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Combined effects of co-existing anions on the removal of arsenic from groundwater by electrocoagulation process: Optimization through response surface methodology

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Abstract: Removal of arsenic from groundwater by an air-fed electrocoagulation (EC) reactor using Fe ball anodes was investigated and operating parameters were optimized. Combined effects of anions such as phosphate (C_{PO4-P}: 1-10 mg/L), silicate ($C_{SiO3-Si}$: 20-80 mg/L), bicarbonate (C_{HCO3}: 130-670 mg/L), fluoride (C_F: 2-10 mg/L), boron (C_B: 5-10 mg/L), and nitrate (C_{NO3-N}: 5-35 mg/L) on the removal efficiency of arsenic at the experimental conditions (initial pH of 7.5, applied current of 0.15 A, Fe ball size of 7.5 mm, 5 cm of Fe ball anodes height in the EC reactor, and air-fed rate of 6.0 L/min) in the EC reactor were evaluated with a Box-Behnken design (BBD) of response surface methodology. The model program was provided responses such as effluent arsenic concentration, removal efficiency and operating cost in the EC process. Analysis of variance for all variables confirmed the predicted models by the experimental design within 95% confidence level (R^2: 0.92, Adj-R^2: 0.83), which ensured a satisfactory adjustment of the quadratic model with the experimental data. Removal efficiency of arsenic reduced with increase in concentrations of $C_{SiO3-Si}$ from 50 to 80 mg/L and C_{PO4-P} from 5.5 to 10 mg/L while its removal efficiency increased with the increase in the operating time. The rest of the anions showed hardly noticeable effects on the removal efficiency. The optimized results for initial arsenic concentration of 200 µg/L provided with removal efficiency of 99.5%, operating cost of 0.037 \$/m^3, removed arsenic capacity of 9.41 µgAs/mgFe and effluent concentration of 1.10 µg/L at 4.80 mg/L of C_{PO4-P}, 26.50 mg/L of $C_{SiO3-Si}$, 596 mg/L of C_{HCO3}, 2.60 mg/L of C_F, 10 mg/L of C_B, 6.80 mg/L of C_{NO3-N} and 6.72 min, respectively.