Arsenic Removal by Electrocoagulation - A Socially Sustainable Water Treatment Technology

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SCHEME OF PRESENTATION

General Outline: Arsenic

Existing Treatment Technologies

Objectives

Electrocoagulation

Arsenic removal by Electrocoagulation

Results

Conclusion
THE DISTRIBUTION OF ARSENIC OVER THE WORLD

[Map showing distribution of arsenic around the world]

LEGEND
- Red: Arsenic-affected aquifers
- Orange: Arsenic related to mining and mineralisation
- Green: Geothermal waters

(http://www.bgs.ac.uk/arsenic)
EXISTING TREATMENT TECHNOLOGIES FOR ARSENIC REMOVAL

• Adsorption and ion Exchangers
• Coagulation/Filtration
• Ion-exchange Resins
• Reverse Osmosis
• Membrane Filtration
• Electrocoagulation
The objective of the research is

- Review of existing arsenic removal technologies for potable water supply

- To study and develop a treatment technology for the removal of arsenic from drinking water to meet the maximum contaminant level of Arsenic based on electro-coagulation using iron electrode
  - Laboratory experiments for arsenic removal
  - Experimental Parameters
    - Current Intensity
    - Initial Arsenic Concentration
    - Iron concentration
    - pH
Electrocoagulation (EC) is an electrochemical technology for the treatment of water and wastewater.

Fig. Schematic representation of Electrocoagulation-cell
Laboratory Scale Batch Electrocoagulation

- 15L Electrochemical Batch Reactor

- Iron Electrodes (99% purity, 2 mm thickness; effective area 180 cm² on each side)

- The plates were placed 10mm apart in the batch cell.

- The mono-polar 3 electrodes connected in parallel were used in electrocoagulation cell for the experiments.

- A direct current (DC) supply (TESTRONIX 34C, 1 - 15V, 0 - 5 A, Digital Display)
Batch experiments were performed in the laboratory at ambient temperatures ranging from 27±1°C.

Experiments were conducted using 15L tap water spiked with Arsenic.

The water is continuously circulated using submersible water pump to ensure complete mixing.

Arsenic concentration was analyzed (using ICP-OES) at fixed time interval in the reactor for first 30 minutes when the current was supplied.
RESULTS

Arsenic removal By Electrocoagulation:

Effect of pH on arsenic removal:

• It is observed that with initial concentration of 100µgL⁻¹, took less than 30 min for the dissolved concentration to drop below 10µgL⁻¹, pH was 6.5 & current was 0.5A with current processing time 20 min and kept back for settlement for approximately 60 to 90 minutes.

• At pH 3.5 and 9.5 it took more than 80 minutes to drop below 50µgL⁻¹. Similarly experiments were carried out with different initial concentration; 100, 150, 200µgL⁻¹
RESULTS

EFFECT OF PH ON ARSENIC REMOVAL:

Figure 1: Effect of initial arsenic concentration at pH 3.5 and 0.5 A

Figure 2: Effect of initial arsenic concentration at pH 3.5 and 1 A
Figure 3: Effect of initial arsenic concentration at pH 6.5 and 0.5 A

Figure 4: Effect of initial arsenic concentration at pH 6.5 and 1A
Figure 5: Effect of initial arsenic concentration at pH 9.5 and 0.5 A

Figure 6: Effect of initial arsenic concentration at pH 9.5 and 1 A
Figure 7: Variation of pH with Time at 0.5A

Figure 8: Variation of pH with Time at 1A
EFFECT OF INITIAL ARSENIC CONCENTRATION

Figure 9: Removal Efficiency (%) of Arsenic at pH 6.5 and 0.5A

Figure 10: Removal Efficiency (%) of Arsenic at pH 6.5 and 1A

Range 75-200µgL⁻¹
Figure 12: Effect of current intensity on Arsenic removal in 100µgL-1.
CONCLUSION

Based on present work following conclusions are drawn:

- pH 6.5 was found to be most appropriate for treating the drinking water for arsenic removal by Electrocoagulation.

- In electrocoagulation increase in pH is observed but the increase is within safety limit prescribed by WHO (as per the limit it is safe to drink water upto pH of 8.5).

- The electrocoagulation process was able to decrease the residual arsenic concentration to 10µgL\(^{-1}\) and meet the drinking water standard (Bureau of Indian Standard (BIS) IS: 10500: 2012) with iron electrode.

- Electrocoagulation is an effective community based chemical mitigation technique when combined with solar power as an electricity generation source.


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