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Electrochemical Coagulation of Hospital Wastewater

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Abstract - *In this study, treatment of hospital effluent by electrocoagulation method in batch mode was investigated. The response surface methodology was accustomed verify the optimum in operation conditions like initial pH scale, electrocoagulation time and current for COD removal and conductor consumption. The responses were associated with maximum Cod removal minimize conductor consumption.*

Keywords - Hospital wastewater, Electrocoagulation, Optimization, RSM

1. INTRODUCTION

Despite the growing difficulty over bio-clinical waste control in India, much less attention is being paid towards the release of wastewater from the medical institution, nursing houses, and scientific laboratories. Hospital is a significant patron of water and it generates a considerable quantity of wastewater containing various unsafe substances which include pathogens, pharmaceuticals and its metabolites, radioactive factors. Numerous resources of pollutants in the hospital includes wastewater from medical care, research sports, operation theatre, kitchen and laundry sports. Medical institution wastewater if discharged untreated in waterbodies can possess health hazards to human and aquatic existence [1].

Electro coagulation process is playing a more prominent role in the treatment of hospital wastewater by virtue of various benefits including environmental compatibility, versatility, energy efficiency, safety, selectivity, amenability to automation and cost effectiveness. This process is characterized by simple equipment, easy operation, a shortened reactive retention period, a reduction or absence of equipment for adding chemicals and decreasing amounts of precipitate or sludge which rapidly forms sediments. [2]. The electrocoagulation process can be carried out by following steps.

Anodic dissolution: Because of the passage of direct electric powered current**,** the anode material undergoes oxidation and cathode get reduced. If iron or aluminum electrodes are used, Fe^{2+} and Al^{3+} ion generation take place at the anode by the following reaction:

$$Fe\ (S) \rightarrow Fe^{2+}\ (aq) + 2e^{-} \qquad \text{Eqn (1)}$$

$$Al\ (S) \rightarrow Al^{3+}\ (aq) + 3e^{-} \qquad \text{Eqn (2)}$$

At the cathode, hydrogen evolution takes place by the following reaction.

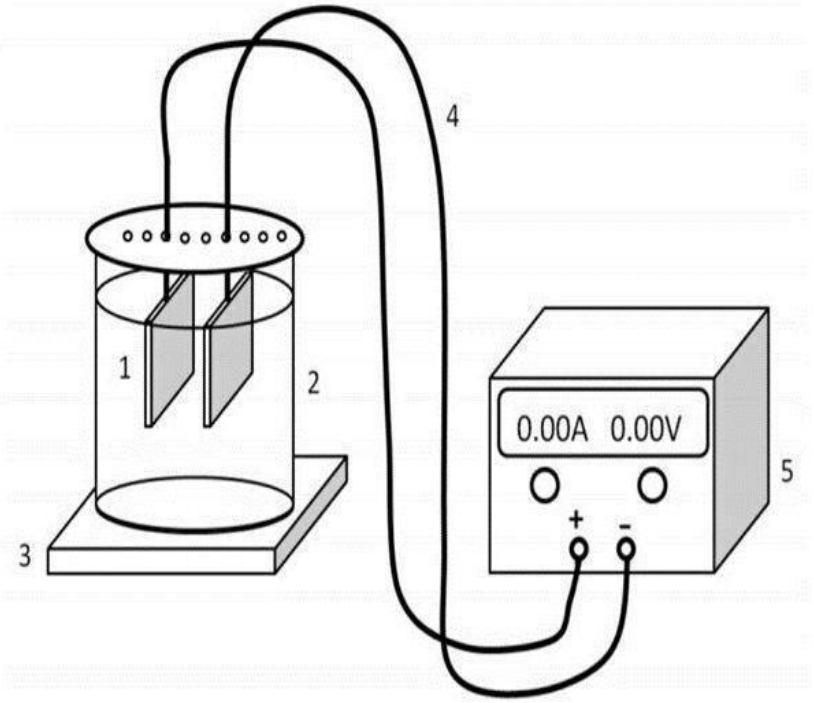
$$3H2O\ (l) + 3e^{-} \rightarrow 3/2\ H2\ (g) + 3OH^{-} \quad \text{Eqn (3)}$$

Generation of coagulants: The Liberated Fe2+ / Al3+ and OH- ions react to form various monomeric and polymeric hydrolysed species, ions-complexes positively charged. Several kinds of the hydrolysed metal species can be formed depending upon the metal concentration and the pH of the solution. When pH is acidic the destabilization of colloidal particles takes place by charge neutralization and at higher pH ions-complexes are completely hydrolysed to generate insoluble amorphous species that causes sweep coagulation.

Flotation: Due evolution of hydrogen gas at the cathode and in some cases, oxygen gas are produced at the anode by electrolysis of water. It is possible that coagulated particles get adhered over the surface of the bubble of these gasses and rise to the surface along with the foam which can be easily removed afterward.

Electrocoagulation process produces effluent with less total dissolved solids, requires less maintenance, operation cost is low, the amount of sludge produced is less and can be used in hilly areas as it requires less area.

Experimental Setup



2. SPECIFICATIONS:

1. **ELECTRODES**
2. **BEAKER**
3. **BASE PLATE**
4. **SINGLE STAND**
5. **DC POWER SUPPLY UNIT**

- Wastewater samples will be collected from hospital.
- Two non-corrosive electrodes will be used.
- The distance between the electrodes will be varied.
- Experiment will be conducted at room temperature.
- Parameters such pH, BOD, COD and Total Suspended Solids will be analysed.

Electrodes

- Electrodes chosen for the project: Copper and Iron.
- These electrodes are chosen, more commonly because of their availability cost effectiveness and because of their efficiency.
- Size of electrodes – 12cm x 10cm x 2mm

TESTING PARAMETERS

Serial Number	Parameter
1.	pH
2.	Electrical Conductivity
3.	Chlorides
4.	Total Suspended Solids
5.	Total Dissolved Solids
6.	Turbidity
7.	COD

The parameters mentioned above will be tested and compared between untreated wastewater and the water obtained after treatment.

3. MATERIALS AND METHODS

1. Hospital wastewater was collected from the source for a duration of 7 days (So as to establish an average value and calculate the average efficiency in terms of percentage).

2. Hospital wastewater was collected from 1st of March to 7th of March2021.

3. The wastewater was collected between the timings of 8 a.m. to 10.30 a.m. everyday.

4. The wastewater was collected in sterilized bottles of 2L capacity and was transported by storing in an ice box.

5. The samples were brought to the lab and were tested for various parameters and noted down as initial values or initial results of the above-mentioned parameters.

6. The samples were treated as per the specified electrocoagulation process (Varying spacing – 4cm & 6cm; Constant voltage – 20V; Constant run-time – 20 minutes) and was later tested for the same parameters as the initial parameters.

7. The values of the parameters tested was noted as final values or results of the chosen parameters.

4. OBJECTIVES OF THE STUDY

1. To study the applicability of Electrocoagulation process for the treatment of hospital wastewater.
2. To evaluate the removal of COD, TSS, TDS and others from the hospital wastewater by Electrocoagulation using different suitable electrode.
3. To study the effect of inter electrode spacing for the removal of COD, TSS, TDS and others at constant voltage for different suitable electrode.
4. To study the effect of different initial pH for the removal of COD, TSS, TDS and others at constant voltage and inter electrode spacing for different suitable electrode.

5. RESULTS

DAY-01: Constant Voltage – 20V; Constant duration – 20 minutes

Parameters : Sample:	pH	Chlorides (mg/L)	TDS (mg/L)	TSS (mg/L)	Conductivity (micro mhos/cm)	COD (mg/L)	Turbidity (NTU)
Initial	7.1	98.9	636.0	40.0	934.0	136.0	32.6
4cm spacing	6.7	91.9	550.0	140.0	810.0	120.0	108.6
6cm Spacing	6.8	91.9	650.0	180.0	811.0	128.0	142.2

DAY-02: Constant Voltage – 20V; Constant duration – 20 minutes.

Parameters Sample:	pH	Chlorid es (mg/L)	TDS (mg/L)	TSS (mg/L)	Conductivity (micromhos/cm)	COD (mg/L)	Turbidity (NTU)
Initial	7.5	106.3	652.0	40.0	935.0	132.0	31.9
4cm spacing	6.9	104.9	574.0	130.0	795.0	119.0	100.6
6cm Spacing	7.0	105.0	632.0	150.0	800.0	124.0	140.1

DAY-03: Constant Voltage – 20V; Constant duration – 20 minutes.

Parameters : Sample:	pH	Chlorid es (mg/L)	TDS (mg/L)	TSS (mg/L)	Conductivity (micro mhos/cm)	COD (mg/L)	Turbidity (NTU)
Initial	8.1	90.1	651.0	30.0	915.0	124.0	36.9
4cm spacing	7.7	87.0	568.0	87.0	763.0	101.0	107.8
6cm Spacing	7.5	91.9	644.0	101.0	825.0	134.0	148.0

DAY-04: Constant Voltage – 20V; Constant duration – 20 minutes.

Parameters :Sample:	pH	Chlorid es (mg/L)	TDS (mg/L)	TSS (mg/L)	Conductivity (micro mhos/cm)	COD (mg/L)	Turbidity (NTU)
Initial	8.2	63.9	480.0	28.0	705.0	180.0	19.5
4cm spacing	7.6	60.0	410.0	96.0	633.0	88.0	119.2
6cm Spacing	7.2	67.9	484.0	101.2	712.0	192.0	88.0

DAY-05: Constant Voltage – 20V; Constant duration – 20 minutes.

Parameters :Sample:	pH	Chlorid es (mg/L)	TDS (mg/L)	TSS (mg/L)	Conductivity (micro mhos/cm)	COD (mg/L)	Turbidity (NTU)
Initial	7.2	96.9	641.0	50.0	942.0	130.0	39.6
4cm spacing	6.8	93.9	560.0	140.0	800.0	123.0	105.2
6cm Spacing	6.9	93.9	640.0	180.0	800.0	129.0	138.2

DAY-06: Constant Voltage – 20V; Constant duration – 20 minutes.

Parameters :Sample:	pH	Chlorid es (mg/L)	TDS (mg/L)	TSS (mg/L)	Conductivity (micro mhos/cm)	COD (mg/L)	Turbidity (NTU)
Initial	8.1	65.0	490.0	30.0	695.0	128.0	25.7
4cm spacing	07.6	61.6	420.0	98.0	626.0	96.0	105.4
6cm Spacing	7.1	68.6	498.0	110.0	702.0	138.0	139.0

DAY-07: Constant Voltage – 20V; Constant duration – 20 minutes.

Parameters :Sample:	pH	Chlorid es (mg/L)	TDS (mg/L)	TSS (mg/L)	Conductivity (micro mhos/cm)	COD (mg/L)	Turbidity (NTU)
Initial	7.8	76.8	590.0	30.0	850.0	140.0	29.8
4cm spacing	7.2	71.2	510.0	83.0	758.0	105.0	126.6
6cm Spacing	7.3	75.7	576.0	120.0	784.0	146.0	149.7

6. ANALYSIS

After the conduction of the experiments and determining the values of the chosen parameter for various conditions, we can see that **4cm spacing produces desirable amounts of reduction in all parameters.**

Therefore, the percentage reduction of various parameters with the use of the specified procedure of electrocoagulation are as follows:

1. pH:

Percentages of Reduction:

DAY 01: 5.64%

DAY 02: 8.00%

DAY 03: 4.94%

DAY 04: 7.32%

DAY 05: 5.55%

DAY 06: 6.17%

DAY 07: 7.69%

Average Value: 6.47%

2. Chlorides :

Percentages of Reduction:

DAY 01: 7.08%

DAY 02: 1.32%

DAY 03: 3.44%

DAY 04: 6.10%

DAY 05: 3.10%

DAY 06: 5.23%

DAY 07: 7.30%

Average Value: **4.80%**

3. TDS:

Percentages of Reduction:

DAY 01: 13.52%

DAY 02: 11.96%

DAY 03: 12.75%

DAY 04: 14.58%

DAY 05: 12.64%

DAY 06: 14.29%

DAY 07: 13.56%

Average Value: 13.33%

4. Conductivity:

Percentages of Reduction:

DAY 01: 13.28%

DAY 02: 14.97%

DAY 03: 16.61%

DAY 04: 10.21%

DAY 05: 15.10%

DAY 06: 9.93%

DAY 07: 10.82%

Average Value: 12.99%

5. COD :

Percentages of Reduction:

DAY 01: 11.76%

DAY 02: 9.85%

DAY 03: 18.55%

DAY 04: 51.11%

DAY 05: 5.38%

DAY 06: 25%

DAY 07: 25%

Average Value: 20.95%

CHART SHOWING THE COMPARISON OF ALL PARAMETER VALUES:

6. CONCLUSION:

Summarizing the report, it can be concluded that,

1. Electro-coagulation technique can be opted for the treatment of hospital waste- water due to its characteristics like affordability, efficiency and easy-to-handle.
2. The parameters considered helped in analysing the characteristics of wastewater before and after treatment to compare and determine the efficiency.
3. The process does not prove to be efficient as the reduction of various parameters is marginally small and cannot be considered as a major change.
4. The Percentage reduction clearly depicts that electrocoagulation of hospital wastewater using Iron and Copper electrodes is not efficient.

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