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Treating Wastewater from a Sugar Mill by Identifying and Removing Major Impurities Using the Eletrocoagulation: A Review

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Abstract: The purpose of this paper is to cover the whole research occurs over a period of 2006 to 2020 through literature review. In this research we take the review on the removal of heavy metals from sugar industrial wastewater through electrocoagulation process. This work is done to see the effect of Electrocoagulation process on various properties through previous research completed during the above period.

Index Terms: Electrocoagulation process, Electrode, Current, sugar industry wastewater.

I. INTRODUCTION

Effluents from the sugar industry and industrial waste significantly impact aquatic life. Various treatment methods like ion exchange, catalytic oxidation, absorption, ultrafiltration, membrane filtration, electrocoagulation, and coagulation are available. Sugar waste water affects temperature, pH, biological oxygen demand, and contains impurities like copper, zinc, nickel, sulfur, phosphate, cadmium, arsenic, mercury, lead, and temperature imbalances. Electrocoagulation is a viable treatment method that utilizes electrical current to remove pollutants. Treating sugar industry waste water before discharge is crucial to safeguard the environment. Adoption of effective treatment methods can mitigate the adverse effects of industrial waste on aquatic life, ensuring the sustainability of natural water resources.

II. ELECTROCOGULATION PROCESS

Electrocoagulation is a cost-effective yet intricate method extensively used to remove various harmful substances from industrial waste waters, including those from the sugar industry, slaughterhouses, olive mills, and nitrate production facilities. The process involves filling a reactor with the to-be-treated solution, immersing electrodes (anode and cathode) into the solution, and applying power through a power source. Aluminum and iron are typically utilized as electrodes in this process. The exact mechanism of electrocoagulation remains not fully understood due to its complexity. The treatment process involves the immersion of electrodes of similar or different materials as anode and cathode into the solution to be treated. When a current passes through aluminum and iron electrodes, Al_3 and Fe_2 ions are produced. Simultaneously, hydrogen gas and hydroxide ions are released at the cathode. These hydroxide ions combine with Al_3 and Fe_2 ions in the solution, forming aluminum and iron hydroxides that act as coagulants. Notably, the role of aluminum and iron electrodes is pivotal in this process due to their ability to generate effective coagulants. The electrocoagulation process's complexity is further reflected in the proposed mechanisms governing the efficient treatment of industrial waste water using iron electrodes. These attributes make electrocoagulation a promising method for effectively removing contaminants through complex chemical reactions involving aluminum and iron ions.

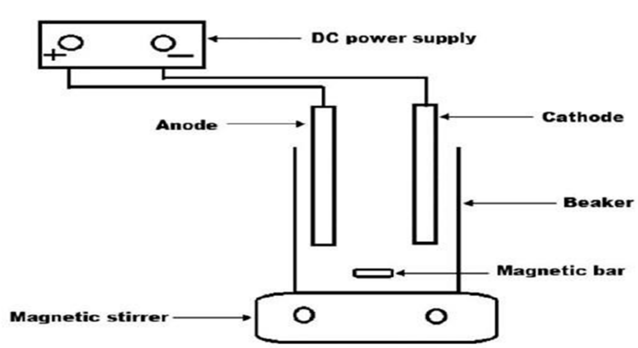

Fig.1 Electrocoagulation System

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1) *Mechanism 1*

Anode: $4Fe \rightarrow 4Fe^{+2} + 8e^-$

$4Fe^{+2} + 10H_2O + O_2 \rightarrow 4Fe(OH)_3 + 8H^+$

Cathode: $8H^+ + 8e^- \rightarrow 4H_2$

Overall: $4Fe^{2}+ + 10H_2O + O_2 \rightarrow 4Fe(OH)_3 + 4H_2$

2) *Mechanism 2*

Anode: $Fe \rightarrow Fe^{+2} + 2e^-$ $Fe^{+2} + 2OH^- \rightarrow Fe(OH)^2$ Cathode: $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$

Overall: $Fe + 2H_2O \rightarrow Fe(OH)_2 + H_2$

III. LITERATURE REVIEW

Sweta Chandra and Devendra Dohare's research conducted in 2020 Aims to provide a comprehensive understanding of the electrocoagulation method and its effectiveness in removing impurities from wastewater. Their study delves into the intricacies of this method, examining various factors that influence its performance.

One key aspect of their research is the exploration of the electrocoagulation process across a range of parameters. This includes investigating the effects of pH levels, electrode materials, inter-electrode spacing, applied voltage, current density, reaction time, and initial concentrations of pollutants. By studying these variables, Chandra and Dohare aim to elucidate the optimal conditions for achieving efficient heavy metal removal through electrocoagulation.

Their research likely involves conducting experiments to systematically vary these parameters and analyze their impact on the electrocoagulation process. By observing changes in impurities concentrations, floc formation, and other relevant parameters,they can draw conclusions about the effectiveness of electrocoagulation under different conditions.

Salman Hussein Abbas and wail Hussan Ali (2018)This review paper delves into numerous studies exploring the efficacy of electrocoagulation in treating industrial wastewater, effectively removing a broad spectrum of impurities such as color, COD (Chemical Oxygen Demand), BOD (Biochemical Oxygen Demand), turbidity, and metal ions. The paper thoroughly investigates various factors that can impact the electrocoagulation process. These parameters, including pH, current density, applied voltage, agitation speed, type and size of electrodes, number of electrodes, inter-electrode distance, initial concentration of contaminants, and electrolysis time, were systematically analyzed and optimized to evaluate their influence on heavy metal removal via electrocoagulation. Several reputable journals have published research on this topic. Electrocoagulation is gaining traction as a viable alternative to biological, physical, and chemical treatment methods due to its environmentally friendly nature and cost-effectiveness in operation.

Fatih Ilhan, et. al. (2019) discusses the electrocoagulation method and used iron and aluminium electrode to precipitation through pH value adjustment it also observed that removal was fast during first min and goes slow but efficiently removed the metal and current not varied very much. Iron electrode are 10% more effective to that of aluminium. Cu, Cr, Zn, Ni also removed by this EC method.

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 Al-Shannag, et. Al. (2015) The study on electrocoagulation (EC) process for removing heavy metal ions, specifically Cu2+, Cr3+, Ni2+, and Zn2+, from metals electroplating wastewater yielded promising results. The experimental setup involved an electroreactor equipped with six steel mixed with carbon electrodes arranged in a monopolar configuration, with three electrodes designated as cathodes and the remaining three as anodes.

The research findings demonstrated that the efficiency of heavy metal ion removal increased with longer residence time during electrocoagulation and higher applied current density. Notably, operating at a current density of 5 mA/cm2, a pH of 8.65, and an electrocoagulation time of 45 minutes resulted in an impressive removal rate of over 97% for heavy metal ions.

Under these conditions, the energy consumption was approximately 6.25 kWh/m3, and the dissolved electrode mass was around 1.21 kg/m3. These values indicate relatively low energy consumption and electrode mass, suggesting the potential economic feasibility of scaling up the EC process for metals coating removal if economically viable.

Rumi Chaudhary (2013) In the treatment of sugar industry wastewater, aluminium plates were utilized as electrode materials in the electrocoagulation process. The findings of this study underscore the high efficiency of electrocoagulation in treating sugar mill wastewater. Specifically, the study achieved an impressive 84.2% removal of Chemical Oxygen Demand (COD) and over 98.7% removal of color within a 90-minute treatment period.

These results were achieved under specific conditions, including a current density of 40 mA/cm2 and a wastewater flow rate of 1000 ml/min. This highlights the effectiveness of electrocoagulation as a treatment method for sugar mill effluent, offering significant reductions in pollutants such as COD and color.

IV. CONCLUSION

The review paper extensively discusses electrocoagulation (EC) as a powerful method for removing waste from the industrial waste water.It highlights significant chemical reactions on electrodes, leading to substantial changes in pH, energy consumption, electrode material, temperature, zinc, copper, and voltage. The method's efficiency surpasses that of other techniques, making EC a compelling and highly effective solution for addressing impurities in industrial waste water.

REFERENCES

[1] Krystynik, P., Masin, P., Krusinova, Z., Kluson, P. (2019). “Application of electrocoagulation for removal of toxic metals from industrial effluents”, International Journal of Environmental Science and Technology, August 2019, Volume 16, Issue 8, pp 4167–4172

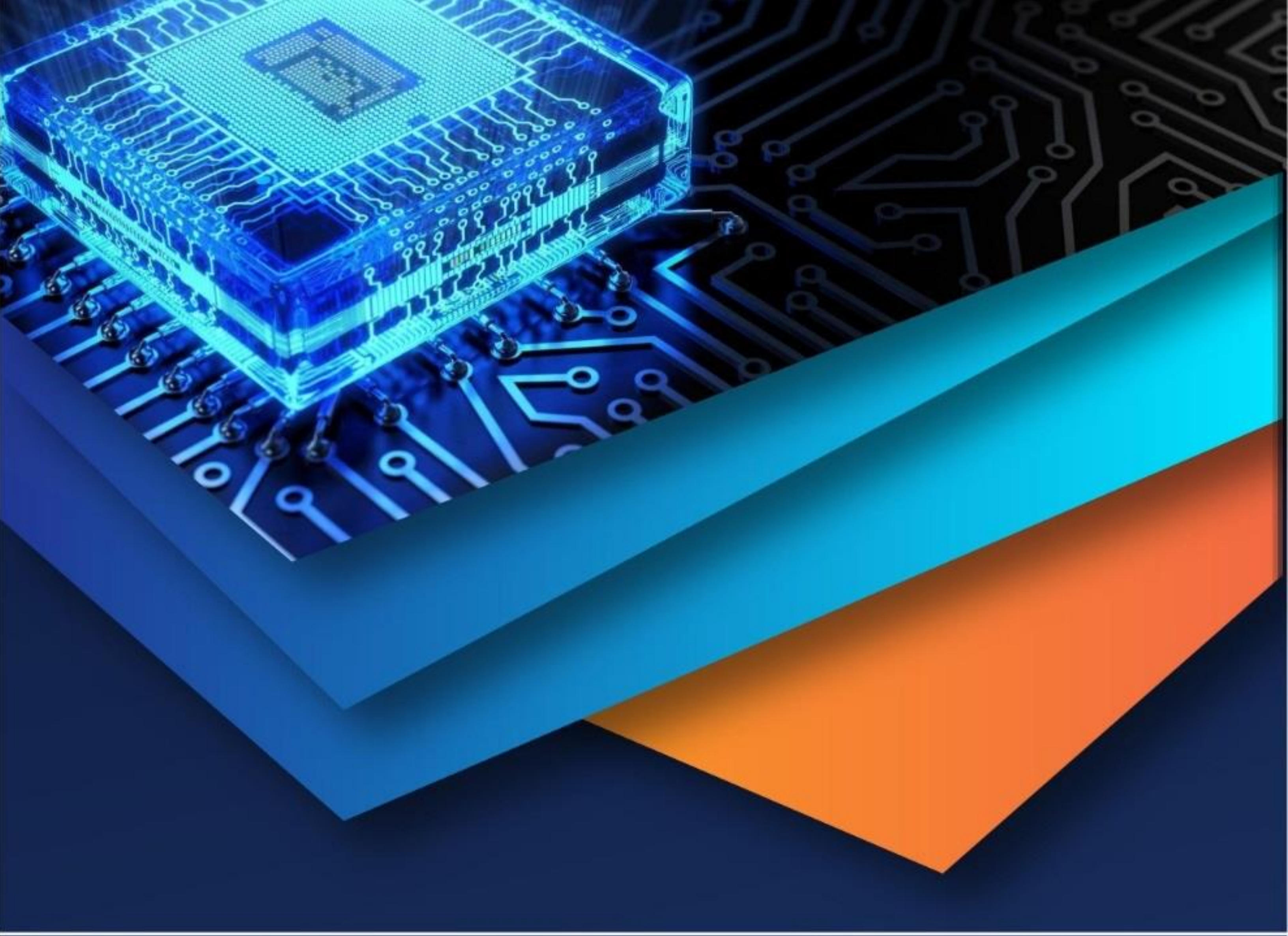
[2] Iwanti, R. (2019). “Lab Scale Study of Iron Removal from Industrial Wastewater by Electro- Coagulation Process: A Case Study”, International Journal of Engineering Research & Technology, Vol. 8 Issue 09.

[3] Abbas, S.H., and Ali, W.H. (2018). “Electrocoagulation Technique Used to Treat Wastewater: A Review”, American Journal of Engineering Research (AJER), Volume-7, Issue-10, pp-74-88.

[4] Jagwani, M.,(2018). “Lab Scale Study of Electro-Coagulation Process for Zinc & Iron Removal from Metal Plating Industrial Waste-Water”, Journal Of Industrial Pollution Control Board.

[5] Al-Shannag M., Al-Qodah Z., Bani-Melhem K., Qtaishat M.R., Alkasrawi M. (2015). “Heavy metal ions removal from metal plating wastewater using electrocoagulation: Kinetic study and process performance”, Chemical Engineering Journal 260 (2015) 749–756.

[6] Bazrafshan E., Mahvi A.H., Zazouli M.A. (2014). “Textile Wastewater Treatment by Electrocoagulation Process Using Aluminium Electrodes”, Iranian journal of health sciences 2014; 2(1):16-29.



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