e-ISSN: 2582-5208
International Research Journal of Modernization in Engineering Technology and Science
(Peer-Reviewed, Open Access, Fully Refereed International Journal)
Volume:06/Issue:04/April-2024 Impact Factor- 7.868 www.irjmets.com

ELECTROCOAGULATION AND WATER TESTING

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ABSTRACT

The study investigated wastewater treatment using electrochemical techniques on a pilot-scale plant. Electrocoagulation (EC), electroflotation (EF), and electrophoretic deposition (EPD) were examined. Parameters were varied to optimize EC reactor conditions for COD, suspended solids, micropollutants, and coagulant removal. Two electrodes were tested with outflows from primary and secondary sedimentation tanks. EC reactor efficacy was assessed for COD, suspended solids, and micropollutant removal at different current densities. The pH and SS aggregation increased with higher applied current. COD removal efficiency was 56–57% and 12– 18% for Fe and Al electrodes, respectively. Applied current was the most influential parameter, with Al electrodes producing more flocs and bubbles compared to Fe electrodes at similar current densities.

Keywords: Electroflotation, Electrophoretic, Electrocoagulation.

I. INTRODUCTION

Cleaning up wastewater to remove tiny pollutants is a big job because there are lots of different kinds of pollutants coming from many sources like factories, farms, homes, and cities. These pollutants include things like leftover medicines, germs, and harmful chemicals. They can harm animals and people, even in small amounts, and can build up in the environment over time, causing problems. To clean up this dirty water, we use different methods. One of these methods, called electrocoagulation (EC), is getting a lot of attention because it's pretty good at cleaning up water without using too many chemicals. EC works by passing electricity through the water to make tiny particles stick together and form bigger clumps that can be easily removed.

We mostly use metals like iron and aluminum to do this job because they help grab onto the pollutants and pull them out of the water. Iron and aluminum electrodes, which are like metal sticks, are put into the water. When electricity passes through them, it causes reactions that make tiny particles join together to form bigger ones, making it easier to take them out of the water. This process is pretty simple, safe, and doesn't take too long.

By using EC, we can turn harmful pollutants into harmless substances, which is good for the environment and for people's health. It's also a pretty cost-effective way to clean up water compared to some other methods. Scientists are still studying how to make EC even better and more efficient for cleaning up water.

In addition to iron and aluminum, other materials like steel and magnesium have also been tested for their effectiveness in removing pollutants from wastewater using EC. Scientists have looked at how well these materials work under different conditions like pH levels and the amount of electricity used. However, there's still more to learn about how to make EC work even better and how to use it most effectively in different situations. Aluminum to do this job because they help grab onto the pollutants and pull them out of the water.

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II. METHODOLOGY

Solar Charge Controller

The solar charge controller is a crucial power electronic device that regulates the power from a photovoltaic panel to charge a rechargeable battery efficiently while preventing overcharging. Using a block diagram and simulation in Proteus software, the project highlights the significance of developing devices to harness

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renewable energy amidst increasing consumer demands and dwindling conventional energy sources. When the solar panel generates voltage, it is directed to a DC to DC converter and an Arduino controller, which manage the voltage through a driver circuit and send it to a buck converter to adjust the voltage level for battery charging. An LCD displays the battery's state of charge, and when fully charged, an IC disables the circuit to prevent overcharging. The design includes potential dividers to manage the voltage from the solar panel, an optocoupler acting as a driver circuit, and Pulse Width Modulation to control the MOSFET duty cycle effectively. The Arduino controller processes all data, adjusting the voltage for battery charging to ensure safe operation and prevent overheating.

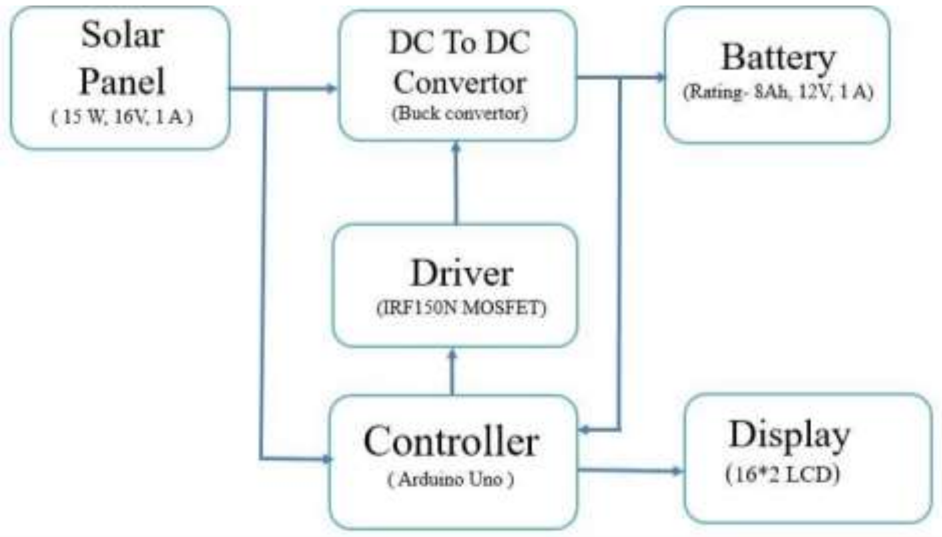

Figure 1: Block Diagram of Solar Charge Controller

Electrocoagulation process

By applying direct current to the electrocoagulating reactor in which sacrificial electrodes are submerged. We used to metals aluminium as anode and copper as cathode in which electrochemical reaction occurs. Whatever current required to the process which is shown in the LCD display for that purpose current sensor is used to sense the current which will required to the process of electrocoagulation.

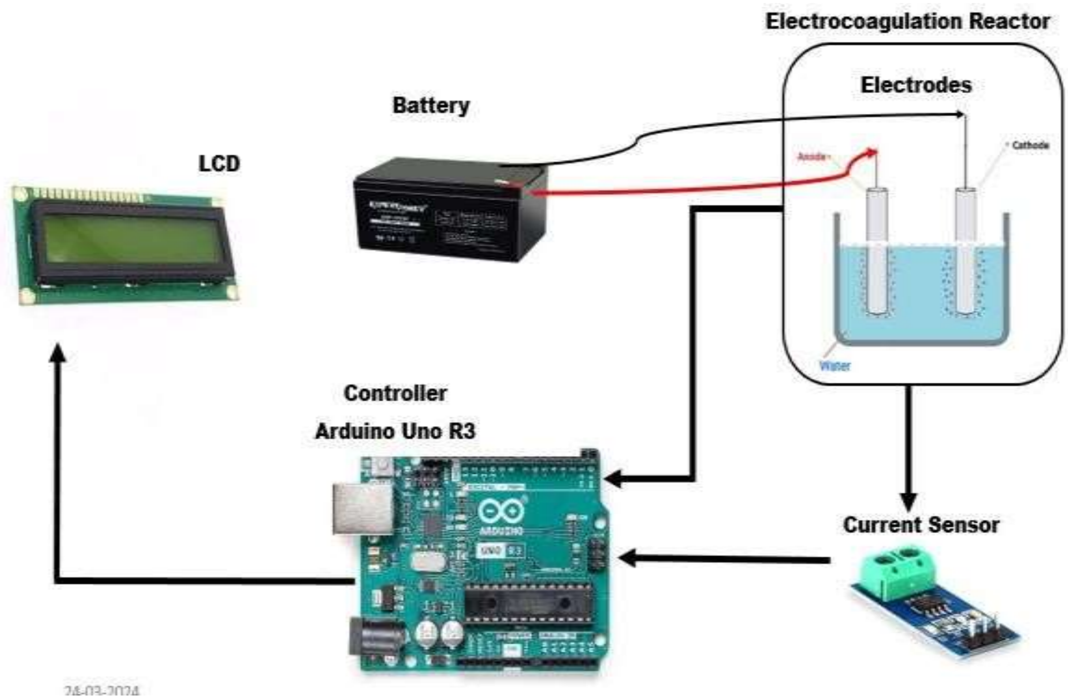

Figure 2: Block Diagram of Electrocoagulation Process

Water testing

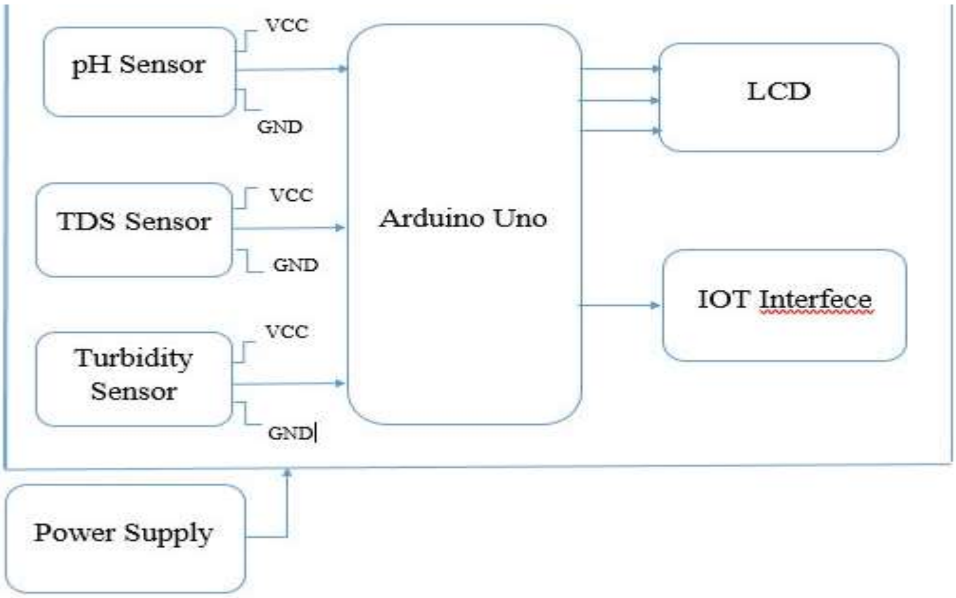

Figure 3: Block Diagram of Water Testing Process

This testing circuit diagram focuses on assessing water quality before and after undergoing wastewater treatment. It involves analyzing several parameters like pH level, total dissolved solids (TDS), and water turbidity.

III. MODELING AND ANALYSIS

The proposed system integrates electrocoagulation-based wastewater treatment with water quality testing using advanced sensor technologies. The system is controlled by Arduino boards, which regulate the treatment process and collect real-time data for analysis. The hardware setup includes a charge controller kit, electrocoagulation kit, and water testing kit, each serving specific functions in the treatment process.

Figure 4: Hardware

Charge Controller Kit Modeling:

Arduino Uno: Model the control logic for regulating power distribution between the electrocoagulation setup and water testing kit. Consider factors such as input voltage, current limitations, and safety protocols.

MOSFET: Analyze the MOSFET's role in managing current flow between the power supply and treatment modules. Simulate the switching behavior to ensure efficient power distribution.

LCD Display and Optocoupler: Model the communication interface between the Arduino Uno and LCD display, ensuring accurate feedback and status updates to the user. Analyze the optocoupler isolation capabilities for high-voltage sections.

Power Supply and Rectifier: Simulate the conversion of AC to DC by the rectifier and capacitor, ensuring smooth output voltage for stable operation of the system.

Electrocoagulation Kit Modeling:

Power Supply: Analyze the power requirements of the electrocoagulation setup and simulate the delivery of sufficient voltage and current to facilitate the treatment process.

Arduino Uno and MOSFET: Model the control mechanism for regulating voltage and current applied to the sacrificial electrodes. Simulate the activation and deactivation of the MOSFET based on sensor feedback to optimize treatment efficiency.

LCD Display: Simulate the display of relevant treatment parameters such as voltage, current, and process status for real-time monitoring and control.

Current Sensor: Model the monitoring of current flow through the electrocoagulation chamber to ensure safe and efficient operation of the system.

Electrodes Configuration: We are going to use electrodes can be arranged in a simple configuration, such as parallel plate or rod configuration, to ensure uniform current distribution and maximize contact with the wastewater. We are using one Al and one Cu pair of electrodes.

Proper spacing between the electrodes and consideration of electrode surface area are essential for optimizing treatment performance.

Water Testing Kit Modeling:

Power Supply Rectifier: Analyze the power requirements for the water testing kit components and simulate the conversion of AC to DC for reliable operation.

Arduino Uno & NodeMCU: Model the data acquisition and communication protocol between the sensors and microcontroller, ensuring accurate measurement and transmission of water quality parameters.

pH and Turbidity Sensors: Simulate the measurement process for pH and turbidity, considering factors such as calibration, accuracy, and response time. Analyze sensor data for real-time monitoring of water quality.

Integration and Operation Analysis:

Power Distribution: Analyze the charge controller's performance in regulating power distribution between treatment modules, ensuring optimal energy utilization.

Treatment Efficiency: Evaluate the effectiveness of the electrocoagulation process in destabilizing contaminants and facilitating their removal based on sensor feedback and treatment parameters.

Water Quality Monitoring: Assess the accuracy and reliability of pH and turbidity sensors in monitoring water quality throughout the treatment process.

System Optimization: Identify opportunities for optimizing treatment parameters and control strategies based on modeling and analysis results to improve overall system performance.

IV. RESULTS AND DISCUSSION

Figure 5: Sample Before Electrocoagulation Process

Observation Table For Before Electrocoagulation Process:

Sr. No	pH	TDS	Turbidity	COD
1.	5.8	1188ppm	89%	4657mg/liter
2.	4.5	1680ppm	85%	5678mg/liter
3.	6.0	980ppm	73%	2745mg/liter

Above Fig Shows the Results Before the Water Treatment and The Observations of The Values of Different Parameters Like PH, COD, TDS, Turbidity of Water Sample and The Water Is Going to Treatment.

Water Sample Result After 30 Minute:

Figure 6: Water Sample Result After 30 Min

The water is kept for Electrocoagulation process after some time solid heavy particles are start to settle down at bottom. And the light particles are coagulated to the top of surrounding the electrode. After 1-2 hrs. the water will be taken in another tank for testing purpose.

Water Sample Result After One and Half Hour:

Figure 7: Water Sample Result After One and Half Hour

After the Electrocoagulation process will be completed. The whole sludge will be collected in another tank. And Electrocoagulation Process will get completed. And the water will be taken in another tank for the water testing.

Observation Table for After Electrocoagulation Process:

Sr. No	Voltage	Current	pH	TDS	Turbidity	COD
1.	12v	1.75A	5.9	880ppm	60%	2346mg/liter
2.	12v	1.5A	6.4	448ppm	48%	1660mg/liter
3.	12v	1.80A	6.8	290ppm	35%	890mg/liter

Observation Waveform for Different Sensors:

Observation Waveform For pH Sensor:

Figure 8: Waveform For pH Sensor

Observation Waveform for TDS Sensor:

Figure 9: Waveform For TDS Sensor

Observation Waveform for Turbidity Sensor:

Figure 10: Waveform of Water Quality Testing

V. CONCLUSION

Wastewater treatment plays a crucial role in safeguarding both human health and the environment. As industries produce vast amounts of wastewater, it's imperative to treat it before discharge to prevent harm to ecosystems, agriculture, and aquatic life. Traditional methods can't cope with the volume of waste generated, prompting the need for water treatment facilities. These facilities accelerate the natural purification process to handle industrial wastewater efficiently. Regulations from pollution control boards mandate that industries treat their wastewater to specified limits before disposal. Electrocoagulation (EC) emerges as a promising technology for industrial wastewater treatment, utilizing sacrificial aluminum and copper electrodes.

Studies have shown that EC offers high pollutant removal rates with minimal energy consumption, especially when coupled with renewable energy sources. Optimization techniques, such as those implemented with Arduino Uno, further enhance removal efficiencies of contaminants like color, chemical oxygen demand (COD), and turbidity while minimizing energy usage. Ultimately, the findings underscore the effectiveness and efficiency of EC as a viable solution for treating industrial wastewater and effluents. By embracing such innovative approaches, industries can mitigate their environmental footprint while meeting regulatory standards.

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