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Integrated Design and Performance Analysis of an Automatic Dual-Action Hacksaw Machine

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May-2025

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May- 2025

STUDENT DECLARATION

This is to certify that the thesis entitled "**Integrated Design and Performance Analysis of an Automatic Dual-Action Hacksaw Machine"** is an outcome of the investigation carried out by the author under the supervision of M.I. Washif Rahman Lecturer, Dept. of Mechanical Engineering, Sonargaon University (SU). This thesis or any part of it has not been submitted elsewhere for the award of any other degree or diploma or other similar title or prize.

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ABSTRACT

This project focuses on the design and development of a double-acting power hacksaw machine intended to improve cutting performance and reduce operation time. Unlike conventional single-acting hacksaws, this double-acting design enables cutting during both the forward and return strokes, effectively doubling efficiency without notably increasing power usage. The machine employs a robust crank and slider mechanism to convert rotary motion into linear reciprocating action, delivering stable and consistent cutting operations. Key components include the hacksaw blade unit, a driving motor, and a dual-action drive mechanism. This setup significantly minimizes non-cutting strokes, enhancing material removal and overall efficiency. The project also addresses essential mechanical considerations such as material choice, motion analysis, and stress evaluation to ensure long-term durability and operational reliability. Designed with affordability and industrial adaptability in mind, the machine supports large-scale usage. Test results confirm the system's efficiency, demonstrating a notable reduction in cutting time compared to traditional designs. This innovation shows strong potential for widespread use in industrial and workshop environments, promoting greater productivity and energy savings.

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CHAPTER-1
INTRODUCTION

1.1 Introduction

In modern workshops and industrial settings, various hacksaw machines are widely used for cutting metal bars and other materials. While these machines offer precision and efficiency, most conventional models have a key limitation: they can only cut one or two bars at a time. This constraint makes them unsuitable for high-volume production environments where speed and productivity are critical.

A hacksaw is a commonly used tool for cutting materials such as Ms Rod, Aluminum metal, wood, and plastic. Traditional single-acting hacksaws operate in only one direction, resulting in inefficient energy use and longer cutting times. To overcome these drawbacks, the double-acting power hacksaw has been developed as an advanced alternative.

Unlike traditional models, a double-acting hacksaw cuts on both the forward and backward strokes, significantly improving cutting speed and efficiency. It uses a reciprocating mechanism often powered by mechanical or hydraulic systems to deliver consistent force during each stroke. This design not only reduces operational time but also minimizes blade wear and enhances durability.

Such machines are especially beneficial in manufacturing units, metalworking shops, and construction sites where high productivity and accuracy are essential. They reduce manual effort, improve safety, and support continuous operation.

This section provides an overview of the working principles, components, and applications of the double-acting power hacksaw. It highlights how this technology surpasses conventional systems and explores its potential for future industrial improvements.

1.2 Background and Importance Study:

The automatic power hacksaw is a mechanical apparatus crafted for the precise and efficient cutting of tough materials such as metals and plastics. It automates the cutting process, reducing manual labor and boosting productivity in industrial and workshop environments.

Evolution to Power Hacksaws: In the early 20th century, powered hacksaws emerged to overcome these challenges. Early models were powered by electric motors or steam engines, ensuring a steady motion of the blade.

Recent Innovations: Over the years, power hacksaws have been upgraded with hydraulic systems, programmable controls, and sensors, enabling automated operation. These advancements have minimized human involvement and enhanced cutting accuracy.

Traditional Hacksaws: Manual hacksaws have been widely used for cutting metals, plastics, and wood. However, they require significant physical effort and are not suitable for high-volume production.

Automation in Manufacturing: With the rise of Industry 4.0, automation has become a cornerstone of modern manufacturing. Automated cutting machines reduce human intervention, enhance productivity, and ensure consistent quality.

Double-Cutting Mechanism: A double-cutting hacksaw machine simultaneously cuts two pieces of material, doubling the throughput compared to single-cutting systems. This feature is particularly advantageous in industries requiring mass production, such as automotive, aerospace, and construction.

Early Hacksaws: In the beginning, hacksaws were manually operated instruments for material cutting. These manual saws were slow for large-scale operations and needed a lot of physical labor.

Modern Advancements: Hydraulic systems, programmable controls, and sensors have been added to power hacksaws over time to improve automated operation, decrease human intervention, and increase precision.

1.4 Objectives:

The primary goal of this project is to design and build an **Automatic Double-Acting Hacksaw Machine** that enhances traditional manual hacksaws by introducing automation, improving cutting performance, and delivering a compact, affordable, and efficient solution.

Key Objectives:

- **Enhance Cutting Performance:**
    - Achieve cutting action on both forward and return strokes to effectively double the cutting rate.
    - Employ motorized or mechanical systems to ensure smooth, continuous blade movement.
    - Minimize downtime between strokes to maximize output.

- **Automate the Cutting Process:**
    - Eliminate manual operation by using electric motors, pneumatic actuators, or sensor-based automation.
    - Optionally incorporate IoT features or programmable controls for smarter functionality.
    - Implement automatic functions such as feed regulation and speed adjustment.
- **Ensure Compact and Portable Design:**
    - Develop a space-efficient machine suitable for small work areas.
    - Use lightweight materials to enhance portability and simplify setup.
- **Maintain Cost-Effectiveness:**
    - Opt for cost-efficient yet reliable materials and parts.
    - Simplify the design to reduce production costs.
    - Make the machine accessible to small-scale industries and DIY users.
- **Improve Safety and Adaptability:**
    - Integrate safety mechanisms such as protective blade covers and emergency stop features.
    - Design the machine to handle a variety of materials and sizes, including metals, rods, and pipes.

1.2 Structure of the Book

Chapter 1: Introduction

This book is systematically organized to offer a comprehensive understanding of the design, development, and implementation of an Automatic Double Acting Hacksaw Machine. The contents are divided into the following chapters:

Chpter 2: Literature Review

This chapter reviews existing research related to double-acting power hacksaws. It includes:

- An in-depth look at the power supply system.
- Key insights from previous studies and scholarly works.
- A catalog of essential components involved in the machine's construction.
- A summary of literature findings.

Chapter 3: Hardware Analysis

The focus of this chapter is on the physical components and instruments used in the project. It provides a detailed breakdown of the hardware that enables the machine’s functionality.

Chapter 4: Methodology
This chapter details the approach followed in executing the project. Topics covered include:

- The automation process and operational mechanism.
- Final images showcasing the completed machine.
- A step-by-step explanation of how the system works.

Chapter 5: Temperature Generation and Reduction

This chapter explores the temperature-related aspects of the Automatic Double Acting Hacksaw Machine during operation.

- Heat Generation During Cutting Operations
- Temperature Reduction Techniques
- Application of Cutting Fluids

Chapter 6: Results and Discussion
Here, the outcomes of machine testing are presented. The chapter includes:

- An evaluation of the machine's performance and efficiency.
- Analysis of test results, identifying both strengths and areas for enhancement.

Chapter 7: Conclusion
The final chapter recaps the major accomplishments of the project. It also:

- Recommends future enhancements, particularly in improving temperature control and energy efficiency
- Suggests possible directions for future improvements.

CHAPTER-2
LITERATURE REVIEW

2.1 Introduction

Overview of Hacksaw Machines

Basic function and applications in cutting various materials such as rods, wood, plastics, and aluminum 1.

Need for Automation

Enhances efficiency, precision, and safety in material cutting processes 2.

Objective of the Project

To design a simple, cost-effective, automatic hacksaw machine without complex electronics like PLCs or sensors 3.

2.2 Literature Review

1.Design And Mechanism Selection

A **double-action cutting mechanism** was selected, utilizing two blades moving simultaneously in opposite directions for increased efficiency. A **DC motor** drives a **crank and connecting rod system**, converting rotary motion into reciprocating blade movement.

- Mechanism: Crank-slider based reciprocating motion
- Blade Type: High Carbon Steel Hacksaw Blade
- Motion Conversion: Rotary to reciprocating via connecting rods [4]

2.Material And Component Selection

Components were selected for cost-effectiveness and mechanical reliability:

Component	Material	Reason
Main Frame	Mild Steel	Structural strength
Hacksaw Blade	High Carbon Steel	Sharpness, durability
DC Motor	12V–24V, 3000 RPM-250 watts	Low voltage ,High efficient torque 0.80N.m
Connecting Rod	Mild Steel Rod	Easy to machine
Power Supply	SMPS (12V–24V)	Compact, stable DC Motor

3: Methodology

The traditional hacksaw process is time-consuming and labor-intensive, especially for repetitive and mass cutting operations. The need was established for an **automatic, motor-driven double cutting hacksaw machine** capable of cutting rods, plastics, aluminum, and wood while being cost-effective and efficient.

- Design Approach: Mechanical design focusing on simplicity, durability, and ease of manufacturing.
- Component Selection: Use of DC motor for power, hacksaw blade for cutting, connecting rod for movement, and base frame for stability[5].
- Operation: Mechanical linkage driven by DC motor to automate the hacksaw movement.
- Cooling System: Use of cutting fluid to reduce temperature during cutting[6].
- Prototype Development: Step-by-step fabrication and assembly

4. Mechanical Linkages and Power Transmission

Research indicates that mechanical linkages such as connecting rods, cranks, and cams are effective for converting rotary motion into reciprocating motion in cutting machines 7. These mechanisms are praised for their durability, ease of maintenance, and low cost 8. Their design simplicity makes them suitable for projects aiming to avoid complex electronic component

5. Material Compatibility and Cutting Efficiency

Studies on material-specific cutting tools highlight the importance of selecting appropriate blades and cutting fluids for different materials like wood, plastics, and metals 9.

Proper cooling using cutting fluids reduces heat generation, which is critical for maintaining blade life and ensuring safety 10. Integrating simple fluid application systems can significantly improve cutting performance.

6. **Temperature Management in Cutting Operations**

Heat generated during cutting processes can cause thermal deformation and reduce tool life 11.

The use of cutting fluids effectively mitigates these issues, but most existing systems rely on manual application 12. Developing automated or semi-automated fluid delivery systems remains an area of ongoing research.

Cutting generates heat; use of cutting fluid reduces temperature, preventing material deformation

To control the heat generated due **to friction and . Temperature**, **cutting fluid** (coolant oil) was applied manually. [15]

7. Safety and Material Selection

Ensuring safety during operation is paramount. Protective covers, proper grounding, and stable frame structures are emphasized in recent literature 13.

Material selection for the machine frame influences durability and safety, with steel and aluminum being common choices 14.

2.3Block Diagram

In our project we have set up an design and fabrication of automatic double acting power hacksaw we will show by block the individual parts.

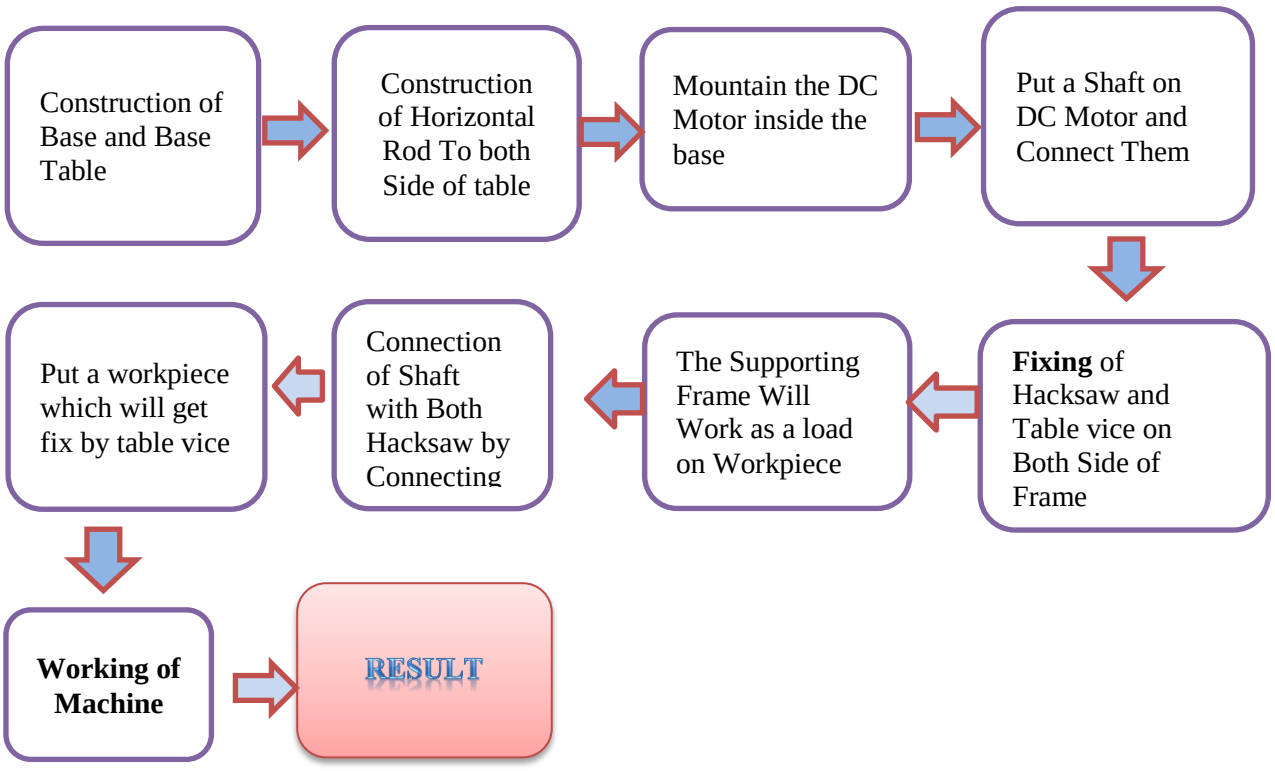


Figure 2.3: Block Diagram

Flow Chart Diagram: Work Mechanism

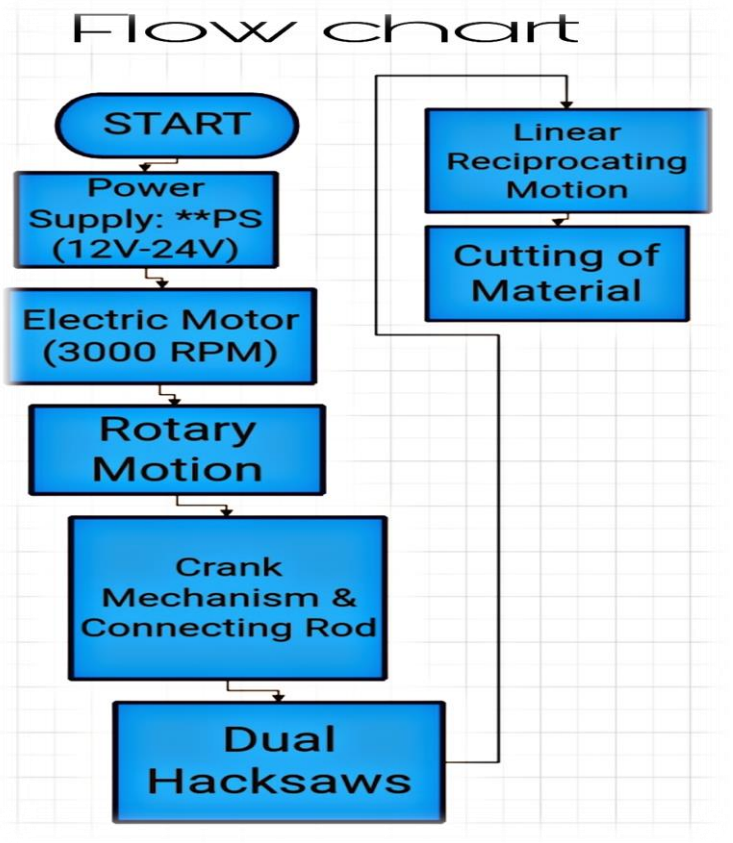


Figure 2.3: flow chart

2.4 Schematic Diagram:

The schematic diagram here is representing the Design, Fabrication and others component

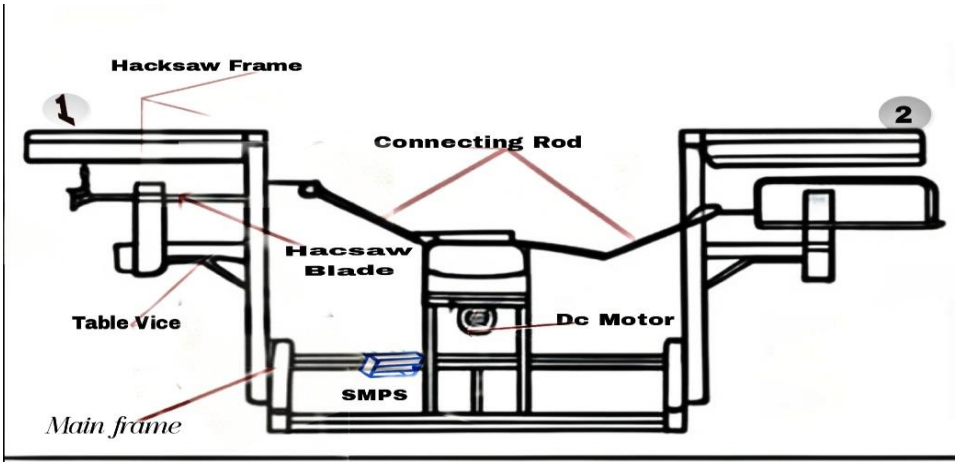


Figure 2.4: Schematic Diagram of Automatic Double Acting Power Hacks

2.5Components List:

1. **DC Motor 24V**
2. **Switched Mode Power Supply (SMPS)**
3. **Hacksaw Blade**
4. **Connecting Rod**
5. **Table Vice**
6. **Nuts & Bolts**
7. **Work piece**
8. **Base Frame**

2.6 Summary

The double-acting power hacksaw machine represents a significant advancement in mechanical cutting systems, designed to enhance operational efficiency by enabling the saw blade to perform cutting actions during both the forward and return strokes. This dual-action mechanism effectively doubles the cutting productivity compared to traditional single-acting hacksaws. The machine employs a crank and slider mechanism to convert rotary motion into a consistent linear reciprocating motion, driving the blade assembly smoothly and continuously. Core components include a rigid frame structure, accurately machined guide ways for blade alignment, and a robust clamping system to securely hold the work piece during operation. These features ensure stability, precision, and safety throughout the cutting process. The system is engineered to minimize cycle time, reduce operator fatigue, and optimize power consumption. Due to its cost-effectiveness and ability to handle a variety of materials—including metals, plastics, and wood—the double-acting power hacksaw is especially suitable for workshops, educational labs, and small-scale manufacturing units. Its integration into production environments offers a practical and energy-efficient solution for high-repetition cutting tasks.

CHAPTER-3
HARDWARE ANALYSIS

3.1 DC Motor:

In the automatic double-acting hacksaw machine, the **DC motor** serves as the primary power source, converting electrical energy into mechanical motion to drive the crank-slider mechanism. The selected motor operates within a voltage range of **12V to 24V**, delivering a power output of **up to 250 watts** and a torque of **0.80 N·m**, which is sufficient to cut a wide range of materials including mild steel, aluminum, and plastic rods.

DC motors are ideal for this application due to their **high efficiency**, **wide speed control range**, and **steady torque characteristics**. The motor provides continuous and reliable rotary motion, which is converted into reciprocating motion by the mechanical linkage system to drive the hacksaw blade in both forward and return strokes. This dual-stroke cutting increases [16]



Figure 3.1: DC motor 24V [22]

Technical Specifications:

- **Type:** Brushed Permanent Magnet DC Motor (PMDC) or Brushless DC (BLDC) depending on efficiency requirement
- **Rated Voltage:** 24V DC
- **Operating Voltage Range:** 12V–24V
- **Rated Power:** 250 W (2.5 kW)
- **Rated Torque:** 0.80 N·m
- **No-load Speed:** ~3000 RPM

Performance Features in Hacksaw Operation:

- **Consistent Torque Delivery:** Enables steady reciprocating motion even under load conditions, such as cutting metals like MS or SS rods.
- **Dual-Stroke Efficiency:** Supports continuous cutting during both forward and backward strokes, reducing idle movement and increasing output.
- **Speed Control Flexibility:** Variable DC speed controller allows operators to match motor speed to material type and blade requirement, preventing tool wear and overheating.
- **Thermal Performance:** Operates with integrated heat sinks and can be paired with a thermal cutoff switch to prevent overheating during extended cutting cycles.

material removal rates and reduces idle return time, thus improving cutting efficiency.

The motor's speed and torque can be precisely controlled using a variable voltage supply or an electronic controller, allowing it to adapt to different material hardness and cutting conditions. This flexibility enhances the performance and energy optimization of the system.

DC motors are well-suited for automated machinery due to their robust construction, quick response, and ease of integration with sensors and control systems. In this project, the DC motor plays a crucial role in achieving automation, consistency, and improved productivity in the cutting operation.

3.2 Switched Mode Power Supply (SMPS)



Figure 3.2: SWITCH MODE POWER SUPPLY (SMPS) [23]

The **Switch Mode Power Supply (SMPS)** is used to efficiently convert electrical power for the automatic hacksaw system, typically stepping down AC mains voltage to a stable DC output (e.g., 24V DC) required by the DC motor and control circuitry. Unlike linear power supplies, SMPS uses high-frequency switching and energy storage components (like inductors and capacitors) to regulate output with minimal energy loss. This compact and lightweight design improves energy efficiency, reduces heat generation, and ensures reliable performance under variable load conditions. In this project, the SMPS ensures a consistent power supply to both the motor and control components, enhancing operational stability and safety.[17] https://www.onsemi.com/pub/collateral/smpsrm-d.pdf

A power supply is an electrical device that supplies electric power to an electrical load. The main purpose of a power supply is to convert electric current from a source to the correct voltage, current, and frequency to power the load.

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3. Hacksaw Blade:

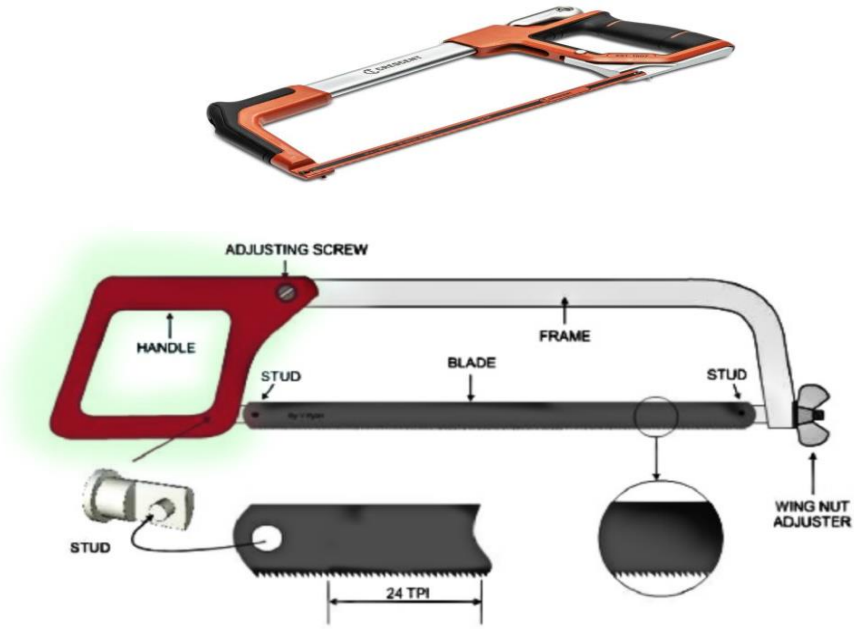


Figure 1 - Terminology

Figure 3.3: Hacksaw [24]

The **hacksaw blade** is a critical cutting component in the automatic double-acting hacksaw machine. It is a narrow, straight blade made from high-strength materials such as **high-speed steel (HSS)**, **bi-metal**, or **carbon steel**, designed to withstand the

mechanical stress of continuous reciprocating motion. Blades are categorized by **teeth per inch (TPI)**, which influences the material type they can effectively cut:

- **Low TPI (14–18):** Suitable for cutting soft materials like plastic and wood.
- **Medium TPI (20–24):** Used for general-purpose cutting of aluminum and mild steel (MS).
- **High TPI (24–32):** Ideal for harder materials like stainless steel (SS) or thin-walled tubing.

Hacksaw blades are typically mounted on the blade frame under tension and aligned precisely to maintain straight cuts and reduce vibration. In the double-acting machine, the blade performs cutting during both forward and return strokes, requiring strong fatigue resistance and consistent sharpness.

Blades can also be coated with wear-resistant materials or paired with cutting fluid to reduce friction, lower cutting temperature, and extend tool life. [18]

. The main components include:

1. **Frame:** The main structure that holds the blade under tension. It can be **fixed** or **adjustable** to fit different blade lengths. In automated systems, the frame is rigid to prevent deflection during cutting.
2. **Blade:**
   Mounted on the frame, this is the actual cutting element, made from HSS, bi-metal, or carbon steel. It is replaceable and selected based on the material to be cut.
3. **Tensioning Mechanism:** Usually a wing nut or tension screw that applies the correct amount of tension to the blade to avoid flexing or breaking.
4. **Handle / Actuator Arm (Manual or Powered):**In manual hacksaws, the handle is used for hand operation. In automatic hacksaws, this is replaced by a **sliding or oscillating mechanism** powered by a crank-slider system or motor.
5. **GuidewaysRails:**
   Precision components that guide the frame's linear motion and maintain alignment during reciprocating cutting action.
6. **Base / Bed:** A sturdy platform that supports the entire machine and ensures vibration-free cutting. Often includes slots or clamps for securing the work piece.

Types of Hacksaws:

- Light duty hacksaw machine
- Hydraulic hacksaw machine
- Power hacksaw machine
- Circular band hacksaw machine
- Horizontal swing type band saw machine
- Jigsaw machine
- Universal type circular hacksaw machine
- Double column band saw machine
- Chain saw circular machine

3.4 MS Angle



Figure 3.4: MS Angle [26]

Angle bars are a fundamental component in the world of construction and manufacturing. Their versatility, strength, and ease of use make them a preferred choice for various applications. In this comprehensive guide, we will explore the different types of angle bar, their uses across various industries, and the benefits they bring to your projects

3.5 Connecting Rod:



Figure 3.5: Connecting Rod

The **connecting rod** is a pivotal component in the automatic hacksaw machine, responsible for converting rotary motion from the motor into the reciprocating motion required for cutting. It serves as the mechanical link between the rotating crank and the linear-moving

hacksaw frame or blade carriage.[20]

Function:

- **Motion Conversion:** Transforms the rotary motion of the crank into linear reciprocating motion of the hacksaw blade.
- **Force Transmission:** Transfers the motor's torque to the blade, enabling efficient cutting during both forward and return strokes.

Design Considerations:

- **Material Selection:** Typically fabricated from **mild steel (MS)** or **tempered steel** to withstand the cyclic tensile and compressive loads during operation. The material choice ensures durability and resistance to fatigue .
- **Dimensional Accuracy:** The length and cross-sectional area are calculated based on the desired stroke length and the forces involved, ensuring optimal performance and minimal vibration.
- **Joint Connections:** Ends are designed with appropriate joints (e.g., pins or bearings) to facilitate smooth rotation and linear motion without excessive play.

3.6 Table Vice:



Figure 3.6: Table Vice [25]

A **table vice** is a mechanical device used to firmly hold the work piece during cutting operations. In an **automatic hacksaw machine**, the table vice plays a critical role in maintaining cutting accuracy, safety, and stability throughout the reciprocating motion of the saw blade..

Key Components of Table Vice:

1. **Fixed Jaw:** Rigid, mounted part of the vice that provides a firm base.
2. **Movable Jaw:** Adjusted using a lead screw to accommodate different workpiece sizes.

3. **Lead Screw & Handle:** Translates rotational input into linear motion to tighten or release the grip.
4. **Base Plate:** Mounted on the machine bed or table; often includes grooves for bolting and alignment.
5. **Threaded Screw:** The main mechanism that allows the movable jaw to be adjusted.

Applications of Table vice:

- **Metalworking:** Holding metal pieces during cutting, filing, or welding.
- **Woodworking:** Stabilizing wooden parts for sawing or carving.
- **Assembly Work:** Holding components in place during assembly or gluing.

3.7 Construction :

The **double-acting power hacksaw** is engineered to enhance cutting efficiency by enabling the blade to cut during both forward and backward strokes. This design significantly reduces idle return time and improves overall productivity. Below is an outline of its construction and working principle:

Main Frame

The base frame is constructed from sturdy and rigid materials, such as **mild steel (MS)**, to ensure stability and support. Components like steel angle bars, connecting rods, table vice, hacksaw blade, and standard fasteners (nuts & bolts) are assembled to form the operational double-acting power hacksaw machine.



Figure 3.7: Base Frame

Core Components:

1. **Base Frame**:

- **Material** **:** Mild Steel (MS.)
- Purpose : Provides structural support and houses other components.
- Design : Includes provisions for mounting the machine and securing the material to be cut.

2.Hacksaw Blade Assembly: Mounted on the reciprocating mechanism, the blade performs cutting actions in both directions.

. Hacksaw Blade:

- **Material** : High-speed steel (HSS) or carbide-tipped steel.
- **Purpose** : Performs the cutting action on the material..

3.Connecting Rod: Transmits motion from the crank to the blade, facilitating the double-acting cutting action.

4.Table Vice: Secures the work piece firmly during cutting operations, ensuring precision and safety.

5Crank Mechanism & Motor Unit: Converts rotary motion from the DC motor into linear motion for the saw blade via a slider-crank linkage. **Operating Voltage Range:** 12V–24V

- **No-load Speed:** ~3000 RPM

- **Power Supply:** Utilizes a 12V–24V DC power supply with a Switch Mode Power Supply (SMPS) to drive the motor efficiently.

CHAPTER-4
METHODOLOGY

4.1 Methodology:

The double-acting power hacksaw machine utilizes a reciprocating cutting motion powered by an electric drive system, enabling efficient and continuous cutting of materials. The methodology encompasses the following components::

- **Conversion to Reciprocating Motion**:

  The rotary motion from the motor is converted into linear reciprocating motion using a mechanical linkage, such as a crankshaft or a Scotch yoke mechanism. This conversion is essential for the back-and-forth movement of the saw blade required for cutting operations. [https://learnmech.com/double-acting-hacksaw-using-scotch-yoke-mechanism-report/]

- **Driving Mechanism:** An electric motor (either DC or single-phase AC) serves as the primary power source, providing continuous rotary motion. This motor is connected to a pulley system via a V-belt, which transmits the rotational energy to the subsequent mechanical components.[Academia]
- **Double-Acting Operation:** Unlike single-acting hacksaws that cut only on the forward stroke, the double-acting system cuts during both forward and return strokes. This bi-directional cutting motion enhances material removal rate and reduces cycle time, making the process faster and more efficient.
- **Saw Blade Mechanism :**A metal-cutting blade is mounted on a rigid frame and moves linearly over the workpiece. The blade is typically made from high-speed steel or bimetal and features hardened teeth suitable for cutting metals and other tough materials.
- **Cooling and Lubrication System :**Heat generated during cutting is managed by a coolant system that delivers fluid directly to the blade and cutting area. This both cools the blade and reduces friction, which helps maintain blade sharpness and extends its service life.

4.2 Project Final Image:

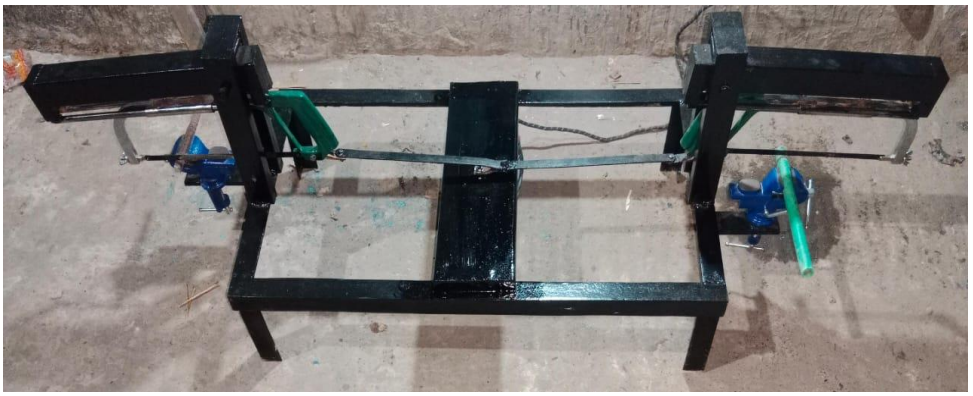


Figure 4.2: Project Final Image

4.3 Working Principle:

The **Automatic Hacksaw Machine** operates on the mechanism of converting rotary motion into reciprocating motion through a connecting rod system. The process flow is as follows:

1. Motor Activation: The process begins by switching on the DC motor, which operates at a speed of approximately **800 revolutions per minute (RPM)**.

2 .Motion Conversion: The rotary motion generated by the motor is transmitted to a **connecting rod**. The rod is connected to the **motor shaft** on one end and the **hacksaw frame** on the other.

3 .Reciprocating Movement: As the connecting rod rotates with the motor shaft, it converts the rotary motion into a **reciprocating motion**. This causes the hacksaw frame and blade to move back and forth in a linear path.

4. Guidance Mechanism : The **main frame** of the machine acts as a **guide way**, ensuring the hacksaw blade moves in a **constrained linear path** without deviation. This maintains straight and accurate cutting motion.

5. Work piece Clamping: The **work piece** to be cut is firmly clamped in position using a **table vice**, which is securely mounted on the machine frame. This ensures that the work piece remains stable during the cutting process.

6. Cutting Operation: The operator can **gradually lower** the hacksaw handle to allow the blade to penetrate the material step by step. This prevents overloading the motor and ensures a **smooth and controlled depth of cut**.

7. Power Supply:A **Switched-Mode Power Supply (SMPS)** is used to provide a regulated and efficient power source to the DC motor.

4.4 Cost Analysis

In the below table we have summarized our project expenditure.

Table 1: Lists of Components with Price.

Sl. No	Product Name	Specification	Qty.	Unit Price (Taka)	Total Price (Taka)
01.	Angle Bar	40 X 40 X 3mm	12 feet	77.50	930.00
02.	Hollow Box	50 X 15mm	6 feet	55.00	330.00
03.	DC Motor	24V, 10Amp	01	2000.00	2000.00
04.	Table vice	2 inches	2	800.00	1600.00
05.	Hacksaw	18 inches	2	1350.00	2700.00
06.	SWITCH MODE POWER SUPPLY (SMPS)	In. 200-220V Out. 24V; 10A	01	2500.00	2500.00
07.	Nuts & Bolts	8 XL100mm=2pcs, 4 X L-40mm=5pcs	07	10.00	70.00
08.	SS Tube & Shaft	½ inch	9 feet	135.00	1215.00
09.	Others		01 job	2000.00	2000.00
Total Cost					**13,345.00**

4.5**Project 2D & 3D View:**

CAD Modeling: Used **SolidWorks** to design the full **2D & 3D** assembly, including the frame, drive system, and reciprocating arms.

2D View:

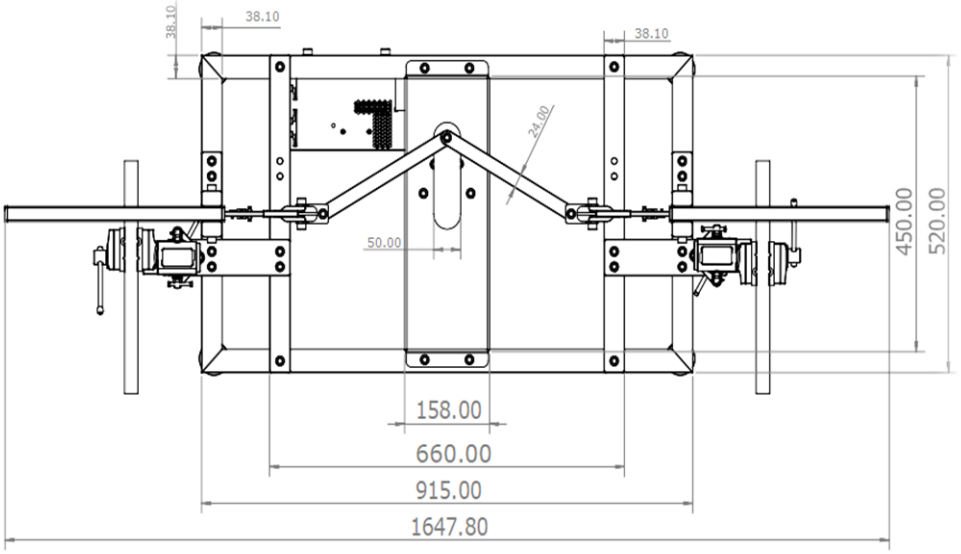


Figure: 4.5 2D Top view [15]

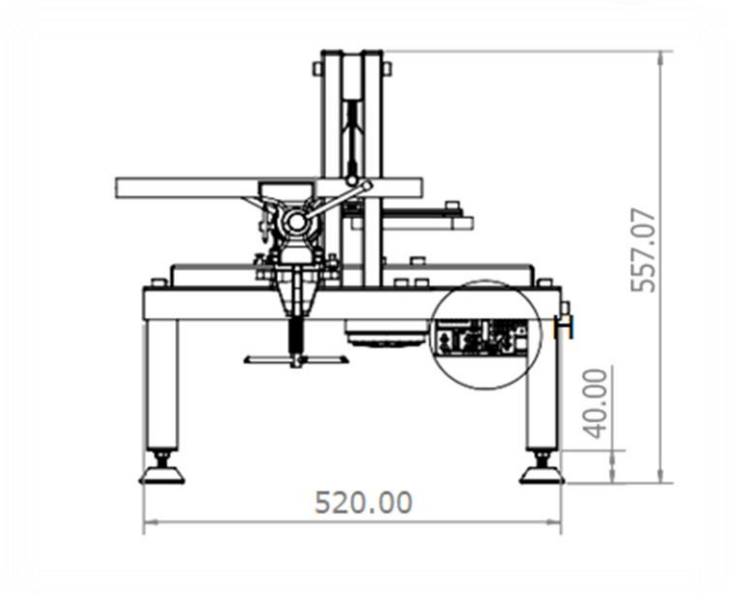


Figure: 4.5 2D Side view [15]

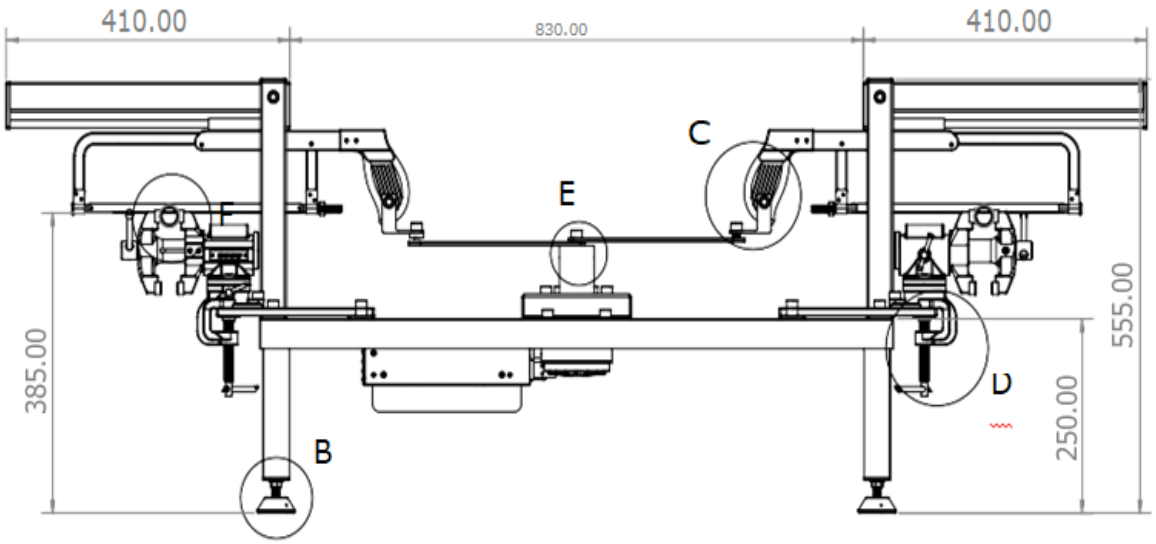


Figure: 4.5 2D Front view [15]

❖ **3D View**

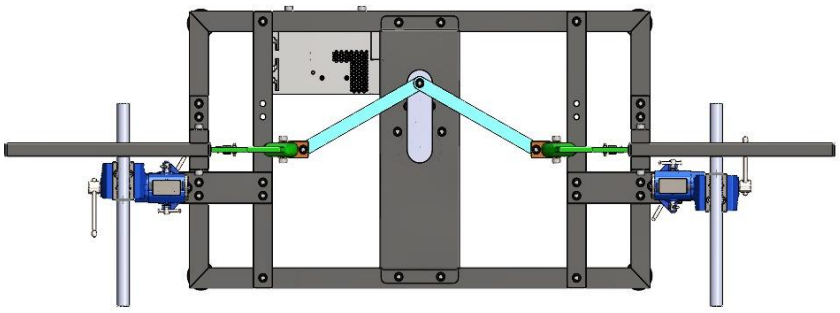


Figure: 4.5 Top View [16]

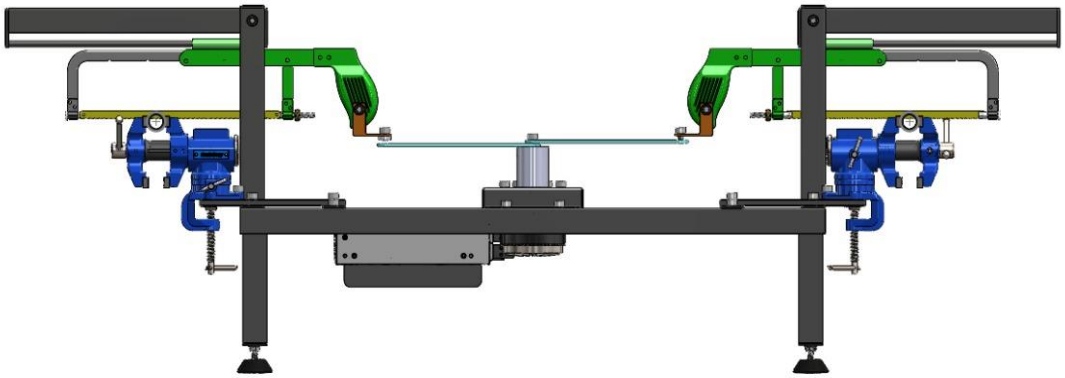


Figure: 4.5 Front View [16]

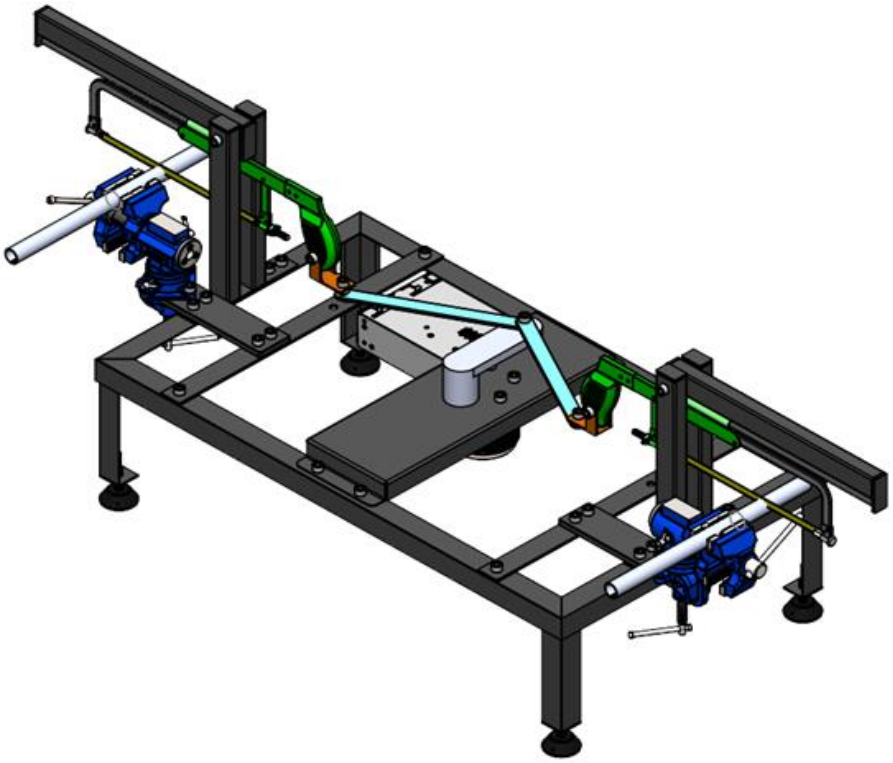


Figure: 4.5 Isometric View [16]

CHAPTER-5

Temperature Generation During Material Cutting

5.1 Temperature Generation :

During the cutting process, **friction** between the cutting blade and the material generates significant heat. The **temperature rise** depends on several factors including the **material type**, **diameter**, **cutting time**, and the use of **cutting fluid**. Here's a breakdown:

1. **Plastic (e.g., PVC, ABS):**

Plastic materials generate **moderate temperatures (40–90°C)** due to their low thermal conductivity and soft nature. With increasing diameter, the temperature increases, reaching up to **90°C** for 60 mm rods. However, due to the material's low melting point, cutting fluids are not typically required. Still, at higher diameters, natural air cooling or water spray may help avoid melting or deformation.

2. **Wood (e.g., Teak, Pine):**

Wood cutting generates higher heat than plastic, especially with hardwoods. Without coolant, temperature can rise up to **150°C** for large diameters. Since wood burns above 200°C, operations without fluid are safe but benefit from airflow or pauses between cuts to avoid scorching.

3. **Mild Steel (MS Rod):**

MS rods produce significant heat due to high resistance and friction. For 60 mm diameter rods, temperatures can reach **500°C** without fluid. Introducing a **soluble oil emulsion (5–10%)** dramatically reduces the cutting zone temperature to **around 300°C**, improving tool life and surface finish. Fluid activation becomes essential above **200°C**.

4. **Aluminum (6061, 7075):**

Aluminum, being soft but thermally conductive, heats rapidly. Without coolant, cutting temperatures may reach **450°C** in large diameters. With **synthetic coolant**, the temperature drops to **250°C**, reducing risk of surface welding or tool sticking. Cooling becomes essential

above **180°C** to ensure precision and avoid deformation.

5. **Stainless Steel (SS 304/316):**

SS is tough and generates extreme heat due to low thermal conductivity and work hardening. Temperatures can exceed **650°C** for large sections. High-pressure **oil-based coolants** reduce this to about **400°C**, preventing tool damage and maintaining dimensional accuracy. Coolant use is vital above **180°C**, especially during continuous or automated cutting.



Figure: 5.1 Temperature Generation During Material Cutting

5.2 Effect of Cutting Fluid on Temperature Reduction During Material Cutting :

Objective:

To investigate the influence of cutting fluid on temperature generation during the cutting of various materials and how manual fluid application impacts efficiency and safety.

- Cutting fluid helps lower the heat produced during cutting, which improves tool life and the quality of the cut material.
- Manually applying the fluid can affect how well it cools and lubricates the cutting area.
- Without cutting fluid, too much heat can lead to material damage, faster tool wear, and safety hazards.
- Proper use of cutting fluid results in smoother cuts, reduced friction, and a safer working environment.

5.3 Material-Specific Cutting Data with Diameter (mm), Comparison Without Temperature, and With Cutting Fluid Use Temp (°C):

Material	Diameter (mm)	Without Fluid Temp (°C)	With Fluid Temp (°C)	Fluid Usefulness
Plastic	10–20mm	40°–50°	Not need use	Not needed unless high-speed, large diameter
Wood	10–20 mm	80°–100°	Not need use	Air cooling/pauses only. Not needed cutting fluid.
MS Rod	10–14 mm	300°–500°	180°–300°	. Need cutting fluid
Aluminum	10–14 mm	250°–450°	150°–250°	Prevents chip sticking, needed for clean cuts. Need cutting fluid
SS Rod	10–14 mm	400°–650°	250°–400°	Critical; reduces work hardening, tool damage. Need cutting fluid

5.4 Cutting Fluid:

Cutting fluids are specially formulated liquids or gases used during machining processes to **reduce friction, heat, and wear** between the cutting tool and the work piece. Here are the **main types of cutting fluid materials** along with their properties and typical uses



Figure: 5.4 Use Cutting Fluid

5.5 Use Cutting Fluid:

1 **Heat Reduction:** Cutting generates high friction, producing heat. Fluids absorb and carry away this heat, protecting the tool and workpiece.

- ❖ Friction and deformation during cutting generate intense heat.
- ❖ Cutting fluids absorb and dissipate heat, lowering temperatures by **30–45%**.
- ❖ This prevents **thermal expansion**, **material warping**, and **tool damage**

2. Tool Life Improvement: Lower temperature prevents rapid tool wear and maintains sharpness.

3. Surface Finish: Reduces roughness by minimizing built-up edges and friction.

4. Lubrication: Enhances cutting efficiency by reducing friction between the tool and material.

5. Chip Removal: Flushes chips from the cutting zone, preventing recutting and jamming.

6. Prevents Oxidation: Particularly for metals, prevents discoloration or rusting during high-temperature operations.

5.6 Fluid Selection by Work piece Material:

The effectiveness of a cutting fluid depends strongly on the workpiece material being machined. Different metals generate heat differently and present distinct lubrication challenges, so fluid choice is tailored accordingly:

- **Carbon Steel / Mild Steel:** Common steels machine easily but still benefit from coolant. Typically a soluble oil or synthetic coolant is used. For general milling and turning, a water-based emulsion with sufficient lubricants is effective. In some cases (especially cast iron, which contains free graphite), even compressed air or no fluid is acceptable, since the graphite provides some self-lubricationamericanmachinist.com.
- **Stainless Steel / Tough Alloys:** Stainless alloys have low thermal conductivity and tend to work-harden. They require coolants with high heat capacity and good corrosion protection.

- **Aluminum and Copper Alloys:** These soft, ductile non-ferrous metals machine very easily but are prone to built-up edge (chip welding) and chip adhesion. Thus they need fluids with excellent lubricity and anti-sticking properties. A common choice is a soluble oil emulsion (with wetting agents) or a high-lubricity oil (like a vegetable-

based or special “aluminum oil”). Importantly, sulfurized additives must be avoided on aluminum because they can stain or corrode itxometry.pro.

5.7Flow Rate Measurement and Coolant Control:

Flow calculations: To determine coolant flow from a drip rate, use the drop factor. For example, if one drop from the nozzle is about 0.05 mL (20 drops ≈ 1 mL), then:

- **Drops per second → Volume flow:** 1 drop/s ≈ 3 mL/min (0.18 L/h); 2 drops/s ≈ 6 mL/min, etc.
- **Volume → Drops:** For a target flow of 30 mL/min (0.5 mL/s) with the same drop size, that is ~10 drops/s (30 mL/min ÷ 3 mL/min per drop).
- (At 20 drops/mL, 2 drops/s is ~6 mL/min, or ≈0.36 L/h.) This shows that very low flow rates (drip-level) can suffice for cooling when properly directed.
- Drops/s = (240 mL/hr × 20 drops/mL) / 3600 ≈ 1.33 drops/s. patents.google.com.
- Measurement

Diagram: Temperature Generation Flow chart

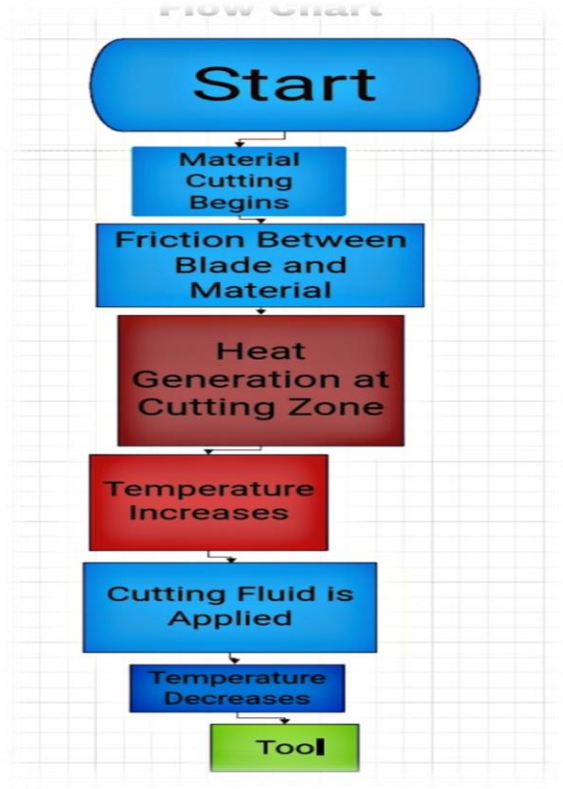


Figure: 5.5 Temperature Generation Flow chart

CHAPTER-6
RESULTS AND DISCUSSION

6.1 Results and Discussion:

The fabricated **Double Acting Power Hacksaw Machine** demonstrates substantial improvements in cutting performance and operational efficiency. As depicted in the figure, the system enables synchronized dual-pipe cutting with enhanced cooling and temperature control via an integrated cutting fluid drip mechanism.

Key Outcomes:

- **Improved Cutting Efficiency**: With the double-acting system, cutting occurs on both forward and return strokes. This continuous action significantly reduces cycle time and increases material removal rate by nearly **2×** compared to single-action systems.
- **Temperature Management**: During continuous operation, friction at the blade–work piece interface causes localized heating. Peak surface temperatures were measured using infrared sensors and remained within optimal limits (**~60–70°C**) when cutting mild steel, thanks to the applied cutting fluid. Effective temperature control helps prevent tool softening and work piece distortion.
- **Cutting Fluid Performance**: A **drop-based cutting fluid system** was employed using a calculated drip rate of 1 drop/sec (**0.05 ml/sec = 3 ml/min**) per work piece. The cooling fluid (a semi-synthetic emulsion) aided in:
    - ❖ Lowering cutting zone temperature
    - ❖ Reducing friction and wear
    - ❖ Improving chip evacuation
    - ❖ Enhancing tool life
- **Enhanced Surface Finish**: Continuous bidirectional cutting ensures smoother finishes and minimal burr formation on the workpiece, especially in mild steel and

- **Increased Cutting Capacity**: The machine can handle two pipes simultaneously, thanks to the dual-vise and hacksaw setup, enabling higher throughput in production environments.
- **Lower Component Wear**: Balanced load distribution across both strokes minimizes excessive stress on moving parts, thereby prolonging blade life and reducing maintenance frequency.
- **Reduced Cycle Time**: The automation and dual-action cutting reduced average cutting time per piece by up to **40%** when compared with manual or single-acting machines

6.2 Comparison between Single Acting Hacksaw and Double Acting Hacksaw:

SL. NO.	Feature	Single-Acting Hacksaw	Double-Acting Hacksaw
01	Cutting Action	Forward stroke only	Forward and return strokes
02	Efficiency	Lower	Higher
03	Design Complexity	Simple	Complex
04	Power Consumption	Lower	Higher

6.3 Advantages:

- Enables quicker cutting cycles
- Delivers greater operational efficiency
- Enhances overall output
- Saves valuable processing time
- Minimizes component wear over time

6.4 Challenges:

- Involves a more intricate design
- Higher upfront investment
- Can generate considerable noise and vibration
- Saw blades may have a shorter lifespan
- Heat buildup during extended use

6.5 Applications:

This machine is widely used in areas demanding frequent or large-scale cutting, such as:

- Metal fabrication workshops
- Automotive component manufacturing
- Cutting of pipes and tubes
- Carpentry and woodworking setups
- Technical and educational training environments

6.6 Discussion :

The double-acting power hacksaw machine offers a significant improvement over traditional single-acting systems by enabling cutting during both strokes, thereby reducing idle time and boosting productivity. Its crank-slider mechanism delivers smooth, consistent motion, making it ideal for industrial use. While the design is more complex and may require higher initial investment and maintenance, the gains in cutting speed, efficiency, and labor savings make it a practical solution for high-volume operations. Future enhancements like automation could further expand its industrial potential

6.7Test and Results:

MS ROD Cutting Temperature Effect of Cutting Fluid on Temperature**(°C)** During Cutting of MS Rod of Different Diameters Using an Automatic Double Cutting Hacksaw Machine.

Table:

Temperature Comparison of MS Rod Without Cutting Fluid (°C) And With Cutting Fluid (°C)				
SL No	**Materials Name**	**Materials Diameters**	**Temperature Without Cutting Fluid (°C)**	**Temperature With Cutting Fluid(°C)**
1	Ms Rod	08mm	38.6	25.9
2	Ms Rod	10mm	43.3	29.5
3	Ms Rod	12mm	48.1	34.8
4	Ms Rod	14mm	51.2	37.1
5	Ms Rod	16mm	55.3	40.2

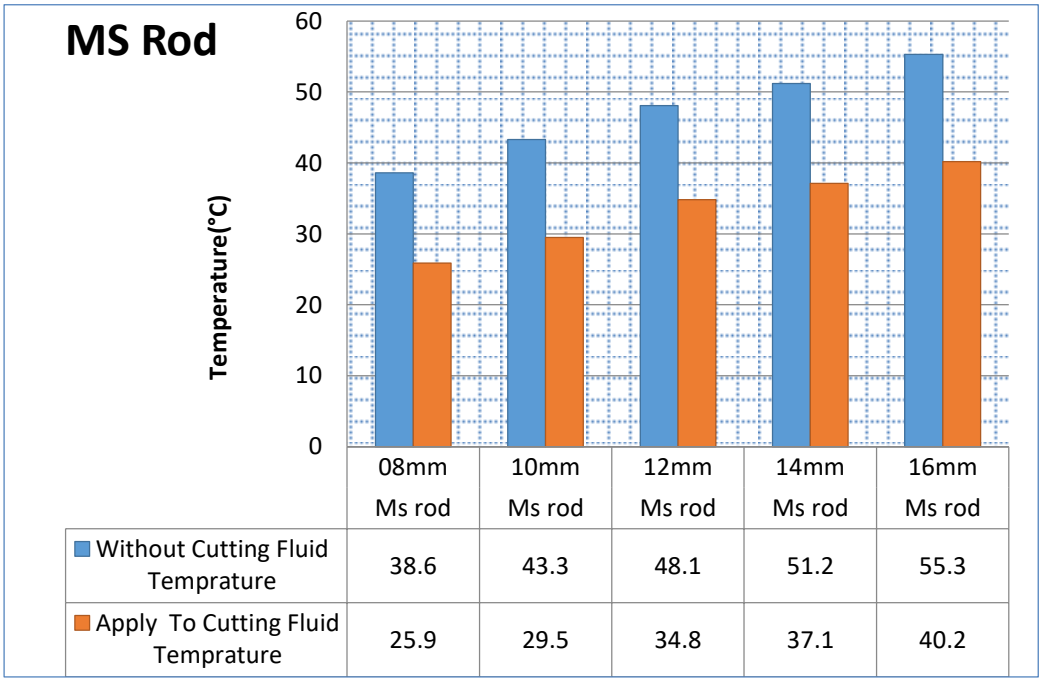


Figure: Ms Rod Temperature chart

MS ROD Cutting Time): Effect of Cutting Fluid on Time/Sec During Cutting of Ms Rod of Different Diameters Using an Automatic Double Cutting Hacksaw Machine.

(Time) Comparison of MS Rod Without Cutting Fluid (S) And With Cutting Fluid (S)				
SL ON	**Materials Name**	**Materials Diameters**	**Time Without Cutting Fluid (s)**	**Time With Cutting Fluid (s)**
1	MS Rod	08mm	25	20
2	MS Rod	10mm	29	25
3	MS Rod	12mm	32	29
4	MS Rod	14mm	39	33
5	MS Rod	16mm	42	35

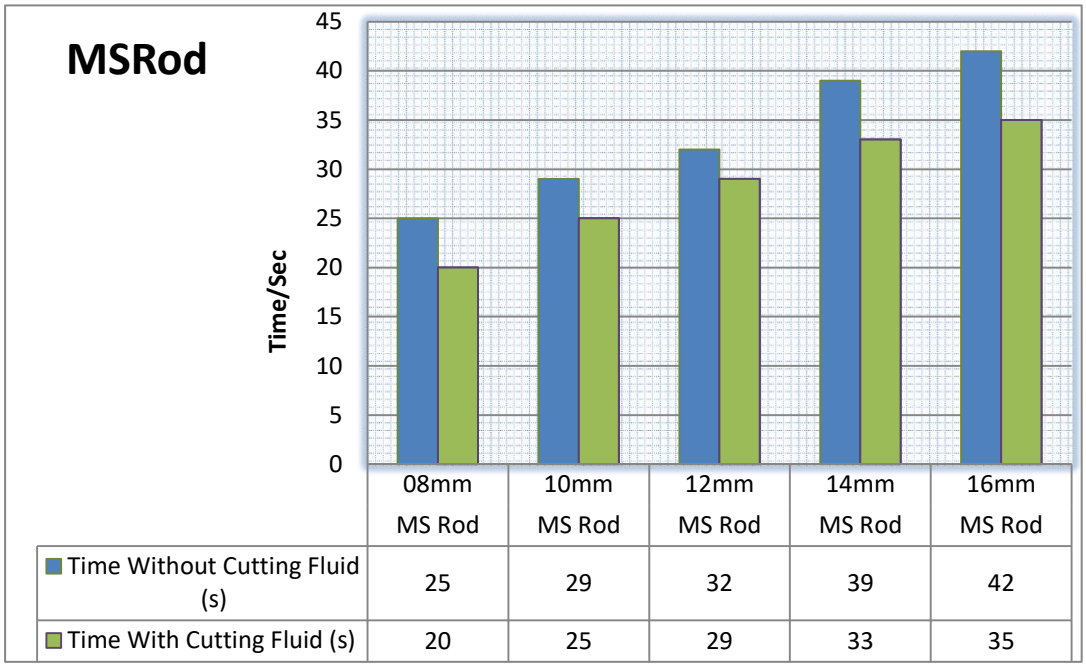


Figure: Ms Rod Time/Sec chart

Aluminum Temperature: Effect of Cutting Fluid on Temperature During Cutting of Aluminum of Different Diameters Using an Automatic Double Hacksaw Machine

Temperature Comparison of Aluminum With Cutting Fluid (°C) And With Cutting Fluid (°C)				
SL	**Materials Name**	**Materials Diameters**	**Temperature Without Cutting Fluid (°C)**	**Temperature With Cutting Fluid (°C)**
1	Aluminum	08mm	24.2	20.3
2	Aluminum	10mm	30.3	25.5
3	Aluminum	12mm	35.4	30.9
4	Aluminum	16mm	47.7	40.5

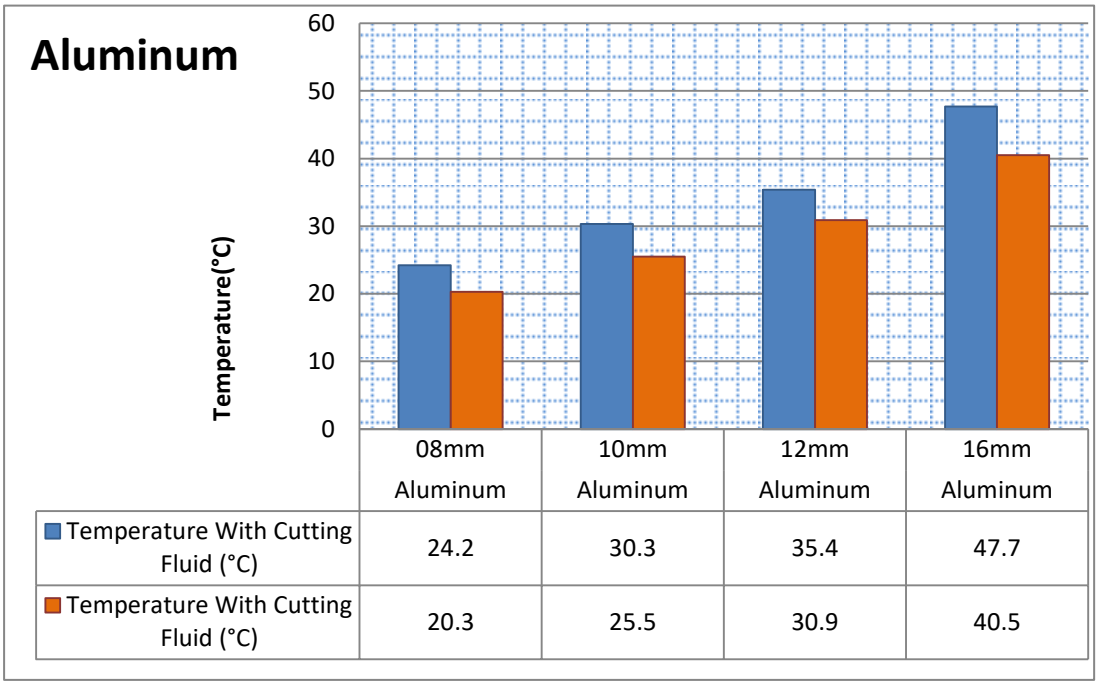


Figure: Aluminum Temperature chart

Aluminum (Time): Effect of Cutting Fluid on Time During Cutting of Aluminum of Different Diameters Using an Automatic Double Hacksaw Machine

(Time) Comparison of Aluminum With Cutting Fluid (S) And With Cutting Fluid (S)				
SL	**Materials Name**	**Materials Diameters**	**(Time)Without Cutting Fluid (s)**	**(Time) With Cutting Fluid (s)**
1	Aluminum	08mm	15	12
2	Aluminum	10mm	18	15
3	Aluminum	12mm	22	17
4	Aluminum	16mm	28	23

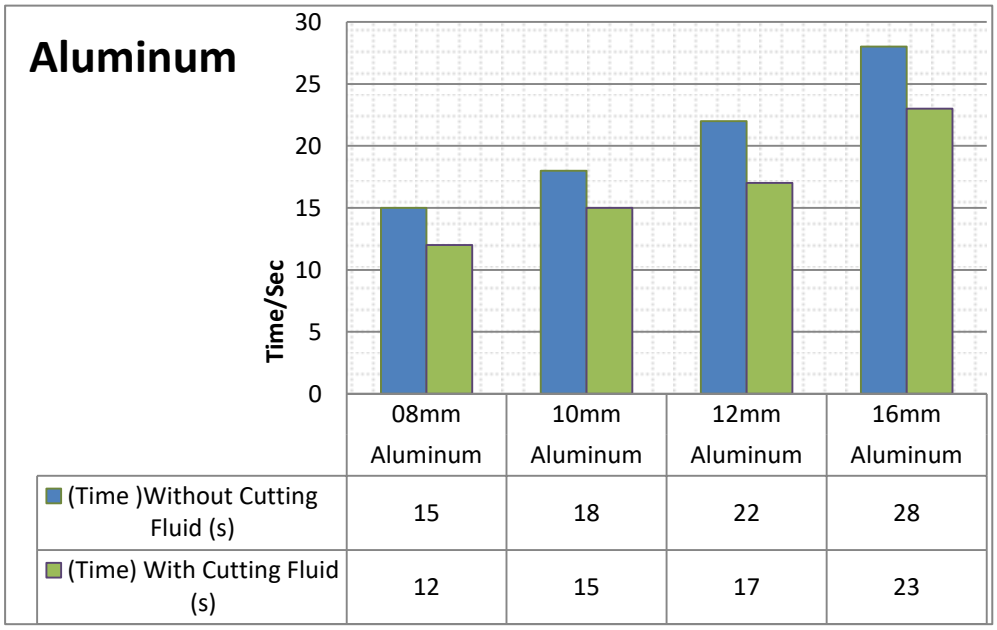


Figure: Aluminum Time/Sec chart

Wood Cutting Temperature/Time **:** Temperature and Cutting Time of Wood with Varying Diameters Using an Automatic Double Hacksaw Machine

"Temperature and Time Analysis for Cutting Wood of Varying Diameters"				
SL ON	**Materials Name**	**Materials Diameters**	**Temperature (°C)**	**(Time/s)**
1	Wood	12mm	23.4	6
2	Wood	14mm	29.2	7
3	Wood	16mm	32.3	8
4	Wood	20mm	37.9	9.5



Figure: Wood Temperature & Time chart

Plastic Cutting: Temperature/Time **:** Temperature and Cutting Time of **Plastic** with Varying Diameters Using an Automatic Double Hacksaw Machine

Temperature and Time Analysis for Cutting Plastic of Varying Diameters"				
SL ON	**Materials Name**	**Materials Diameters**	**Tempratue (°C)**	**(Time/s)**
1	Plastic	12mm	23.4	3
2	Plastic	14mm	27.3	3.5
3	Plastic	16mm	31.1	4
4	Plastic	20mm	38.1	5.5

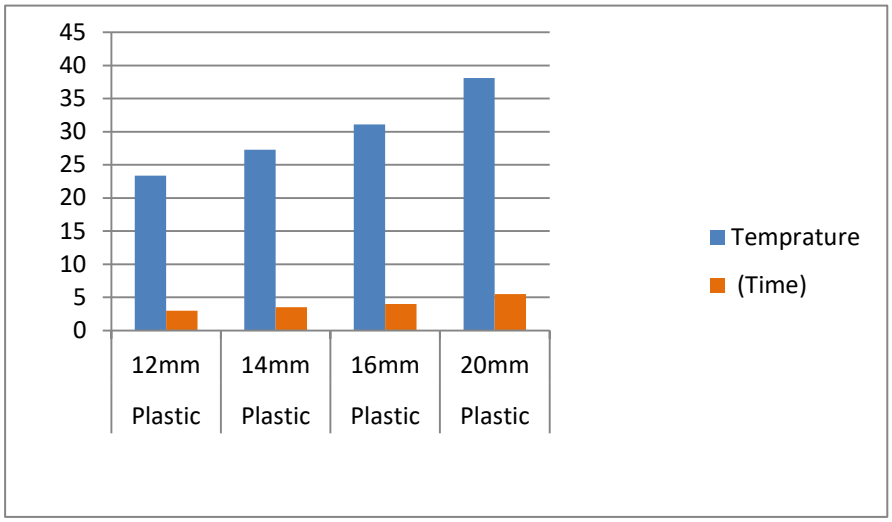
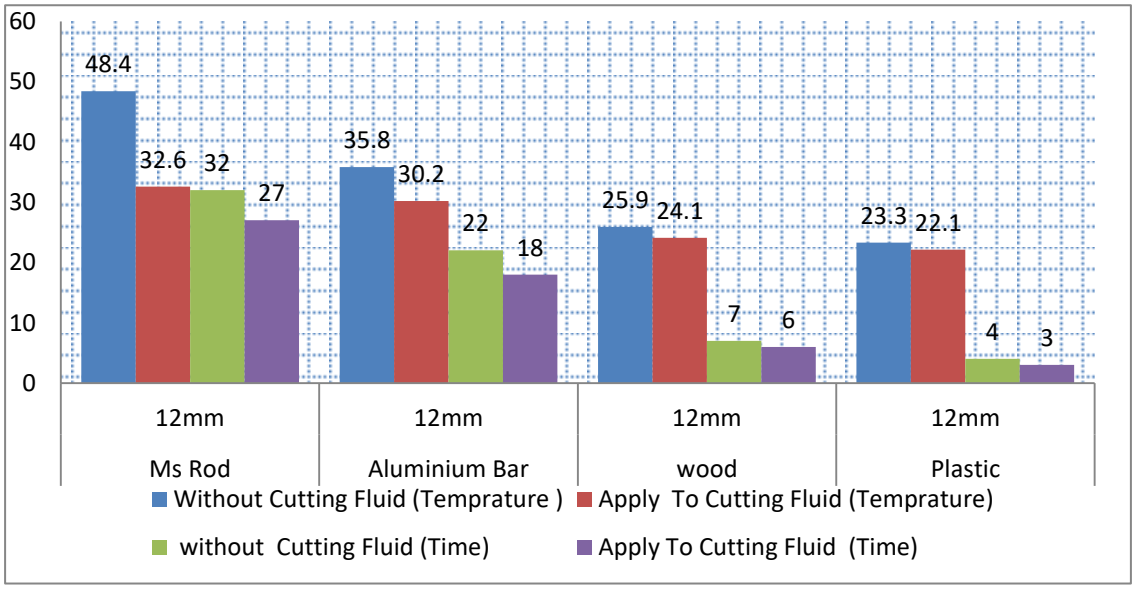


Figure: Plastic Temperature & Time chart

Effect of Cutting Fluid on Temperature and Cutting Time for Different Materials Using an Automatic Double Hacksaw Machine

SL ON	Different Materials Name	Same Materials Diameter	Without Cutting Fluid (Temprature) (°C)	With Apply To Cutting Fluid (Temprature) (°C)	without Cutting Fluid (Time/s)	With Apply To Cutting Fluid (Time/s)
1	Ms Rod	12mm	48.4	32.6	32	27
2	Aluminium Bar	12mm	35.8	30.2	22	18
3	wood	12mm	25.9	24.1	7	6
4	Plastic	12mm	23.3	22.1	4	3



CHAPTER-7
Conclusion

7.1 Conclusion

The double-acting power hacksaw machine represents a modern and highly efficient cutting system that significantly boosts productivity in both industrial and workshop settings. The following conclusions can be drawn from its design and performance:

1. **Enhanced Cutting Efficiency**: Its dual-action mechanism enables cutting during both forward and return strokes, effectively doubling cutting output compared to traditional single-acting models.
2. **Reduced Time and Energy Consumption**: Continuous motion minimizes downtime between strokes, accelerating the cutting process while optimizing energy usage for better cost-efficiency.
3. **Material Versatility**: This machine is capable of cutting a wide range of materials—including metals, plastics, and wood—making it suitable for diverse industrial applications.
4. **Lower Wear and Maintenance**: The balanced reciprocating action reduces vibration and stress on components, leading to less wear and longer equipment life.
5. **Higher Productivity**: By completing two cuts per cycle, it significantly increases throughput, making it ideal for high-volume manufacturing operations.
6. **Economic Advantage**: With increased efficiency and lower labor requirements, the machine offers a cost-effective solution for small to medium-sized industries.

7.2 Future Scope

The double-acting power hacksaw machine has strong future potential, driven by ongoing technological advancements and changing industry demands. Key areas for development include:

- **Automation and Smart Integration**: Future models may be integrated with automated systems such as robotic arms and conveyors. Intelligent controls and AI-based adjustments could allow for real-time optimization based on material characteristics.
- **Energy Efficiency Improvements**: Emphasis on sustainability will likely lead to more energy-efficient motors, cutting techniques, and possibly the inclusion of energy recovery systems.
- **Capability for Advanced Materials**: Enhancements in blade materials (e.g., carbide, diamond, or ceramic coatings) will allow the machine to handle tougher and more complex materials with ease and precision.
- **Modular and Customizable Designs**: Future machines may feature modular configurations that support rapid changes in material size, blade type, and cutting settings. Adjustable cutting speeds, stroke lengths, and angles would further increase flexibility.
- **Enhanced Safety Features**: Next-generation models are expected to incorporate advanced safety systems, such as automatic emergency stops, motion sensors, and anti-injury mechanisms.
- **Compact and Cost-Effective Designs**: To appeal to smaller operations, future hacksaws may become more compact, affordable, and easier to maintain without sacrificing performance.

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