Treatment of Kitchen Wastewater By Electrocoagulation

Sana Sayyed[1], Avinash Pawade[2], Mehnaz Sayed[3], Humera Shaikh[4], Dr.Ashok More[5]

[1]UG Student, Department of Civil Engineering, DYPCOE, Akurdi, Pune.
[2]HOD, Department of Civil Engineering, DYPCOE, Akurdi, Pune.

Abstract - This report presents a comprehensive study on the electrocoagulation (EC), process utilizing aluminum plates as electrodes, for the treatment of kitchen wastewater. The objective of this study is to investigate the effectiveness of the EC process in removing contaminants from kitchen wastewater and to optimize key parameters. The study includes theoretical analysis, experimental methodology, and analysis of the obtained results. The conclusion highlights the potential of EC with aluminum plates as an efficient and sustainable technique for kitchen wastewater treatment. This process required simple equipment and easy operation.

***Key Words*:** Electrocoagulation, Electrodes, Wastewater, Operation, Contaminants, Analysis.

1. INTRODUCTION

Kitchen wastewater is characterized by high organic content, suspended solids, and oil and grease, necessitating effective treatment methods to safeguard the environment and public health. The EC process, based on the principle of coagulation and flocculation, has emerged as a promising approach. This section provides an overview of the importance of kitchen wastewater treatment, introduces the concept of EC using aluminum plates, and highlights the significance of this study.

Electrocoagulation has several benefits, including the capacity to treat a variety of pollutants, ease of use, and possibility for automation. It may be used in many different sectors, including food processing, mining, metal polishing, and municipal wastewater treatment. Additionally, because electrocoagulation frequently does not require the use of chemicals, it is seen to be an ecologically beneficial procedure.

Energy consumption can be substantial, especially when purifying large amounts of water. The process's effectiveness and longevity depend on the material used for the electrodes, therefore choosing the right one is essential. To obtain the appropriate water quality, electrocoagulation may potentially produce sludge or require extra post-treatment processes.

Overall, electrocoagulation is a promising method for the treatment of water and wastewater, giving a potentially effective and environmentally friendly way to deal with different pollution problems.

2. Objective:

The objective of this study is to assess the effectiveness of the EC process using aluminum plates in treating kitchen wastewater. Specific objectives include:

1. Investigating the theoretical principles and mechanisms of the EC process.
2. Optimizing key parameters such as current density, pH, electrolysis time, electrode distance, wastewater temperature, and electrolyte concentration.
3. Evaluating the removal efficiency of contaminants from kitchen wastewater.
4. Assessing the quality of treated water in accordance with relevant regulatory standards.

3. Theoretical Concepts:

3.1 Electrocoagulation

For the electrochemical treatment of wastewater, industrial effluents, and polluted water, electrocoagulation is utilized. It includes introducing an electrical current into the water to destabilize and remove dissolved or suspended pollutants. In an electrolytic cell, which has two electrodes—a cathode (negative electrode) and an anode (positive electrode)—that are submerged in the water or wastewater to be treated, the electrocoagulation process is normally carried out. Typically, conductive materials like iron, aluminum, or stainless steel are used to create these electrodes.

Several electrochemical processes take place at the electrodes when electrical current is delivered. Metal ions disintegrate at the anode, creating metal cations that serve as coagulants. Hydrogen gas is often created at the cathode. The pollutants in the water react with the metal cations created at the anode, causing them to congeal and form bigger particles.

The coagulated particles can then be conveniently removed using techniques like filtering, flotation, or sedimentation. Various pollutants, including as suspended particles, oils and grease, heavy metals, organic compounds, and certain pathogens, can be successfully removed using the electrocoagulation technique.

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3.2 Mechanism of Electrocoagulation:

Various electrochemical reactions that take place when an electrical current is applied in an electrolytic cell make up the electrocoagulation mechanism. These procedures result in the removal and destabilization of pollutants from the water. Here is a detailed breakdown of the mechanism:

The electrolytic cell has two Electrodes, an anode (positive electrode) and a cathode (negative electrode), both of which are submerged in the water or wastewater to be treated. This results in the formation of metal cations. Typically, the anode is constructed from a metal like iron, aluminum, or stainless steel. The anode undergoes oxidation processes when a direct current is provided, dissolving metal ions into the water. For instance, iron cations (Fe2+) are released in the case of an iron anode.

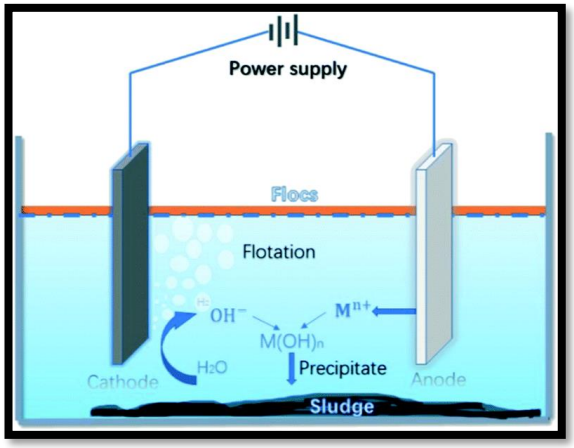

Fig.1.EC Process

Water is electrolyzed at the cathode as a result of reduction processes that take place there. Hydrogen gas (H2) and hydroxide ions (OH-) are produced when water molecules (H2O) are reduced. This response aids in keeping the system's electrical neutrality.

Coagulation: The metal cations produced at the anode, such as Fe2+, interact with the water pollutants. The suspended or dissolved particles become unstable due to the metal cations' coagulant effects. They reduce the electrostatic attraction between the particles by neutralizing the charges on them. As a result, the pollutants coagulate and become bigger, or floc, into particles.

Gas bubbles, notably hydrogen gas bubbles, are produced at the cathode during the electrocoagulation procedure as a result of the reduction processes. The coagulated particles are carried by these bubbles as they ascend through the water.

Removal of Particles: The coagulated particles, or flocs, rise to the surface of the water together with the gas bubbles. Flotation is the name of this procedure. Alternative methods for removing the coagulated particles from the water include sedimentation and filtering.

Sludge Formation: As the coagulated particles are removed from the water, they condense into a sediment or sludge that sinks to the bottom of the treatment vessel. This sludge needs to be managed properly, and depending on the impurities, it could need to be further treated or disposed of.

Electrocoagulation's efficacy is influenced by a number of variables, including the electrode material, electrolyte concentration, PH, and treatment duration. It is essential to optimize these parameters in order to accomplish effective coagulation and contamination elimination.

It is significant to remember that the specific electrocoagulation method may change based on the electrode material, water composition, and the kinds of pollutants present. According on the individual application and treatment goals, the procedure may also entail other reactions, such as the oxidation of organic molecules or the reduction of heavy metal ions.

4. Methodology:

4.1 Experimental Setup:

A laboratory-scale EC system was constructed, consisting of an electrochemical cell, aluminum plates as electrodes, a power supply, a PH controller, and a wastewater collection and monitoring system.

4.2 Wastewater Sampling and Characterization:

Kitchen wastewater samples were collected from college canteen and analyzed for initial pH, Biological oxygen demand (BOD), Turbidity, Conductivity, Total Suspended Solids (TSS), and oil and grease content.

4.3 Parameter Optimization:

A central composite design (CCD) and response surface methodology (RSM) were employed to determine the optimal conditions for key parameters, including current density, pH, electrolysis time, electrode distance, wastewater temperature, and electrolyte concentration.

4.4 Performance Evaluation:

The treated wastewater was analyzed for BOD reduction, TSS removal efficiency, and oil and grease removal efficiency.

5. Results and Discussion:-

This section consists of the results of kitchen wastewater characteristics. The results obtained by analyzing the samples of Kitchen wastewater.

In this study, Kitchen wastewater (KWW) collected from college canteen (DYPCOE, Akurdi, Pune) was treated by EC Process. The sampling was done thrice in a day by grab sampling method. The characterization of KWW was done for different parameter such as PH, BOD, TDS, turbidity, conductivity and TS,TSS throughout the study. Here we obtained 90%colour removal efficiency. The characteristics of KWW are presented through the average values . The treated water met the regulatory standards for discharge or reuse for non-potable purposes. The efficiency and effectiveness are Obtained by the EC Process in removing contaminants from kitchen wastewater are followed in the table.1.

Sr. no	Parameter	Values (mg/l)		Efficiency (%)
		Before Treatment	After Treatment	
1.	PH	9	8	-
2.	Turbidity	62.28	21.03	66.24
3.	Conductivity (µs/cm))	2.07	1.38	33.14
4.	TDS	826.67	423.33	51.21
5.	TS	1290	603.23	53.23
6.	TSS	468.33	180	61.15
7.	BOD	65.33	35.83	45.16

Table.1

6. Conclusion:

The EC process utilizing aluminum plates demonstrated high efficiency in treating kitchen wastewater by effectively removing contaminants. The optimization of key parameters, including current density, pH, electrolysis time, electrode distance, wastewater temperature, and electrolyte concentration, contributed to improved treatment performance. The study concludes that EC with aluminum plates has the potential to be a viable and sustainable technique for kitchen wastewater treatment. It is a promising technique for removal of pollutants from wastewater due to its simple, cheap to operate, easily available equipment and environmental friendly. EC as a pre-treatment process can significantly reduce the total energy usage, while also improving the quality of treated water. It was found that electrocoagulation Technique is an effective treatment for the removal of heavy bacteria and impurities from wastewater as it is economical and having higher removal efficiency via other conventional treatment methods.

ACKNOWLEDGEMENT

We would like to express our thanks to our guide Dr. Ashok B More for his technical guidance, valuable suggestions and constant inspiration throughout the project work,and for his immense support and advice in our endeavor. We would like to express our greatest appreciation to the Principal Dr. Mrs. P. Malathi who has been a continuous source of encouragement and cooperation throughout. We are also grateful to all the faculty and staff members for their constant support and their help in completing our project.

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