Advanced Treatment Methods for the Rejuvenation of Lake Water

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Abstract- These days, lakes are mishandled to a greater extent. Most of the wastes generated are directly being discharged into the lake, thus causing harm to the aquatic lives. On understanding its features, the lakes have to rejuvenated and maintained for its future utilization. There are Sewage Treatment Plants (STPs) build in the vicinity of the lake to treat the wastewater entering into the lake. Yet, the condition prevails and demands the need for an advanced methodology for rejuvenating such polluted lakes.

Nanoscience and Nanotechnology together can influence the treatment process to a greater extent. Metal rich metal oxide nanoparticles like Fe – Fe_2O_3 synthesized in an inert atmosphere proves to be an efficient material for the water purification. The morphology of this synthesized nanoparticle is determined through the sophisticated characterization like Scanning Electron Microscopy (SEM). The paper reviews the efficiency of using the synthesized nanoparticles for the purification of Lake Waters.

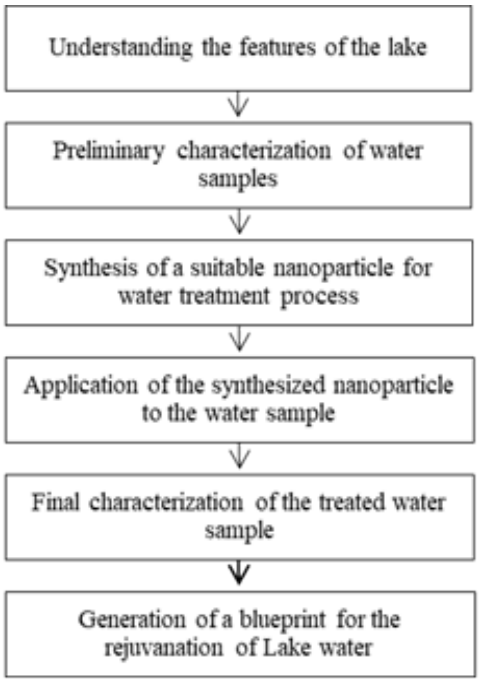
Keywords – Nanotechnology, Urbanization, SEM, Morphology, Water Treatment

I. INTRODUCTION

Lakes were once the source of drinking water. But due to rapid urbanization along with the industrialization, the condition of the lakes have been pathetic. Also, the increasing population has increased the generation of enormous amount of sewage that is directly let into the lakes. Various pharmaceutical industries, dye and detergent industries discharge untreated effluents into the lakes thus degrading its quality.

Nanosciences in modern aspects is the upcoming technology which supports these critical issues. The size of the particles is in the nanometer scale. The nanometer size particle supports composites like carbon, polymers, oligomers, etc. These composite based Nanosciences are the highlights of the present technology, to resolve the complicated issues. These nanoscale particles can efficiently support wastewater treatment.

II. METHODOLOGY



2.1 Preliminary Characterization of Lake Water –

For the purpose of research, the lake water samples were collected from the discharge of Varthur Lake, Bangalore. Preliminary characterization is mainly done for the purpose of reference – to determine the concentration of contaminants in the lake. These tests confer to IS: 3025 (1983) and the water quality standards as per IS: 10500 (2012). Various tests like pH, Alkalinity, Hardness, Acidity…etc. were carried out; the results of which are as follows:

PARAMETERS	UNITS	DISCHARGE WATER	DESIRABLE RANGE
Color	-	Greenish Yellow	Colorless
Odor	-	Present	Absent
pH	-	7.07	6.5 – 8.5
Turbidity	NTU	23	< 5
Total Alkalinity	mg/L	568	200
Total Dissolved Solids	mg/L	776	500
Total Acidity	mg/L	17	15
Total Chlorides	mg/L	161.5	250
Total Sulphates	mg/L	39	250
Total Hardness	mg/L	210	< 120

Table 1. Preliminary Water Sample Test Results

2.2. Synthesis of Iron-based Metal Oxide Nanoparticles –

The Iron-based metal oxide nanoparticles were synthesized by Inert-Ambient Pyrolysis. A single source precursor was used for the synthesis. The Iron precursor was initially loaded into the quartz tube, back filled with an inert gas and sealed. Rapid annealing and cooling were optimized. Once the stabilization duration was attained, the nanoparticles were extracted and characterized to understand its morphology. Scanning Electron Microscopy (SEM) technique was used to determine its surface morphology.

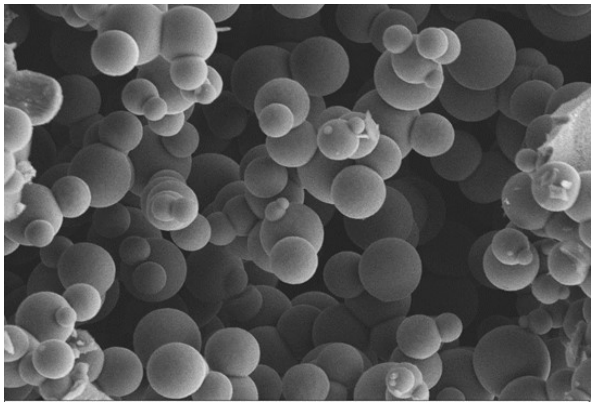


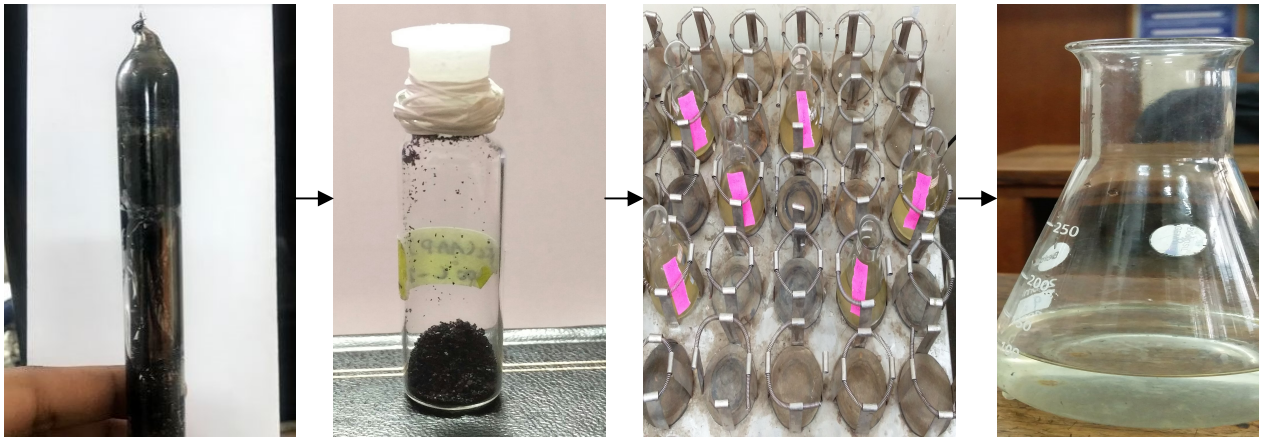
Figure 1. SEM Image to Determine the Surface Morphology

The SEM image confirms spherical shaped nanoparticles with an average size of 100-200 nm, also being polycrystalline in nature. It also shows that the nanoparticles are not agglomerated, which is an important pre-requisite for the adsorption phenomenon that initiates the water purification.

It was also found that the Iron based metal oxide nanoparticles were coated with a carbon layer thus enhancing the treatment process.

2.3 Application of Nanoparticles for the Treatment Process –

The untreated lake sample was initially filtered to remove all the suspended impurities present in it. This is because the macro particles could interrupt the nano level treatment processes. Later, the 2 hours annealed (at 700^{o} C) Iron Oxide nanoparticles were applied to the filtrate at a concentration of 80 mg/L and stirred for 210 minutes in a flask shaker. Soon after attaining the contact time, the nanoparticles were removed from the water and tested for various parameters to determine if there are any contaminants after the treatment process.



a) Nanoparticles in the Ambel b) Iron-Oxide Nanoparticles c) Stirring of Water along with Nanoparticles d) Purified Water

Figure 2. Nanotechnology Treatment Process

III. Experiment and Result

The pH of both the untreated and the treated water samples were well within the desired limits. The water used for domestic activities must be nearly a neutral solution with pH ranging between 6.5 and 8.5. Turbidity of the water is the haziness created by a large number of suspended or colloidal impurities. Removal of the large number of such suspended impurities from the lake water sample was a challenging task. Any traces of the nanoparticle itself could cause turbidity in water. Alkalinity is the capacity of water to neutralize the acid. Too high alkalinity can induce algae growth due to inhibition of the activity of chlorine. The color of water turns green. Thus, keeping alkalinity within the limits is necessary. The alkalinity upon treating had decreased to some extent. These three aspects along with the total hardness of water were of major consideration for the treatment process.

The experiment procedures confer to the IS: 3025 (1983) and the water quality standards are as per IS: 10500 (2012). The nanoparticles being polycrystalline in nature, prove to be an efficient method for purification of water. The comparison of the results are as follows –

PARAMETERS	UNITS	UNTREATED WATER	TREATED WATER	DESIRABLE RANGE
Color	-	Greenish Yellow	Almost Colorless	Colorless
Odor	-	Present	Absent	Absent
pH	-	7.07	8.32	6.5 – 8.5
Turbidity	NTU	23	5	< 5
Total Alkalinity	mg/L	568	310	200
Total Dissolved Solids	mg/L	776	541	500
Total Acidity	mg/L	17	14	15
Total Chlorides	mg/L	161.5	182	250
Total Sulphates	mg/L	39	25	250
Total Hardness	mg/L	210	110	< 120

Table 2. Treated Water Sample Test Results

It was evident that the Iron-Oxide Nanoparticles efficiently removed most of the contaminants from the water thus bringing the level of pollutants within the desirable range. A very minimal concentration of the nanoparticles could effectively remove most of the contaminants.

IV. Conclusion

Wastewater treatment and reuse is a practice related not only to a number of benefits concerning water balances and management but to a number of questions. Employing iron oxide nanoparticles has received much attention due to their unique properties, such as extremely small size, high surface-area-to-volume ratio, surface modifiability, excellent magnetic properties and great biocompatibility.

The waste water treatment results shows the efficiency of Iron based nanoparticles synthesized from the inert ambient pyrolysis, which is a unique process. The controlled atmosphere resulted in a metal - metal oxide nanoparticle. The Inert ambient pyrolysis is the most effective technique to make an interesting metal oxide nanoparticle by a simple method. The surface chemistry of nanoparticles play a vital role in the adsorption and large surface area favors the purification process. The Iron based nanoparticle was found to be perfectly spherical in nature as confirmed by SEM. The average size of nanoparticle being nearly 100 – 200 nm effectively removed all the contaminants from the lake water.

On sustained treatment of the industrial effluents and the sewage that is directly being discharged into the lakes, the polluted lakes could be effectively rejuvenated thus reducing the concentration of contaminants in it. This study is a clear evidence for the rejuvenation of polluted lakes by advanced methods of treatment.

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