VISVESVARAYA TECHNOLOGICAL UNIVERSITY
BELGAUM

ELECTROCHEMICAL COAGULATION (ECC) TECHNOLOGY FOR TREATMENT OF HOSPITAL WASTEWATER

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ABSTRACT

Electrochemical treatment (ECT) technology has shown considerable interest during recent years as a very effective treatment method for wastewaters containing refractory and non-biodegradable materials. It uses sacrificial electrodes in an electric field, which can directly or indirectly degrade the pollutants/contaminants at ambient temperatures.

In a country like India, there has been a practice/tendency of disposing wastewater directly into municipal sewer system, which is further treated along with the domestic sewage in the municipal sewage treatment plant. Hospitals use a variety of chemical substances such as pharmaceuticals, radio-nuclides, solvents, and disinfectants for medical purposes as diagnostics, disinfections and research. These effluents are loaded with pathogenic microorganisms, partially metabolized pharmaceutical substances, radioactive elements, and other toxic substances. Such effluents if not treated properly could be dangerous to the ecological balance and public health.

The prime objective of the present work is to electrochemically treat the real hospital wastewater (HWW) stream generated from the operation theatre (OT) (diluted blood water with solids-tissue) as also combined sewage.

To fulfill the above objective, hospital wastewater was obtained from the operation theatre as also the combined sewage. Both these wastewaters had a very low transparency with OT-HWW having blood red color and COD ~10,100 - 10300 mg/L. This wastewater was directly subjected to electrolysis using iron plate electrodes. This OT-HWW that was used in the ECC had the following characteristics: phosphates: 12.55 mg/L, chlorides ~999-1100 mg/L dm^{-3}, total solids ~340 mg/L dm^{-3}, pH ~6.12 – 7.68 and color ~2350 platinum cobalt unit (PCU).

The ECC in batch mode were conducted in a 1.5L ECR of cubical shape using iron plates as electrodes. The electrodes were arranged in parallel and connected to the respective terminals of the DC rectifier. In each batch experimental run, 1.5L of wastewater was fed into the electrochemical reactor (ECR), and stirred continuously to maintain good mixing in the reactor. The coagulant additives used in the ECR during the batch studies were PAC and sodium chloride (NACl). Of the 2, 4 and 6 plate

configurations, a cell voltage of 4V and a 4 plate arrangement was found optimal achieving a maximum COD and color removal of over 92%. The ECC in batch mode was carried out by varying the cell voltage and by varying the number of plates. The optimal results were obtained at 4V and 4 plate configuration. For an applied cell voltage of 4V, the COD concentration decreases to a value of 510 mgL^{-1} (a reduction of ~94 - 95%) from its initial value of 10140 – 10350 mg L^{-1}. An optimal PAC dose of 100 mg/L in to the ECR provided a decrease in COD concentration to a value of 380 mgL^{-1} (a reduction of ~95 - 96%) from its initial value of 10060 – 10272 mg L^{-1} also providing sturdy sludge. Use of NaCl as an additive (250 – 2000 mg/L) at optimal operating conditions to improve COD degradation was a total failure, as the chloride content in the wastewater increased thus increasing the applied current. The ECC of OT-HWW with NACl generated more sludge which could not be settled in the settling column with shear lines and is also ascribed to the entrapment of gas generated during ECC. COD removal using Al electrodes (in comparison with Fe electrodes) showed a terminal COD value was 1925 mg L^{-1} (only 82% removal). Al electrodes showed no sludge formation nor showed good filterability.

At optimal operating conditions of 4 volts, the sludge solid-liquid interface (H/H_0) showed better sludge settlability as compared to that of at higher voltages with 380 mL sludge in the column. For different PAC concentrations of 100, 300 and 400 mg L^{-1} used as additives introduced to the reactor, a PAC concentration of 100 mg L^{-1} provided better settling properties as compared to a situation without any additives. Sludge generated from ECC of common sewage showed better settling properties as also a clear supernatant than the sludge generated from ECC of OT-HWW. Further, an anode dissolution of 2.9 g/L was obtained at an applied current of 4.63 A, and an anode dissolution of 1.42 g/L was obtained at an applied current of 1.65 A for OT-HWW and sewage respectively.

SEM micrographs showed the changes in the anode plate structure with dents formed after repeated ECC cycles. Prolonged use of iron electrodes as anodes produced large number of dents on their surface.

The zero value of ΔpH was at the pH_0 value of 6.4, which is considered as the pH_{PZC} of the untreated dried sludge obtained after the ECC of OT-HWW.

The filtered sludge can be dried and fired as fuel in the furnaces/incinerators for its heat recovery. The bottom ash can be used for blending with organic manure for its use in agriculture/horticulture or can be blended with clay/coal flyash for use in making bricks/ceramic tiles for the building industry.