Iron oxide waste to clean arsenic-contaminated water

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ABSTRACT
Serious cases of arsenic (As) toxicity of people by drinking water have led to the development of water purification methods. For instance, arsenic can be removed from water by adsorption on natural iron oxides. The use of iron oxide from waste could decrease the cost and recycle iron. Here, we studied arsenic removal from contaminated water using iron oxide wastes from a pickling unit of a steel plant. This iron oxide was reduced to magnetic iron oxide in a fluidised bed reactor. We tested arsenic removal from As-spiked solutions and from contaminated waters from West Bengal. Results showed more than 95% arsenic removal within 10 min. The arsenic concentration of contaminated waters was decreased from 0.010-0.018 to 0.002-0.008 mg/L. We also found that the occurrence of Ca, Mg, SO4, and PO4 decreased arsenic adsorption. Iron oxide waste is therefore a new low-cost and effective arsenic adsorbent to clean water.

INTRODUCTION & OBJECTIVE
• Arsenic contamination in ground water identified as global problem.
• About 6 million people in West Bengal (India) and 25 million population in Bangladesh are affected by As-contaminated ground water (Chakraborti et al. 2002).
• Consumption of As-contaminated water found linked to heart related deceases (Moon et al. 2013).
• Acceptable limit of arsenic in drinking water according to BIS and WHO is 0.01 mg/L.

OBJECTIVE: Physico-chemical characterisation and utilisation of iron oxide waste for studies on treatment of arsenic-contaminated ground water.

EXPERIMENTAL METHODS
• The iron oxide waste (Haematite) was converted to magnetic iron oxide (Magnetite) by controlled reduction in fluidized bed reactor using CNG as reductant. Characterisation carried out for chemical analysis, phase identification by XRD, morphological analysis by SEM, determination of particle size, surface area, pHm, and magnetic susceptibility.
• Batch sorption studies were carried out by mixing As(A) (0.2 mg/L) spiked 100 mL water with iron oxide waste (1.0 g/L) in a flask and shaking for 1 h at pH 7. Each parameter was varied to evaluate As(A) removal properties of iron oxides waste. The resultant arsenic was determined by Hydride Generation-AAS method. Real ground water from West Bengal was also tested to remove arsenic.

RESULTS
Physico-chemical properties of iron oxide waste

Iron oxide based adsorbent & pH As removal capacity (%) Reference

<table>
<thead>
<tr>
<th>Iron oxide based adsorbent</th>
<th>Initial As (A) mg/L</th>
<th>pH</th>
<th>Arsenic removal/loading capacity (%)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural oxe (Haematite)</td>
<td>1.0</td>
<td>0-10</td>
<td>0.204</td>
<td>Govt et al. 2007</td>
</tr>
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<td>Natural oxe (Haematite)</td>
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<td>0-10</td>
<td>0.80</td>
<td>Zhang et al. 2004</td>
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<td>Natural iron oxide (Magnetite)</td>
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<td>0.214</td>
<td>Babayeva et al. 2013</td>
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<tr>
<td>Commercial haematite</td>
<td>0.1-0.5</td>
<td>0.9</td>
<td>0.411</td>
<td>Mamindy et al. 2009</td>
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<td>0.9</td>
<td>1.219</td>
<td>Mamindy et al. 2009</td>
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<td>Commercial magnetite</td>
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<td>0.852</td>
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<td>Natural haematite</td>
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<td>0.253</td>
<td>Gimenez et al. 2007</td>
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<td>0.45</td>
<td>Gimenez et al. 2007</td>
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<tr>
<td>Goethite rich</td>
<td>0.17±0.98</td>
<td>7.3</td>
<td>0.204</td>
<td>Sultana et al. 1987</td>
</tr>
</tbody>
</table>

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Treatment of arsenic-spiked water

CONCLUSION
• Iron oxide waste exhibited fast uptake of arsenic. Initial arsenic level of 0.2 mg/L was brought down to BIS and WHO specification for drinking water, within 10 min contact time. Arsenic removal efficiency was found to be unaffected by pH of water.
• Arsenic-contaminated ground water obtained from Nadia district, West Bengal was successfully cleaned (As level <0.01 mg/L) making suitable for drinking purpose, using both the adsorbents.
• Advantages of iron oxide as adsorbent are: (a) It is by-product of industrial process and no chemical routes for synthesis are needed, (b) no secondary pollutants are produced during preparation, (c) simple and rapid separation of As-loaded magnetite from the treated solutions can be achieved via external magnetic field and (d) it recycles iron oxide. This makes the iron oxide-cleaning (Haematite and magnetite) environmentally very friendly sorbents.

REFERENCES:

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