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Abstract

Wastewater from pulp and paper manufacture, coffee and tea processing is a complex and highly variable mixture of many polluting substances which induce color coupled with organic load. Wastewater color in particular can reduce the aesthetic value and light penetration of the receiving waters, impede photosynthetic activity and potentially affect benthic growth and habitat. In addition wastewater color can result in increased long term BOD5 and water treatment problems for users downstream. Industrial wastewater color removal has been the subject of significant attention in the recent past, not only owing to its visibility, but also because of the resistance of color removal by microbial population in a conventional biological treatment. Several alternative treatment methods which include ozone treatment, activated carbon, membrane adsorption, cationic coagulation, polymer addition, ultrafiltration, biological, chemical oxidation and electrochemical have been proposed. However these physical and chemical methods are unable to achieve color removal economically and sustainably.

Electrocoagulation (EC) presents a robust novel and innovative alternative in which a sacrificial metal anode doses water electrochemically. This has the major advantage of providing active cations required for coagulation, without necessarily increasing the salinity of the wastewater. Electrocoagulation is a complex process with a multitude of mechanisms operating synergistically to remove pollutants from wastewater. Electrocoagulation involves applying a current across electrodes in water. This results in the dissolution of the anode (either aluminum or iron). These ions then form hydroxides which complex with and/or absorb contaminants and precipitate out. The precipitate with the contaminants can then be removed from the wastewater by settling and decantation or filtration. EC has the potential to be applied in many other areas besides the textile and semiconductor industry. However over electrical potential within electrodes during electrocoagulation normally causes extra voltage, which wastes energy. There have been attempts to reduce this extra voltage which, in these days of escalating prices on the World oil market, will render the electrocoagulation process uneconomical. The inclusion of supporting electrolyte such as NaCl achieves such reduction. In this paper, we report on the successful application of ash leachate as supporting electrolyte for the reduction of electric power consumption during decolourization of wastewater from pulp and paper manufacture and coffee processing by electrocoagulation. Different ash to water ratio (1:2.5 or 1:2) were used to prepare the leachate. When applied on samples of pulp and paper mill effluent, the leachate inclusion reduced energy consumption by over 80%. With coffee factory effluent, the consumption of power decreased by 57% when electrocoagulation combined with wood ash leachate (ELCAS) was applied to the wastewater and 58% when electrocoagulation was combined with leachate from coffee husks ash (ELCHAS). Besides the 100% colour removal, ELCAS and ELCHAS reduced other effluent physico-chemical parameters such as BOD5, COD, by between 78.1% and 88%, 82.6% and 91.1% respectively. Other wastewater characteristics i.e. TS and TDS were substantially reduced, with ELCHAS proving slightly superior to ELCAS. Unfortunately, the electrical conductivity of the treated effluent from the coffee processing plant increased by between 108.6% and 136% in both cases during ELCAS and ELCHAS. When applied to pulp and paper mill effluent, ELCAS reduced BOD5, COD, TSS, TS and turbidity by 81.2%, 80.6%, 94.9%, 97.3% and 92.1% respectively. The elemental analysis of the treated effluent showed ELCAS had mixed impact on its final metal content. But their concentration depended on the type of electrode used during electrocoagulation. Iron electrodes reduced the concentration of most metals such as Al, Zn, Cr, Cd while Fe increased considerably in the final treated effluent. It is recommended ash leachate be considered as a viable inexpensive supporting electrolyte when using electrocoagulation for wastewater treatment.

Keywords: ash leachate; electrocoagulation; supporting electrolyte; wastewater treatment.

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