Treatment Of Domestic Waste Water by Using Unified Bipolar Electrode System

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Abstract — The treatment of domestic wastewater is critical for safeguarding environmental resources and public health. This study explores the use of a Unified Bipolar Electrode System (UBES), an advanced electrochemical method, for the efficient treatment of domestic wastewater. Domestic wastewater, rich in organic matter, nutrients, pathogens, and suspended solids, poses significant challenges for conventional treatment systems, which often involve high costs, complex operations, and environmental impacts. The UBES operates by applying an electric current through bipolar electrodes, typically made of aluminium or iron, to generate coagulants in situ. These coagulants effectively aggregate and remove pollutants such as suspended solids, organic matter, and heavy metals through electrocoagulation.

Keywords: Domestic Waste Water, Unified Bipolar Electrode System

I. INTRODUCTION

Domestic wastewater treatment is a critical aspect of maintaining public health and environmental sustainability. Conventional treatment methods, although effective, often require significant energy inputs, large land areas, and generate substantial amounts of sludge. In contrast, the unified bipolar electrode system offers a innovative and efficient approach to domestic wastewater treatment. This system utilizes a single electrode to perform multiple functions, including electrocoagulation, electrooxidation, and electroreduction, thereby removing suspended solids, organic pollutants, and nutrients from the wastewater. The unified bipolar electrode system boasts several advantages, including energy efficiency, compact design, reduced sludge generation, and improved treatment efficiency. By leveraging this technology, domestic wastewater can be effectively treated, reused, or safely discharged into the environment, thereby mitigating the risks associated with untreated wastewater and promoting a more sustainable future.

II. METHODOLOGY

The study was conducted at the Environmental Engineering Laboratory. Domestic wastewater samples were collected from the main discharge point of the Vijayapura, approximately 5 km from the laboratory. The selection of this site was based on its accessibility and suitability for obtaining untreated wastewater samples for the experiment. was Analysing various physical parameters (Temperature, turbidity, TDS,) Chemical parameters (pH, BOD, COD, Heavy metals) and Biological parameters.

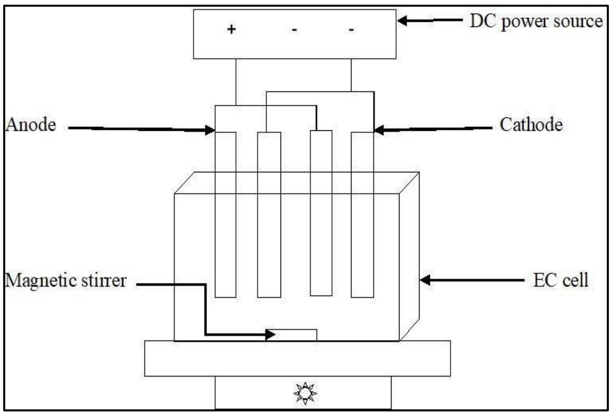

Fig 2.1: experimental set up of EC

A. *Experimental Set up*

The electrocoagulation process using solar energy is an innovative and sustainable method for treating wastewater by combining renewable energy with electrochemical techniques. In this process, solar panels generate direct current (DC) electricity, which powers electrodes submerged in the wastewater. These electrodes, commonly made of aluminium or iron, release coagulant ions when an electric current is applied. The ions react with pollutants, forming flocs that aggregate and can be removed through sedimentation, filtration, or skimming. Solar-powered electrocoagulation is effective in removing a wide range of contaminants, including suspended solids, heavy metals, organic matter, and pathogens, without the need for chemical additives. The use of solar energy makes the system eco-friendly, cost-effective, and suitable for remote areas without access to grid electricity.

B. *Brief Methodology*

After the initial characterization of Domestic waste water, batch experimental studies were conducted to optimize the various parameters. Experiments were performed with four electrodes connected to the DC power supply to determine optimum condition. The space between electrodes is maintained 1cm in all the experiments. In each run the voltage is varied to a desired value of 4, 6,8,10 & 12 volts. The volume of the solution in each batch experiment was 1L. To maintain homogenous mixing of the reactor contents, magnetic stirrer was used. Electrodes were washed before the start of every experiment. EC experiments were performed for optimum electrolysis time (ET) of 40 min & in each run samples were retrieved at every 10, 20,25,30,35 & 40 minutes for chemical analysis.

C. *Analytical Methods*

A sufficient quantity of wastewater was collected from nearby domestic wastewater discharge point and characterization of sample was carried out according to standard methods. The methods followed for various parameters.

III. RESULTS

The wastewater samples collected from Bijapur Municipal wase water discharge point was Analysed for Physico-chemical parameters like pH, colour, COD, TDS, conductivity, turbidity and TOC by using standard methods.

The average characteristics of wastewater are shown in the Table 5.1. As seen, COD and all other parameters are not within the standard limit and need treatment. The focused parameters during EC process were COD, Colour, TOC, and turbidity.

Sl No	Characteristics	Value
1	pH	6.5-8.5
2	COD (mg/L)	200-800
3	BOD (mg/L)	100-400
4	TDS (ppm)	100-500
5	Conductivity (µS/cm)	500-2000
6	Turbidity (NTU)	10-100
7	TSS (mg/L)	100-500
8	Temperature	10-30°C

Table 3.1 Characteristics of Domestic wastewater

A. *Batch Electrocoagulation using Aluminium Electrodes*

Batch EC treatment of sample was carried out using aluminium and iron electrodes in reactor. Numbers of experiments were carried out at different applied cell voltages and ET for different electrodes combination and for different cell voltages.

1) Effect of cell voltages and pH on COD removal.

To begin with the EC experiments were carried out without changing the initial pH and COD of sample i.e., 5.42 and 6000 mg/L respectively. The COD were measured at different cell voltages of 4, 6, 8, 10 and 12 Volts and with 10, 20, 25-, 30-, 35- and 40-minutes interval. The COD reduced from 6000 to 1560 mg/L during this process. For these experimental conditions COD removals were calculated and the results are shown in the fig. 3.1.2

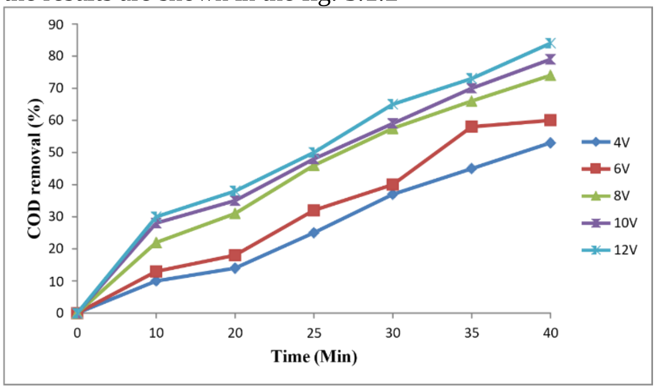

Fig. 3.1.2: COD removal with ET at different voltages (Electrodes Aluminium PH-6)

From the figure 3.1.2it can observe that, the applied cell voltage 4V the maximum COD reduced was 6000 to 2820 mg/L and 6V the maximum COD reduced was 6000 to 2400 mg/L and 8V the maximum COD reduced was 6000 to 1560 mg/L and 10V the maximum COD reduced was 6000 to 1260 and 12V the maximum COD reduced was 6000 to 960 mg/L at 40 minutes of operation.

The experiment was carried out at pH 7, cell voltages 4, 6, 8, 10 and 12V. However, with initial COD of 6000 mg/L and COD values at different time intervals are shown in Fig.3.1.2

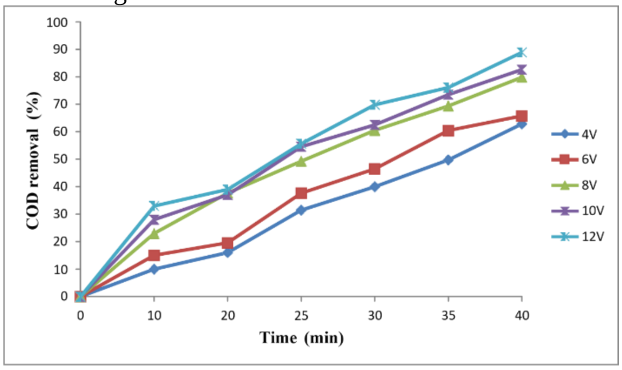

Fig. 3.1.2: COD removal with ET at different voltages (Electrodes Aluminium pH-7)

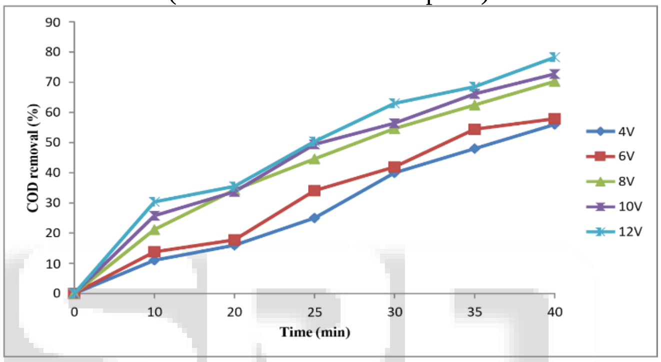

Fig. 3.1.3: COD removal with ET at different voltages (Electrodes Aluminium pH-8)

From the above Fig 3.1.3 pH 7 the maximum COD reduced from 6000 to 664 mg/L at 12V at 40 minutes operation.

The next experiment was carried out at pH 8, cell voltages 4, 6, 8, 10 and 12V. However, with initial COD of 6000 mg/L and COD values at different time intervals are shown in

Fig.5.3. From the above Fig 5.3 pH 8 the maximum COD reduced from 6000 mg/L to 1305 mg/L at 40 minutes operation remain same at 45 minutes.

From the above graphs it was found that, as cell voltage increases with increasing the ET, the COD removal is also increases. The pH 7 and 12V at 40 minutes of duration is capable of reducing the COD of the sample more effectively than pH value 5.42 and pH 8.

IV. CONCLUSIONS

1) The experimental study was carried out at laboratory. Based upon the experimental results following conclusions are drawn.
2) For Aluminium, Iron and hybrid connection, the optimum operating parameters were found to be pH: 7 voltages: 12V and ET: 40minutes.
3) Performance of Electrocoagulation with Aluminium electrodes; COD removed from 6000mg/L to 664mg/L. turbidity reduced from 264 NTU to 0 NTU.

4) Performance with Iron electrodes; COD reduced to 1363 mg/L and turbidity reduced to 7.92 NTU.
5) Performance of hybrid electrodes connection; COD reduced from initial value 6000 mg/L to 360 mg/L and colour removal efficiency obtained as 100% and turbidity reduces from 264 NTU to 0 NTU.
6) For hybrid electrodes connection COD (360mg/L) and turbidity (0 NTU) was found most effective removed compare to Iron (1363 mg/L and 7.92 NTU) and Aluminium (664.8mg/L and 0 NTU).
7) During the experiment, current density increases with increasing the voltage and ET.

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