**Synthesis and application of iron oxide nanoparticles for household level water treatment**

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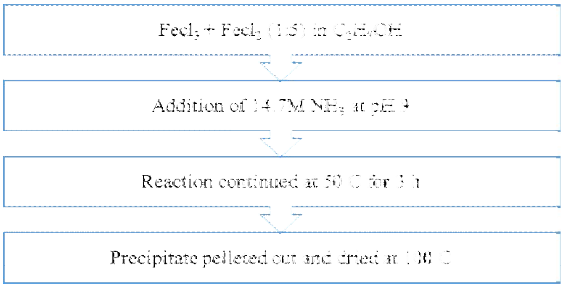
## Introduction

Access to safe drinking water is one of the main prerequisite for a healthy life. About 748 million people lack access to safe drinking water globally, explaining the gravity of the current situation [1]. Arsenic has been reported to be one of the significant inorganic pollutants in water, detrimental to both the environment and human health with the permissible limit being 10 ppb [2-4]. Fluoride is another contaminant of concern commonly present in groundwater. Iron oxide based materials have been reported to be effective for the removal of arsenic in view of their strong adsorption properties and the ease of separation and reuse with the help of external magnetic field [5]. Nano-sized adsorbents are of current interest in view of smaller size and larger specific surface area [6]. In the current study, magnetite nanoparticles were prepared and their arsenic removal capacity was studied.

## Materials and Methods

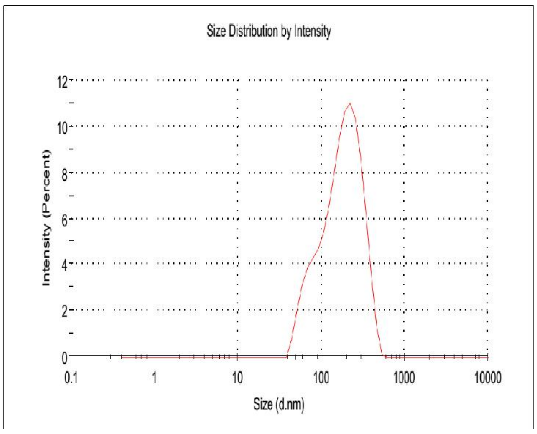
Synthesis of $Fe_3O_4$ nanoparticles was carried out by chemical precipitation method [7] with modifications.




The synthesized nanoparticles were characterized physico-chemically for the particle size and zeta potential. The morphology of the particles were determined using Scanning Electron Microscopy (SEM) and the elemental composition was confirmed using Energy Dispersive Analysis X ray Spectroscopy (EDAX). The arsenic and fluoride adsorption efficiencies were determined by conducting laboratory-scale adsorption experiments and fitting the isotherm models to the experimental results.

## Results

The synthesized nanoparticles had an average particle size (as determined using a particle size analyzer) of 192 nm (Fig. 1(a)) whereas SEM revealed an average size of ~200 to 400 nm (Fig.1(b)). The stability of the particles under static conditions was determined over a period of 24 h to determine the suitability of the particles for the adsorption study. The particles appeared stable with no significant changes in the size till 4 h. At the end of 24 h, the particle size decreased between ~12 to ~40 nm signifying settling down of larger particles. The zeta potential of the particles was studied to determine the overall surface charge. The particles had a zeta potential of 76.7 ± 2.28 at pH 6. EDAX analysis confirmed the presence of Fe and O in the samples.



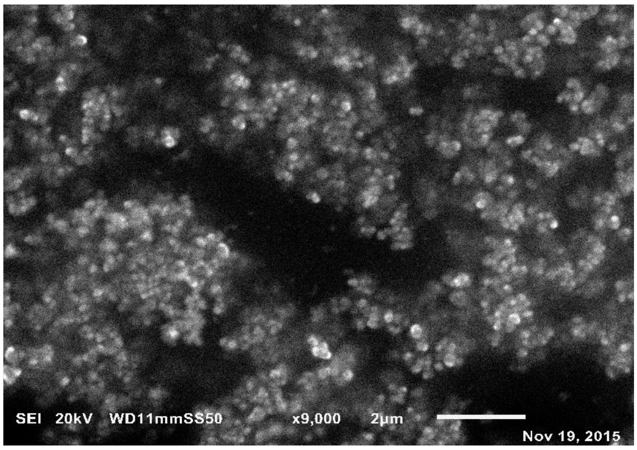




**Figure 1: (a) Particle size distribution and (b) SEM micrograph of iron oxide nanoparticles**

The adsorption capacity of $Fe_3O_4$ nanoparticles for arsenic were determined at different initial concentrations of both As(III) and As(V). The isotherm study was performed at pH 7 and the adsorption isotherms fitted the Langmuir model. The maximum adsorption capacity of As (III) was calculated to be 2000 µg/g while it was 23.64 µg/g for As (V). Furthermore, the fluoride adsorption capacity at pH 7 was estimated to be 1.47 mg/g.

## Conclusion

The synthesized nano-adsorbent with an average size ~ 200 nm was stable for 4 h under static conditions in the absence of any stabilizing agent. The particles possessed a net positive charge at pH 6. The material had a significant adsorption capacity for As (III) and the isotherm fitted the Langmuir model confirming monolayer adsorption. Ease of separation post-treatment using an external magnetic field is the major advantage of the synthesized adsorbent. Further detailed studies on the effect of various process parameters on adsorption capacity and mode of application of this adsorbent for household level water treatment are being carried out.

## References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