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Treating Sugar Mill Wastewater by Identifying and Removing Major Impurities Using Eletrocoagulation

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***Abstract:** The study investigates electrocoagulation for removing impurities from wastewater of the sugar industry.With optimal conditions (75mins electrolysis, pH 7, 25V), significant removal efficiencies were achieved for conductivity (93%), chloride (92.5%), COD (up to 79.6%), and color (96.8%). Exploring the impact of electrolytes on pollutant removal efficiency provides insights for further process optimization, highlighting the technique's potential to minimize environmental and health impacts.*
***Keywords:** Electrocoagulation process, Electrode, Current, sugar industry wastewater.*

I. INTRODUCTION

Electrocoagulation, known for its accessibility, affordability, and environmental friendliness, effectively removes a wide range of pollutants from wastewater. Attention to operational details is vital for its success. By generating coagulating agents through electrical current, it can treat heavy metals, suspended particles, organic compounds, dyes, and arsenic. Optimizing factors like pH, current density, electrode material, and treatment duration enhances pollutant removal. Its adaptability to various industries and ability to address diverse contaminants make it a valuable, cost-efficient solution for improving water quality and mitigating environmental pollution.

The dissertation explores electrocoagulation for sugar industry wastewater treatment, studying factors like flow rate, current density, and polyelectrolytes on COD and color removal. It addresses wastewater challenges in countries like India, emphasizing effective treatment for organic waste.

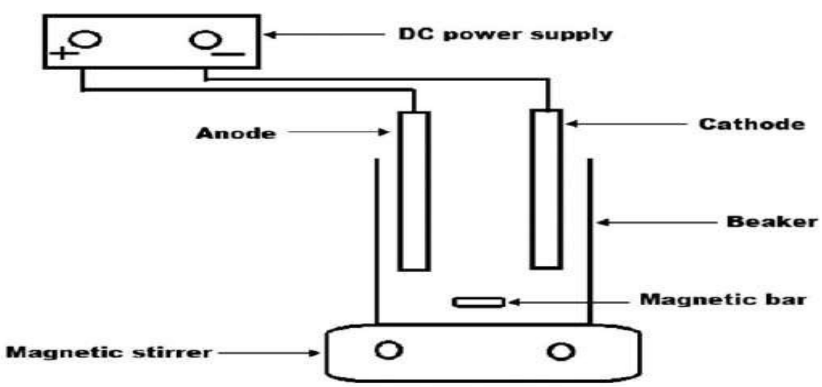

Figure 1: Electrocoagulation process

It investigates modern technologies like Fenton's reaction and ozone oxidation alongside electrocoagulation. Metal classification includes hazardous (Ni, Cd, As, Pb), useful (Pt, Au, Ag), and radioactive (U, Ra, Th). Emphasizing pre-treatment for various industries to prevent harm to aquatic life and human health.

II. LITERATURE

Amira Doggaz et, al. (2019) study investigates electrocoagulation for iron and zinc removal from freshwater, highlighting the impact of hydrocarbonate ions on treatment efficiency and proposing strategies for optimization in wastewater treatment.

Salman Hussein Abbas and wail Hussan Ali (2018) The review paper explores electrocoagulation's efficacy in treating industrial wastewater, optimizing heavy metal removal, and gaining traction as a cost-effective solution.

Chethan Moral and Puneet K. (2017) An experimental investigation was conducted to study the removal of turbidity and conductivity from milk dairy wastewater using the direct current (DC) electrocoagulation (EC) method. This experiment examined the effects of initial pH, conductivity, electrolysis time, initial turbidity and conductivity concentrations, and voltage. Aluminum plates were employed as sacrificial electrodes in the EC process, resulting in the effective removal of turbidity and conductivity from the aqueous phase. The experimental investigation determined the optimal operating parameters for each variable. The experiment demonstrated highly efficient removal of turbidity, achieving an overall removal efficiency of 94%. Similarly, the overall removal efficiency for conductivity reached 93%. The optimal voltage, pH, and electrolysis time were determined to be 25V, 7, and 75 minutes, respectively.

Mohammad Hasnainlsa et al. (2015) researched boron removal via electrocoagulation and hydrothermal mineralization from wastewater. Optimal conditions included pH 6.3, 17.4 mA/cm2 current density, 89 minutes treatment, achieving 99.7% boron removal. Real produced water treatment showcased 98% boron removal. The process followed pseudo-second kinetics and chemisorption with successful boron recovery.

Edris Bazrafshan and colleagues (2014) evaluated electrocoagulation's efficiency in removing basic red 18 dye from aqueous solutions using aluminum electrodes. They achieved a remarkable 97.7% removal efficiency under specific conditions, demonstrating electrocoagulation as a rapid and effective method for treating dye-contaminated wastewater, with reliable performance and efficient removal rates.

III. OBJECTIVE

1) *Identification and removal of impurities in Sugar Industrial Wastewater:*

This objective aims to identify and quantify the presence of impurities in sugar industrial wastewater, highlighting the extent of contamination for effective remediation strategies.

2) *Removal of Conductivity and Chloride at Different pH Values:*

Investigating the removal efficiency of conductivity and chloride in sugar industrial wastewater at various pH levels to optimize the electrocoagulation process for enhanced purification.

3) *Assessment of Electrocoagulation Method in Removal of major impurities (Dwarikesh Puram Plants):*

Analyzing the efficacy of electrocoagulation as a viable method for removing major impurities from wastewater specifically in the context of the Dwarikesh Puram Plants within the sugar industry.

4) *Evaluation of Parameter Influence in Electrocoagulation for impurities removal optimization:*

Assessing the impact of different parameter levels in the electrocoagulation process to determine the most effective conditions for maximizing impurities removal efficiency and optimizing the treatment process.

5) *Comprehensive Understanding of the Electrocoagulation Process:*

Delving into the intricacies of the electrocoagulation process to gain a detailed insight into the mechanism, principles, and operational aspects involved in effectively treating impurities-laden wastewater in the sugar industry.

These objectives collectively aim to contribute to the advancement of knowledge and the development of sustainable solutions for the efficient removal of impurities from sugar industrial wastewater through electrocoagulation techniques.

IV. METHODOLOGY

The electrocoagulation technique, utilizing an electrochemical cell with anode, cathode, and electrolyte, efficiently removes contaminants from water and waste streams, addressing water pollution and wastewater management. Commonly employing aluminium and iron electrodes, it presents a versatile and effective approach for treating diverse pollutants, necessitating continued research and development for optimization.

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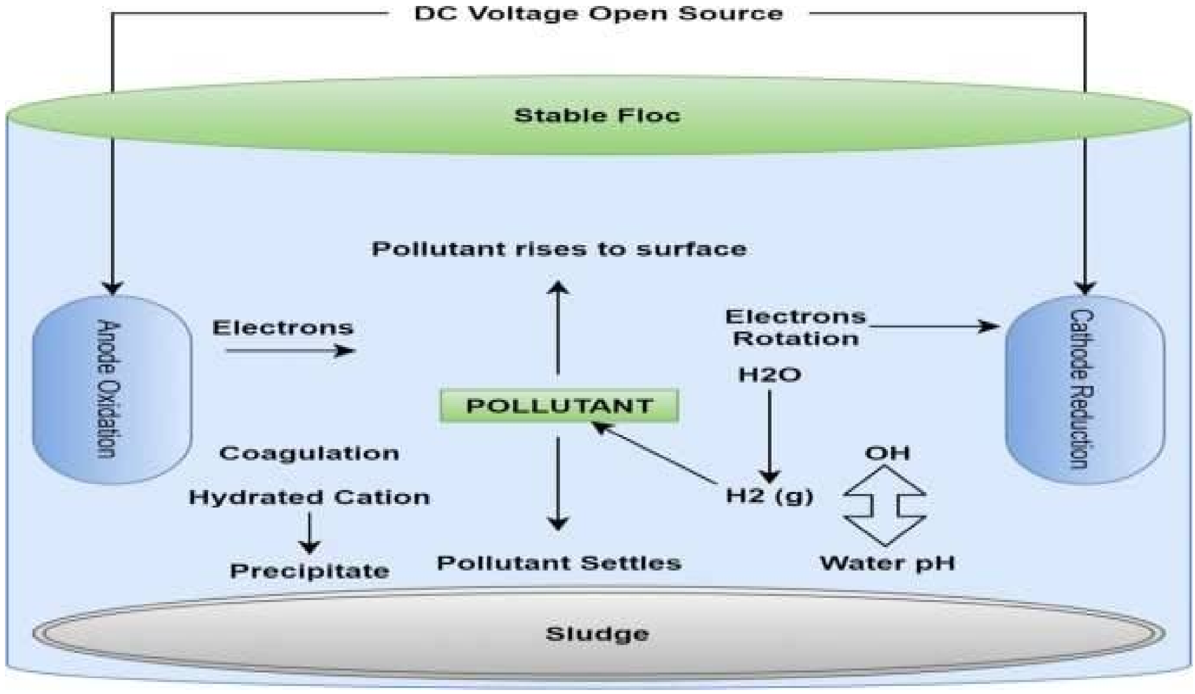

Figure 2: Process of electrocoagulation in details

The analysis of the Electrocoagulation system involves several steps:

1) The sacrificial electrode undergoes electrolytic oxidation, leading to the formation of Zcoagulants.
2) At the surface of cathode, the formation of OH ions and H2 takes place.
3) Electrolytic reaction occurs at the surfaces of the electrodes.
4) Contaminants, particulate suspensions, and emulsions undergo destabilization.
5) The destabilized phases aggregate to form flocs.
6) Colloids are removed through either alluviation or flotation.

V. RESULTS

The study focuses on impurities present in sugar industrial wastewater like Zn, Ni, Fe, Pb etc. It aims to quantify heavy metal levels and investigate the influence of voltage and pH on chloride removal,colour removal,COD etc. for optimizing the electrocoagulation process. The research holds substantial implications for environmental protection and sustainable industrial practices.

	Zn	Ni	Cu	Mn	Cd	Cr	Fe	Pb
Calculated Value	1.84	0.15	0.19	0.10	0.03	0.04	3.32	0.08
Permissible Value	5	0.05	0.05	0.1	0.01	0.05	0.3	0.1

Figure 3: Concentrations of heavy metal in sugar waste water

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The current density has a significant impact on Electrocoagulation, particularly on the removal of COD and colour.

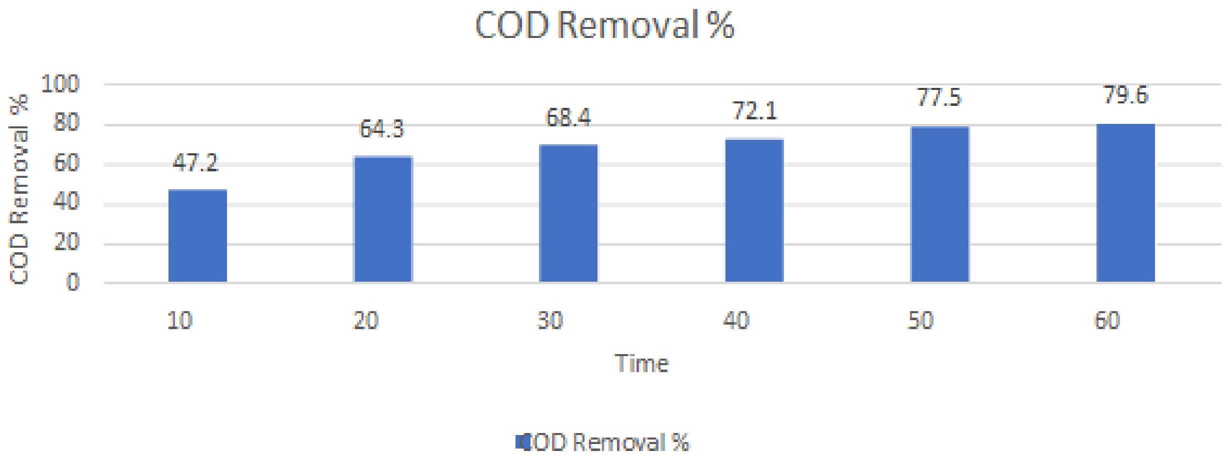

Figure 4: Effect of current density on COD Removal in % with time

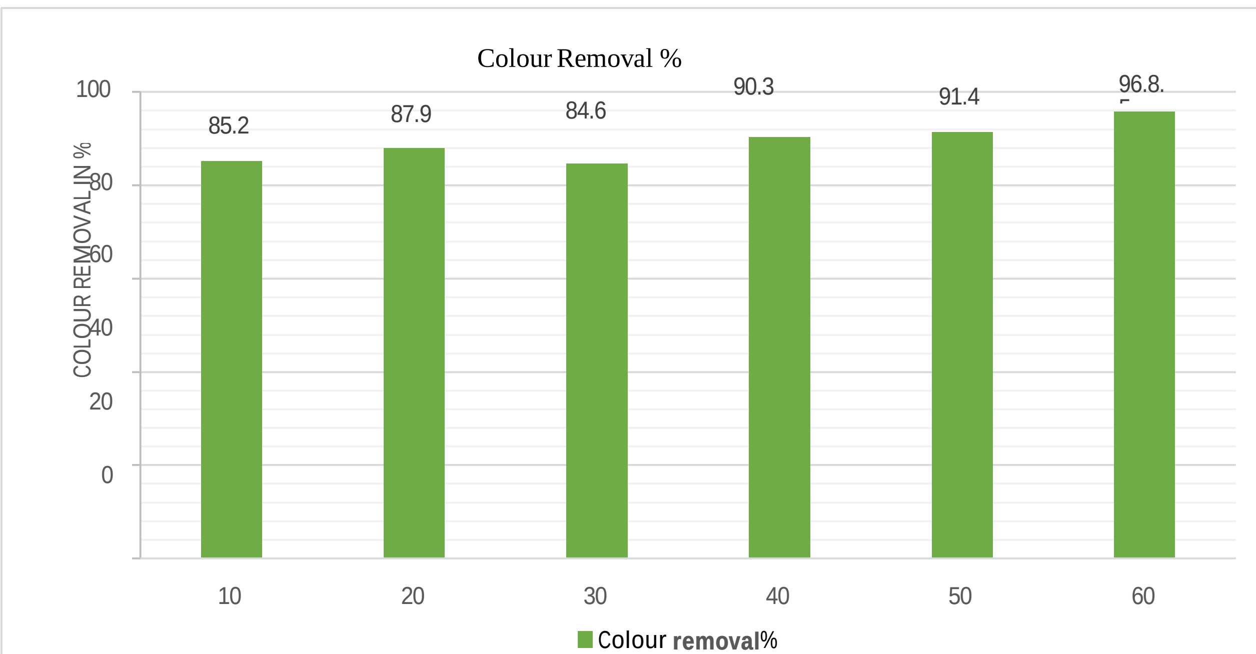

Figure 5: Effect of current density on Colour Removal in % with time

In order to enhance the performance of the aluminium reactor and achieve effluents that meet discharge standards, the utilization of polyelectrolyte as a coagulant was explored. The addition of polyelectrolyte aims to induce particle destabilization and increase particle size (up to 10 times), thereby facilitating the effective remove of organic substances present as COD. The results of this study, directed at a current density of 40 mA/cm^2 with the incorporation of polyelectrolyte, the COD removal efficiency improved from 79.6% to 82.2% after an operating duration of 60 minutes.

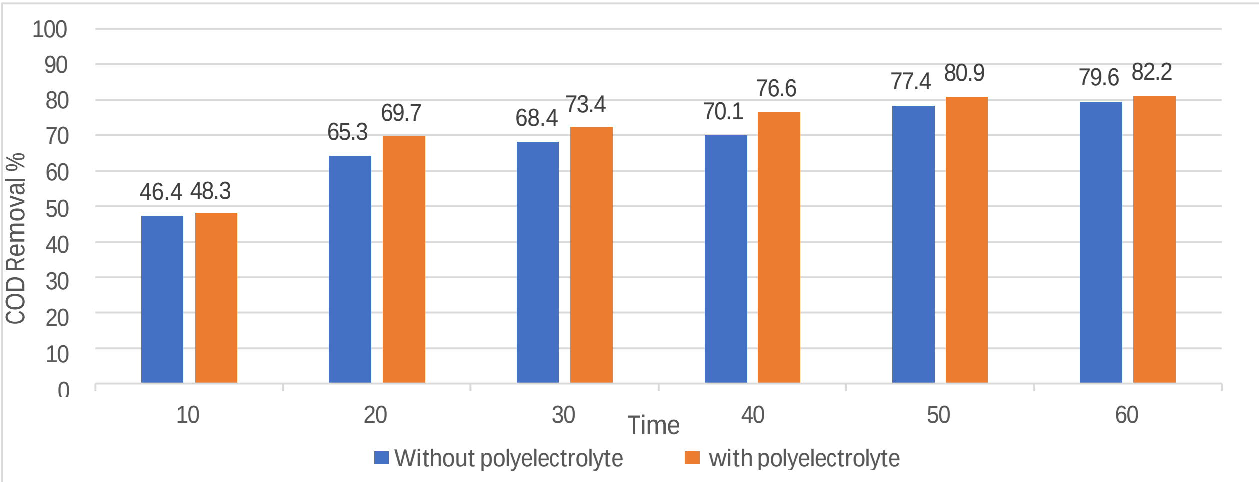

Figure 6: Effect of Polyelectrolyte on COD removal with time

VI. CONCLUSION

Based on the findings of our experimental study on sugar industry wastewater treatment using Electrocoagulation (EC), Several key parameters were identified as crucial for efficient treatment:

1) Optimal Operating Parameters: An electrolysis duration of 75 minutes, a pH value of 7.0, and a voltage of 25V were determined to be the optimum operating conditions for the treatment process using aluminium electrodes.
2) Efficiency of Treatment: At these optimal conditions, the treatment process exhibited significant removal efficiencies, including 92.5% chloride elimination efficiency and 93% conductivity removal efficiency.
3) Chemical Oxygen Demand (COD) Removal: The percentage of COD removal varied with different current densities, ranging from 47.2% to 79.6% after one hour of electrolysis at current densities of 10 to 40 mA/cm^2.
4) Color Removal Efficiency: The electrocoagulation process demonstrated a maximum color removal efficiency of 96.8% for sugar industrial wastewater, indicating effective treatment of color-causing compounds.
5) Effect of Electrolytes: The addition of electrolytes was found to enhance the removal efficiency of COD. After adding electrolytes, the COD removal percentage increased to 82.2% compared to 79.6% without electrolytes, highlighting the importance of electrolytes in the treatment process.

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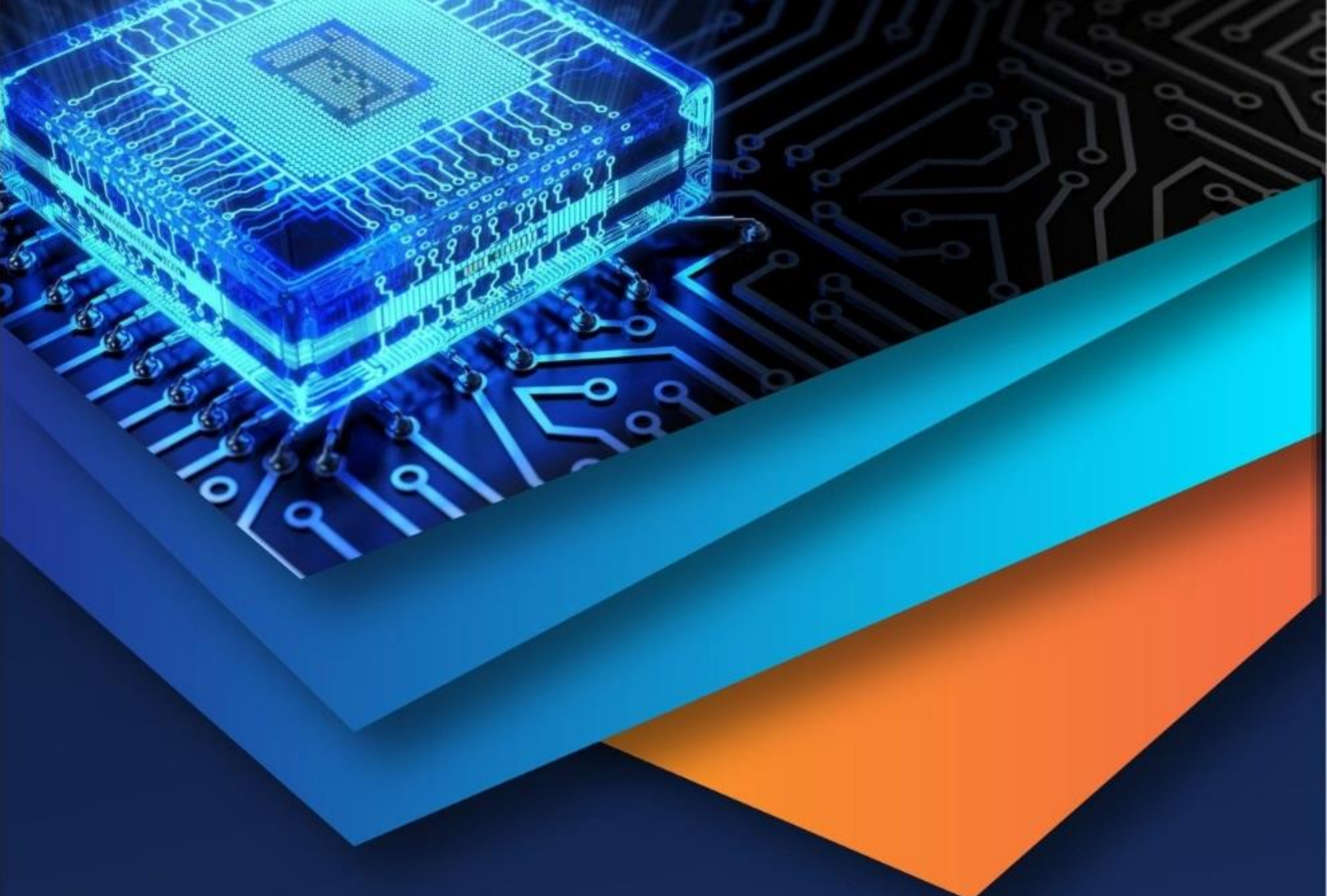

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