International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 12 Issue: 12 | Dec 2025 www.irjet.net p-ISSN: 2395-0072

ELECTROPLATING MACHINE

sharabanna[1], Venkatesh k[2], S Harshavardhan[3] , Devindrappa[4]

[1]*Lecturer, Department of Mechanical Engineering, Sanjay Gandhi polytechnic college Ballari, Karnataka, India*
[2]*Lecturer, Department of Mechanical Engineering, Sanjay Gandhi polytechnic college Ballari, Karnataka, India*
[3]*student, Department of Mechanical Engineering, Sanjay Gandhi polytechnic college Ballari, Karnataka, India*
[4]*student, Department of Mechanical Engineering, Sanjay Gandhi polytechnic college Ballari, Karnataka, India*

Abstract - Electroplating *is a crucial surface treatment process that enables the deposition of a thin metal layer onto conductive substrates through electrolysis. The electroplating machine is equipped with essential components including an electrolyte solution, an anode, a cathode, and a power supply. The electrolyte contains metal ions that, when subjected to an electric current, are reduced and subsequently adhere to the cathode, creating a uniform metal coating. This process significantly enhances the aesthetic appeal, structural integrity, and corrosion resistance of various materials, making it indispensable across multiple sectors. Applications range from jewelry and automotive components to electronic circuitry and industrial equipment, highlighting electro plating's versatility. By facilitating precise control over layer thickness and coating properties, electroplating is essential for achieving desired functional and decorative outcomes. The technique is thus integral to industries seeking durability and enhanced performance, paving the way for innovation and improvement in product longevity and reliability.*

Key Words: Electroplating, Electrolysis, Metal coating, Surface finish, Corrosion resistance.

1. INTRODUCTION

1.1Introduction to Electroplating Machines

Electroplating machines, which use the electrochemical proc ess of electrolysis to put thin layers of metal onto a variety of substrates, are vital equipment in today's manufacturing and surface finishing sectors.

The primary objective of electroplating is to enhance surface qualities, such as corrosion resistance, wear resistance, elect rical conductivity, and aesthetic appear e machine operates by immersing the object to be coated (cathode) and the plati ng metal (anode) into an electrolyte solution containing diss olved metal ions. When an electrical current is supplied,

metal ions from the electrolyte are deposited onto the surface of th e cathode, generating a homogeneous and durable metal coating.

Electroplating machines are widely utilized across numerous industries, including:

Automotive: For chrome plating and corrosion protection of automobile parts.

Electronics: For gold and silver plating of circuit board sand connectors.

Jewelry: To add ornate finishes or guard against tarnishing.

Aerospace and Industrial: To enhance wear resistance and reduce friction on essential components. This technology serves a critical role in generating high-quality, durable, and visually appealing goods, making it a cornerstone of modern material processing

1.2Problem Statement:

Electroplating is a procedure used to cover a material (usually metal) with a thin coating of another metal using electrical current. Electroplating machines are widely employed in many different industries, but they frequently encounter particular difficulties that compromise their effectiveness, quality, and long-term viability.

1.3Key Challenges:

a. Inconsistent Coating Thickness: Product rejections or subpar results may result from uneven coating material deposition.

b. Environmental Concerns: Electroplating includes the use of hazardous chemicals, bringing concerns of pollution and health dangers if not managed adequately

c. High Energy Consumption: The process consumes significant electrical energy, making it pricey and environmentally unsustainable.

d. Material Wastage: Ineffective plating material use raises expenses and results in waste.

e. Maintenance Issues: Electroplating devices often require frequent maintenance owing to corrosion, chemical wear, and equipment inefficiencies.

f. Process Monitoring: Inadequate automation and real-time monitoring may lead to process variations that lower the quality of the finished product.

g. Adaptability: Many machines are not flexible enough to handle different types of materials and plating needs

1.4OBJECTIVES

- **Resistance to Corrosion**:
  To preserve the basic metal from rusting or corrosio n by applying a protective metal coating like chromi um or nickel.

- **Aesthetic Appeal:**
  To give a thing a glossy, ornamental, or appealing fi nishlike gold or silver plating
  to improve its appearance.

- **Electrical Conductivity:**
  To improve electrical conductivity by coating objects with metals like silver, gold, or copper, especially in electronic components.

- **Restoration and Repair:**
  To restore the proportions of wornout pieces by bui lding up layers of metal through electroplating.

2. Literature survey

- **Emmanuel Chukwuebuka Gugua etal.:** Discusses a systematic review of electroplating in the modern era, covering its history, commercialization, techniques, materials, challenges, and future recommendations.

- **Ojo Sunday Isaac Fayomi:** Defines electroplating as an electrochemical process for creating thin film layers, highlighting its unique functional applications and aesthetic properties, particularly in corrosive environments.

- **John X.J. Zhang & Kazunori Hoshino:** Describes electroplating as an electrode position process used for producing thicker metal films (>5 μm) in Nano/micro fabrication, mentioning specific applications like micro electrical coils and magnetic force actuators.

- **Piotr Augustine:** Reviews the possibilities for electroplating of polymer materials, focusing on methods of metallization, electrical properties of polymers, and the use of nanoparticles to enhance conductivity and deposition efficiency.

3. METHODOLOGY

Components used: Electroplating equipment normally co mprises of numerous components that work together to co at a material with a thin layer of metal.
The important components include:

3.**1.1Power Supply**: -
Provides a regulated DC currentsupplies a regulated DC cu rrent for the electroplating procedure.Allows modification of voltage and current to meet the specific plating material and requirements.

3.1.2Anode:
Made of the metal to be deposited or an inert substance lik e graphite or platinum.Connected to the positive terminal of the power supply.

3.1.3 Cathode:
The item to be plated, attached to the power supply's negativ e terminal.Attracts the positively charged metal ions, causing them to settle on its surface.

3.1.4Heating System:
Some plating methods require the electrolyte to be kept at a specific temperature**.**

3.2Construction

3.2.1Design and Fabrication: Determine the size and shap e of the electrolyte tank based on the size of the Work pieces to be plated.Design and build a mounting system for the ano de and cathode within the tank.

3.2.2**Electrical Connections**:
Connect the positive Terminal of the DC power supply to the anode. Connect the negative terminal of the DC power supply to the Cathode.

3.2.3Assembly:

Place the anode and cathode in the electrolyte tank, Ensuring they are properly positioned and insulated From each other. Fill the tank with the electrolyte Solution. Testing and Operation: Turn on the power Supply and adjust the current to the desired amount

WORKING PRINCIPLE
The electrolysis process, which uses electrical energyTo dep osit a thin coating of metal onto a conductiveSurface, is then dation of an electroplating machine's operation.The working principle is explained in detail below:

Preparing for Perspiration: -
1. The object to be plated (cathode) is properly cleaned to re move dirt, grease, and oxides, ensuring proper adhesion of th e plating.The metal to be deposited (anode)Is selected and pr epared.

2. The process of electrolysis:
When the DC power supply is switched on

- Ionization in the Electrolyte Solution
  the electrolyte comprises metal ions (e.g., Cu^{2+}, Ni^{2+}) from the metal salt dissolved in it.
- Metal Deposition.
  At the cathode, positively charged metal ions gain el ectrons (reduction) and form a solid metal layer
- .Cathode reaction: Dissolution of anode (if active).T he anode can dissolve in the electrolyte to replace m etal ions.

- Anode reaction: d. Current flow: The plating Process is sustained by the continual passage of Ion s and electron exchange through the electrical curre nt.

SETUP: 1 Removing Rust from a Steel Bolt by Electrochemical Cleaning (Electrolysis Method) **Objective:** To remove rust from a steel bolt using an electrochemical (electrolysis) process.

Materials Required:

- Electroplating / electrolysis setup
- DC power supply
- Iron rod (acts as anode)
- Rusted steel bolt / iron screw (acts as cathode)
- Electrolyte solution:
- Baking soda – 50 g
- Salt – 50 g
- Water (sufficient to immerse the materials)
- Sandpaper

Fig-1 Metal Before Plating

Fig-2 Under Proces Electroplatng

Fig-3 After Electroplating

Steps:

Surface Preparation Use sandpaper to clean the surface of the rusted bolt (cathode) to remove loose rust, dirt, grease, or oil. This improves the efficiency of the process.

Prepare the Electrolyte Dissolve 50 g baking soda and 50 g salt in water. Stir the solution until fully mixed.

Electrical Connections
Connect the iron rod (anode) to the positive (+) terminal of the power supply.
Connect the rusted steel bolt (cathode) to the negative (–) terminal.

Immersion
Immerse both the anode and cathode in the electrolyte solution. Ensure they do not touch each other.

Electrolysis Process
Switch on the DC power supply.
Bubbles will form at the cathode due to reduction reactions.
Rust will start breaking down and detaching from the bolt.

Observation
After a few minutes to several hours (depending on rust level), remove the bolt, scrub off loosened rust, and rinse with clean water.

- Ensure the electrodes do not touch each other.
- Do not use too high voltage (6–12 V is usually sufficient).
- Perform the experiment in a well-ventilated area.
- Avoid touching the solution while the power is on

Table -1:

Sl.No	Initial weight(M1) Before Removing Corrosion In Grams	Final weight(M2) After Removing Corrosion In Grams	Corrosion On Nail M1-M2 In Grams
1.	8.58	8.36	0.22

Result: Rust gets removed from the steel bolt due to the electrochemical reduction process at the cathode. After conducting this experiment bolt weight has been reduced 0.22 grams

SETUP 2: Applying a copper coating to steel nails via electroplating.

Objective: To electroplate steel nails with copper using an electroplating apparatus.
Equipment:
1. Electroplating machine.

2. Power source.
3. Steel nail (cathode).
4. Copper wire (anode).
5. Copper sulfate electrolyte solution.

Fig-3 before Coating

Fig-4 Coating under Process

Fig-5 after Coating

Steps:

1. Clean the steel nail's surface using sandpaper to eliminate any dirt, grease, or contaminants, ensuring optimal coating adhesion.
2. Create the electrolyte solution by dissolving copper sulfate in water and thoroughly mixing.
3. Attach the copper wire anode to the positive terminal of the power supply.
4. Connect the steel nail cathode to the negative terminal of the power supply.
5. Submerge both the anode and cathode in the electrolyte solution. Apply a direct current (DC) to the solution.
6. Copper ions (Cu^{2+}) from the electrolyte migrate to the cathode, where they acquire electrons through reduction, forming a copper deposit.
7. At the anode, copper atoms release electrons through oxidation, thereby replenishing the copper ions in the electrolyte.

Table -2:

Sl.No	Initial Wight(M1) Before Coating In Grams	Final Wight(M2) After Coating In Grams	Deposition Of Copper On Nail M1-M2 In Grams
1.	10.14	10.18	0.04

Result: After conducting this experiment on nail weight has been increased 0.04 grams

4. CONCLUSION

In conclusion, electroplating represents a versatile and efficient method for rust removal and the deposition of copper coatings, effectively enhancing the lifespan and aesthetic quality of metallic surfaces. The technique hinges on a thorough understanding of the underlying electrochemical processes, particularly the importance of maintaining optimal current density and a balanced electrolyte composition. Utilizing substances such as baking soda, salt, and copper sulfate provides a foundation for the electroplating process, ensuring that the deposition of copper is uniform and adheres properly to the substrate.
Moreover, attention to these parameters not only influences the functional properties of the coated materials but also plays a significant role in determining the visual appeal of the final product. Industries ranging from automotive to decorative fabrication can greatly benefit from implementing precise electroplating protocols, thus achieving high-quality finishes and prolonged durability. As research and technology continue to advance, further refinement of electroplating methods is anticipated, paving the way for even more innovative applications in material science. Ultimately, proper maintenance and control within the electroplating process serve as fundamental practices for maximizing the potential benefits of this valuable technique in both industrial and decorative realms.

REFERENCES

[1] Electroplating: Basic Principles, Processes and Practice: By N. Kanani, published by Elsevier Advanced Technology in 2004

[2] Modern Electroplating: By Frederick Adolph Lowenheim, published by J. Wiley and Sons in 1974

[3] Principles of Electroplating and Electroforming (electrotyping): By William Blum and George B. Hogaboom, published by McGraw-Hill Book Company Inc in 1949

[4] General Chemistry: Principles and Modern Applications: By Ralph H. Petrucci, Harwood William S., Herring F. G., and Madura Jeffrey D., published by Pearson Education, Inc in 2007

[5] Review on Types and Methods of Electroplating on Metals: A PDF available on ResearchGate

[6] Emmanuel Chukwuebuka Gugua etal

[7] Ojo Sunday Isaac Fayomi

[8] John X.J. Zhang & Kazunori Hoshino

[9] Piotr Augustyn

BIOGRAPHIES

Sharabanna, lecturer in Mechanical Engineering at Sanjay Gandhi Polytechnic College, Ballari, India, holds an M.Tech in Thermal Power Engineering and has teaching assistant experience at IIT Dharwad. He is a lifetime ISTE member and has published six international journal papers, with interests in heat transfer, power generation, and renewable energy.