HIGH PERFORMANCE IRON ELECTROCOAGULATION SYSTEMS FOR REMOVING WATER CONTAMINANTS

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PATENT STATUS

Patent Pending

BRIEF DESCRIPTION

The inventors have developed an iron electrocoagulation (Fe-EC) system for arsenic removal. The system offers a highly effective, low cost, robust method for removing arsenic from groundwater used for drinking, at community scale (10,000 liters per day).

The main advance of this invention is to replace the assembly of inter-digited flat steel plates with an assembly of spiral-wound or folded and inter-digited two steel sheets separated only with perforated insulating spacers. This substantially reduces the energy consumption in comparison to other Fe-EC reactors, and allows for larger flow rates for a given reactor size than the standard inter-digited flat plate configuration. This advance is possible because the system relies on:

- externally added (ppm quantities) of oxidizer (H_2O_2), and
- a newly-discovered effect that allows consistent iron dissolution at high current densities.

High current density also produces copious quantities of micro-bubbles of H_2 gas, which flushes the space between the electrodes continuously during operation, preventing the clogging that has defeated earlier attempts.

In a typical Fe-EC reactor, parallel inter-digited plates of mild steel are inserted into the contaminated water and a small DC voltage is applied between alternate plates to promote anodic dissolution of F(0) metal to release Fe(II) ions into the contaminated water. The Fe(II) ions react with dissolved oxygen in the water to produce Fe(III) that is used to capture the contaminants. Typically, an assembly of flat inter-digited parallel steel plates, with nearest neighbor spaced 2 cm to 5 cm, is used in Fe-EC reactors. Occasionally, externally added or in-situ produced oxidants may be used (e.g. externally added strong oxidants such as H_2O_2, O_3, Chlorine, Permanganate, etc., or in-situ produced strong oxidants such as H_2O_2 using carbon based cathodes).

SUGGESTED USES

The commercial applications of this novel approaches include removal and capture of:

- arsenic
- emerging organic contaminants of concern (e.g., pharmaceuticals, organic pesticides)
- ions of other metals such as copper, manganese, nickel, cadmium, uranium, cobalt, and lead
- phosphate
- silicate
- hexavalent chromium (this uses the same reactor design, but without adding external oxidizer)

Fe-EC systems employing this novel approach can directly replace arsenic treatment technologies in arsenic-affected regions around the world, such as the United States, India, Bangladesh, and China. For example, this superior approach can replace the ECAR technology for

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OTHER INFORMATION

KEYWORDS

electrocoagulation, arsenic, Fe-EC

CATEGORIZED AS

- **Environment**
  - Remediation
- **Engineering**
  - Engineering
- **Semiconductors**
  - Processing and Production

RELATED CASES

2020-025-0

treating arsenic contamination in India.

In the oil and gas industry, this Fe-EC system can:

- remove dissolved silicate for pre-treatment of produced water to, and to t
- treat arsenic from the ash-pond water for Coal-fired thermal power plants
- perform ex-situ remediation of hexa-valent chromium from contaminated aquifers

ADVANTAGES

Iron electrocoagulation (Fe-EC) is a promising water treatment technology for removing arsenic, hexavalent chromium, emerging organic contaminants of concern, and contamination from ions of other metals such as copper, manganese, nickel, cadmium, uranium, cobalt, lead, etc. The advantages of the high-performance Fe-EC system developed by the inventors include:

- low potential drop across the electrode plates. This translates directly to nearly 10 times, or more, reduction in electrical energy
- the operating voltages to drive the electrolytic processes remain below 30 V, which increases safety in case of electrical exposure of plant workers
- extremely small footprint in comparison to conventional Fe-EC systems; 10 times smaller
- the electrode plates can be completely consumed during the process without any wastage
- during the electrolytic process, hydrogen bubbles form on the cathode in copious amounts, which aids in efficient mixing and flushing of the solution
- additionally, hydrogen gas can be recovered to generate energy, or for other chemical process use
- the residual H_2O_2 can be used for additional advanced treatment by combining with UV

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Modified Bauxite for Phosphate Recovery and Recycling
- Robust Low-Cost Air Diffusion Cathodes For Water Treatment

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