of Nanotech Egypt for photo-electronics, Bhagat Group, & Assistant Professor at

ISSN (online): 2250-141X
Vol. 5 Issue 3, October 2015

National Institute of Laser Enhanced Science, Cairo University, United Nations Educational, Scientific and Cultural Organisation.

IX. Sayan Bhattacharya, Indranil Saha, Aniruddha Mukhopadhyay, Dhrubajyoti Chattopadhyay, Uday Chand Ghosh, Debashis Chatterjee, West Bengol, India, International Journal of Chemical Science and Technology, 3(3):59-64, 2013.

X. Zhang K., Dwivedi V., Chi C., Wu J., Graphene oxide/ferric Hydroxide composites for efficient arsenate removal from drinking water, Journal of Hazardous Materials 182:162-168, 2010.

XI. Shah M.A., Ahmed T., Principles of Nanosciences and Nanotechnology, Narosa publishing house, New Delhi, India, pp.34-47. 2011.

XII. WHO, 2012, Progress on Drinking Water and Sanitation, 2012 update.

XIII. Liu Z.Y., Bai H.W., Lee J., Sun D.D., A low energy forward osmosis process to produce

XIV. drinking water, Energy & Environmental Science 4(7): 2582-2585.

XV. Xiaolei Qu, Pedro J.J. Alvarez, Quilin Li, Department of civil and Envkironmental Engineering, Rice University, Houston, TX 77005, USA, 2013.

XVI. Crane R.A., Scott T.B., Nano-scale zero-valent iron: Future prospects for an emerging water treatment technology, J. Hazard mater, pp 211-212, 2012.

XVII. P.K. Khare, Pankaj Mishra , Jyoti Mishra, Indian Journal of Physics, 82(10)2008.

XVIII. Pankaj K.Mishra, Jyoti Mishra, P.K.Khare the 54th DAE Solid State Physics Symposium, held at M.S. University Vadodara on 14-18, Dec. 2009, 607-608.

Authors Profile

Mohan Kantharia Graduated in B.E. in Civil Engineering from Devi Ahilya University M.P. (S.G.S.I.T.S. Indore) in 1986. And M.E. in Construction Technology and Management from RGPV (MITS Gwalior) in 2010. Started his carrier as a Construction Engineer at HCCL, Bombay (A multinational construction company of India) in 1987.As a faculty he joined College of science and Engineering (CSE) Jhansi U.P.in 2005, and then worked in IPSCTM Gwalior and different Engineering colleges of RGPV (MP) from 2006 to 2013. In feb .2013 he joined Amity University Gwalior, where he is working till now as **Head of Civil Engineering Department**.

Dr. (Mrs.) Jyoti Mishra is currently working as an Associate Professor and Head, Department of Applied Science. She has a teaching and research experience of almost 12 years. She has completed research project titled "S**tudy of Performance of Electrets Based on Novel Polymer blends"** funded by MP Council of Science and Technology, Bhopal .She has published 15 research papers in International/National Journals of repute, hir research interests include electret and thin film technology with various polymers and their composites developed with special reference to Electrets material.

ISSN (online): 2250-141X
Vol. 5 Issue 3, October 2015

Dr. Pankaj Kumar Mishra is currently working as an Asst. Professor, Applied Physics and Ph.D coordinator of Amity School of Engineering and Technology, Amity University Madhya Pradesh, Gwalior. Dr. Mishra has a teaching and research experience of almost 13 years. For his meritorious performance he was conferred with **Gold medal** in post-graduation. Dr.Mishra completed research project titled "s**tudy of performance of electrets based on novel polymer blends"** funded by MP Council of Science and Technology, Bhopal and Coauthored a book on **Applied Physics (Theory and Experiments)**, published by University Science Press (An Imprint of Laxmi Publications Ltd.).
He has published 16 research papers in International/National Journals of repute in the field of microelectronics, his research interests include electret and thin film technology. His work in this field has progressed in different veins including TSDC, Dark Conduction Current, dielectric relaxation, SEM, XRD, UV, FT-IR, AFM, charge trapping and its transport by working with various polymers and their composites developed with special reference to Electrets material containing quasi permanent polarization properties. Mechanism and character of charge storage and transport properties in polymers and their industrial applications comprise the subjects of his interest.

Mrs. Priyanka Sharma currently working as a Laboratory Technician in Oil Seeds Australia Pty Ltd. Hillston NSW Australia.
I did my Bachelor of Science in and Master Degree in Physics from Jiwaji University Gwalior and after completion of my Master Degree I have worked as Lecturer for Engineering Physics in Naga Ji Group of Education Gwalior and IPS group of Colleges Gwalior.
I have also completed my M.Phil in Physics from Chittorgarh.

Mr. Akhilesh Udeniyan working as a Process Engineer in RIVERINA OILS AND BIO ENERGY PTY LTD. Wagga Wagga, NSW Australia. This is a fast growing company in the field of Agri- Processing in the Australia.
I did my Bachelor of Engineering in Chemical from RGPV Bhopal (Technical Board of Madhya Pradesh). I am working in this FMCG sector since last 8 years and also given my services in the field of Education too for a short tenure before joining this sector.
I am continuing my journey of research since last 5 years.

Dr. Ranjeet K Brajpuriya has more than 13 years of rich teaching and research experience including post-doctoral research work in Italy, Germany and India. Dr. Brajpuriya did his post-graduation and doctoral degree from Devi Ahilya University, Indore. He was a visiting Scientist from Sept 2009 to June 2010 at Synchrotron Elettra, Trieste, and from Mar 2015 to August 2015, at ENEA, Rome, Italy. He has been awarded with numerous national and international fellowships. Recently, he was also awarded by a Prestigious ENEA International Research Fellowship, Italy. He is the member of many scientific and educational societies and referee for some of the reputed International Journals. He has published more than 70 research papers in International/National reputed journals. Dr. Brajpuriya research interest includes Carbon based Nanomaterials and Material Science.