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Arsenic removal from groundwater by horizontal-flow continuous electrocoagulation (EC) as a standalone process

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Abstract

In this study, laboratory scale experiments were conducted with the horizontal continuous-flow EC reactor as a standalone technology with the capacity of 300 L/day with iron (Fe) plate bipolar electrodes to assess its efficiency in the removal of arsenic from raw groundwater without pre- and post-treatment pH modification of groundwater.The optimum EC reactor operating conditions were determined to be current density of 1.98 A/m^2, charge loading of 52 C/L, flow rate of 12 L/h. The EC reactor was able to remove 96% of arsenic from raw groundwater and met respective World Health Organization (WHO) guideline value of 10 µg As/L within the 4 hour experimental runs. The Fe electrode polarity change at 30 minutes successfully controlled passivation of Fe electrodes and enabled a steady reactor operation with the high As removal efficiency. Residual Fe concentration in treated groundwater was in the range 0.17 ± 0.07 mg/L and met WHO guideline value for drinking water. The preliminary estimated operating cost at the optimum operating conditions was 0.0135 €/m^3.

Keywords: continuous – flow electrocoagulation, groundwater, arsenic removal, electrode passivation

1. Introduction

Groundwater, as major source of drinking water, contaminated with arsenic represents a serious matter of public health concern worldwide. Arsenic is classified as a Group I carcinogenic substance to humans based on epidemiological evidence [1]. Long-term exposure to arsenic leads to chronic health problems such as hyperpigmentation and keratosis of the hands and feet; it also causes bladder, lung, skin, kidney, liver, and prostate cancer [2]. The WHO has established 10 µg As/L as a guideline value for arsenic concentration in drinking water [3].

Groundwater of the Pannonia basin which covers the parts of Hungary, Romania, Croatia, Serbia and Slovakia represents the complex system with elevated to high values of heavy metals and arsenic, color, turbidity, suspended solids, ammonia, and other nutrients as well as natural organic matter. In Vojvodina, a northern region of Serbia, groundwateras the main source of water supply is characterised with the high concentration of total arsenic. The type and geochemical composition of the groundwater in this area is strictly determined by sedimentology and paleogeographic factors. Approximately 40% of wells used for