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Integrated Design and Performance Evaluation of an Automatic Dual-Action Hacksaw Machine with Speed Control and Recirculating Automated Cutting Fluid Delivery System.

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DEPARTMENT OF MECHANICAL ENGINEERING SONARGAON UNIVERSITY (SU)

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STUDENT DECLARATION

This is to certify that the thesis entitled '**Integrated Design and Performance Evaluation of an Automatic Dual-Action Hacksaw Machine with Speed Control and Recirculating Automated Cutting Fluid Delivery System**.' 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 Background

Hacksaws are one of the most commonly used tools for cutting metals and other materials in workshops and manufacturing environments. Traditionally, hacksaw blades operate in a single direction — typically the forward stroke — where the blade performs the cutting action, while the return stroke is simply a reset movement that does not contribute to material removal. This single-acting mechanism leads to underutilization of the blade's potential and increases the overall time required for cutting operations.

Additionally, during metal cutting, heat generation at the blade-work piece interface can cause rapid blade wear and poor surface finish. To mitigate these issues, cutting fluids are applied to provide lubrication and cooling. However, in most manual or conventional setups, the application of cutting fluids is often inconsistent, relying on operator intervention, which can result in uneven lubrication, increased friction, and thermal damage to the blade and work piece.

1.2 Motivation

Improving the efficiency and effectiveness of the hacksaw cutting process can significantly enhance productivity and reduce operational costs. By integrating a dual acting hacksaw blade mechanism that cuts during both the forward and return strokes, the cutting process becomes more continuous, effectively doubling the cutting action per cycle. This innovation reduces the time taken for each cut and increases overall throughput.

Furthermore, the inclusion of an automatic cutting fluid delivery system ensures consistent and precise application of lubricant and coolant directly to the cutting zone. This system not only protects the blade from excessive wear and overheating but also improves the quality of the finished surface by reducing friction and preventing material buildup.

1.3 Problem Statement

Despite the widespread use of hacksaws, traditional designs suffer from inefficiency due to the single-acting cutting mechanism and the lack of automated lubrication. These limitations result in longer cutting times, higher blade replacement frequency, and inconsistent product quality. There is a need for an integrated system that enhances cutting action and automates fluid delivery to address these challenges effectively.

1.4 Objectives

The primary objectives of this project are:

- To design and develop a dual acting hacksaw blade system capable of cutting on both forward and return strokes.
- To integrate an automatic cutting fluid system that delivers cutting fluid accurately and consistently during the cutting process.
- To evaluate the performance of the integrated system in terms of cutting speed, blade wear, and surface finish.
- To demonstrate the advantages of the proposed system over conventional hacksaw setups through experimental testing.

1.5 Scope of Work

This thesis focuses on the mechanical design and fabrication of a dual acting hacksaw blade assembly and the development of an automatic cutting fluid system. The project includes prototype construction, integration of fluid delivery components, and performance evaluation under controlled experimental conditions. The study is limited to metal cutting applications in a workshop environment and emphasizes optimization of cutting efficiency and tool life.

Chapter 2: Literature Review

2.1 Overview of Hacksaw Machines

Hacksaws are fundamental tools in metalworking and fabrication, primarily used for cutting metals, plastics, and wood. They consist of a C-shaped frame with a tensioned blade, typically ranging from 6 to 12 inches in length, designed to cut through various materials. While manual hacksaws are common, power hacksaws, which are powered either by an electric motor or connected to a stationary engine, have been developed to increase cutting efficiency. These machines often feature mechanisms to lift the saw blade on the return stroke and may include coolant pumps to prevent overheating.

Power hacksaws are particularly effective for cutting metals such as steel, aluminum, and brass. They are widely used in workshops and industrial settings for tasks requiring precision and versatility. However, despite their advantages, traditional hacksaw machines operate with a single-acting mechanism, cutting only during the forward stroke and returning idle, leading to inefficiencies in material removal and increased operational time.

2.2 Need for Automation in Material Cutting Processes

The integration of automation in material cutting processes addresses several challenges associated with traditional methods. Automated systems enhance efficiency by performing tasks with exact specifications, reducing the margin for error and ensuring consistent results. This precision is crucial in industries where even minor deviations can lead to defects or product failures.

Moreover, automation accelerates production by enabling continuous operation without the need for breaks or shift changes, significantly increasing output compared to manual processes. This increased speed not only meets rising demand but also allows companies to take on more projects, boosting revenue. For instance, a steel manufacturing company increased its output by 40% after automating their production line, allowing them to fulfill large orders faster than ever before. In addition to efficiency and speed, automation improves safety by taking over dangerous tasks, reducing the need for human workers to be exposed to risks such as sharp tools and high temperatures. Automated systems equipped with sensors and safety mechanisms can prevent accidents, further protecting workers. At a large metal processing plant, automating the most dangerous tasks, such as metal cutting and forming, reduced workplace accidents by 50%, safeguarding employees and reducing downtime due to injuries.

2.3 Integration of Dual Acting Mechanisms and Automatic Cutting Fluid Systems

The concept of integrating dual acting mechanisms into hacksaw blades aims to enhance cutting efficiency by enabling the blade to cut during both the forward and return strokes. This approach maximizes the utilization of the blade's movement, effectively doubling the cutting action per cycle and reducing the overall time required for each cut.

Simultaneously, the incMain Frameorporation of automatic cutting fluid systems ensures consistent and precise application of lubricant and coolant directly to the cutting zone. This system not only protects the blade from excessive wear and overheating but also improves the quality of the finished surface by reducing friction and preventing material buildup. Automated fluid delivery systems have been developed to monitor cutting conditions and adjust fluid application accordingly, optimizing the cutting process and extending tool life.

2.4. Material And Component Selection

Component	Material	Reason
Main Frame	Mild Steel	Structural strength
Hacksaw Blade	High Carbon Steel	Sharpness, durability
DC Motor	12V–24V, 3000 RPM250 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
AC motor	220V-240V . 50Hz, POWER: 10W	Completely Submersible Motor
Cutting Fluid Reservoir	Plastic and SS	Sharpness, durability
Motor Speed Controller	ABS	LED Display Design which shows percentage rate of actual speed to maximum speed
Motor on/off sw	ABS	On/ Off the motor

2.5 Summary

The integration of dual acting mechanisms and automatic cutting fluid systems into hacksaw machines represents a significant advancement in material cutting technology. By addressing the limitations of traditional single-acting hacksaw blades and manual fluid application methods, these innovations enhance cutting efficiency, reduce tool wear, and improve surface finish. The adoption of automation in material cutting processes not only boosts productivity but also contributes to safer and more consistent operations.

Chapter 3: Methodology

3.1 Design and Construction of the Main Frame and Mechanical Linkages

The main frame of the power hacksaw is built using mild steel, selected for its strong structural properties, ease of fabrication, and excellent weldability. It acts as the primary support structure, bearing the load of all attached components and withstanding the mechanical forces generated during cutting.

The connecting rod, fabricated from a mild steel rod, is engineered for easy machining and consistent mechanical performance. It serves as the key linkage that translates the motor's rotational motion into the reciprocating action of the hacksaw blade.

3.2 Selection and Integration of the Hacksaw Blade and Motor

The hacksaw blade selected is made from high carbon steel, chosen for its excellent sharpness, wear resistance, and long-lasting performance, making it ideal for prolonged cutting tasks.

A DC motor rated at 250 watts, operating within a 12V–24V range and capable of 3000 RPM with a torque output of 0.80 N·m, is used to drive the reciprocating mechanism. This motor is selected for its high efficiency and compatibility with low-voltage systems.

Additionally, for applications involving immersion or fluid-based environments, a 220V–240V, 50Hz, 10W AC submersible motor is incorporated. This motor

powers the fluid circulation system, enhancing both operational safety and component durability in such conditions.

3.3 Design of the Automatic Cutting Fluid System

The cutting fluid reservoir is made from a combination of plastic and stainless steel (SS), offering a balance of corrosion resistance, strength, and ease of maintenance. This system is designed to automatically deliver lubricant and coolant to the blade and workpiece interface during cutting, ensuring smooth operation and prolonging tool life.

A motor speed controller, enclosed in a durable ABS casing, includes an LED display that shows the motor speed as a percentage of its maximum capacity. This enables accurate adjustment of cutting speeds to suit various material types.

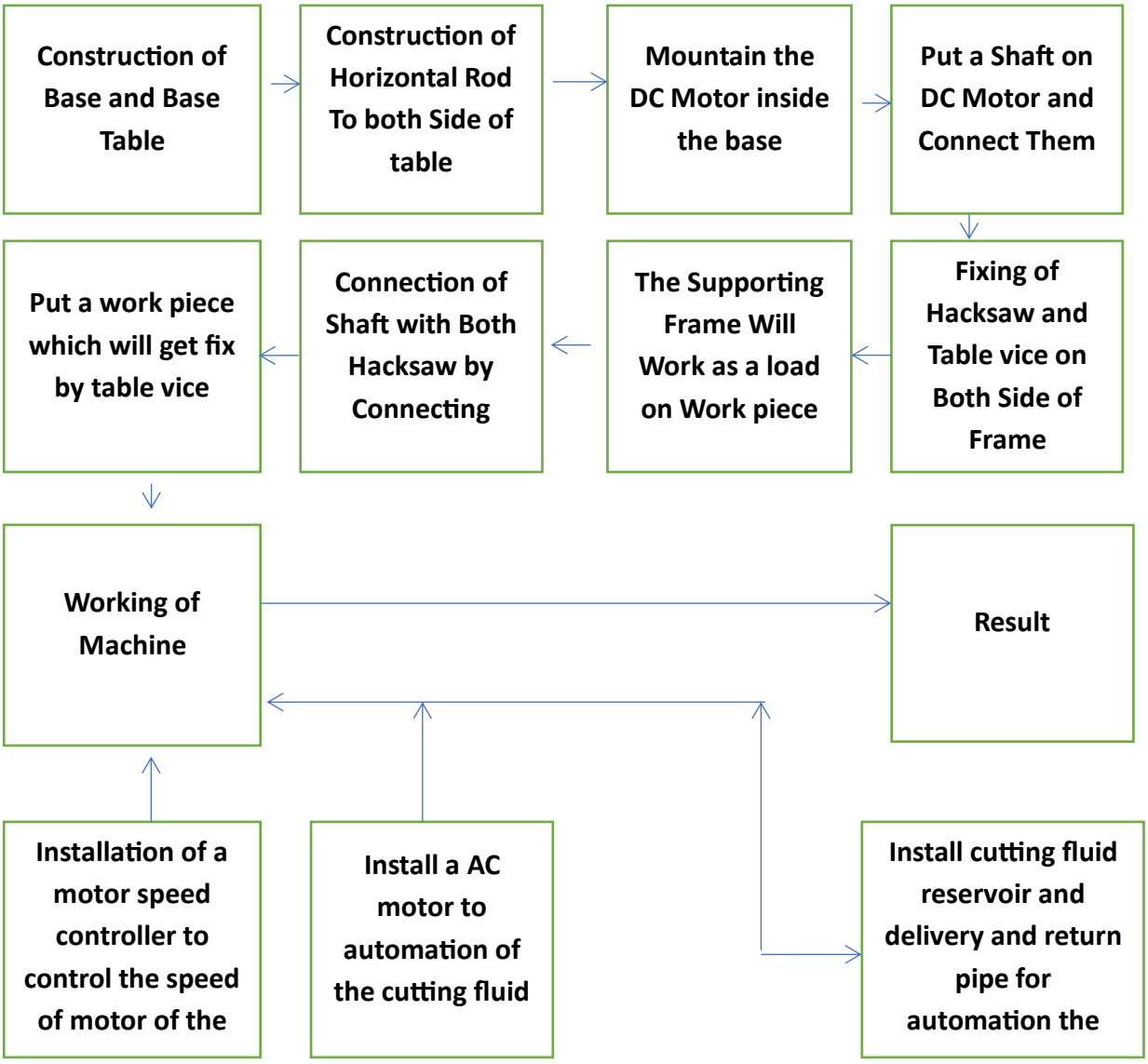
For added safety and control, an ABS On/Off switch is integrated to manage power supply to the motor, allowing for secure and user-friendly operation.

3.4 Assembly and Integration

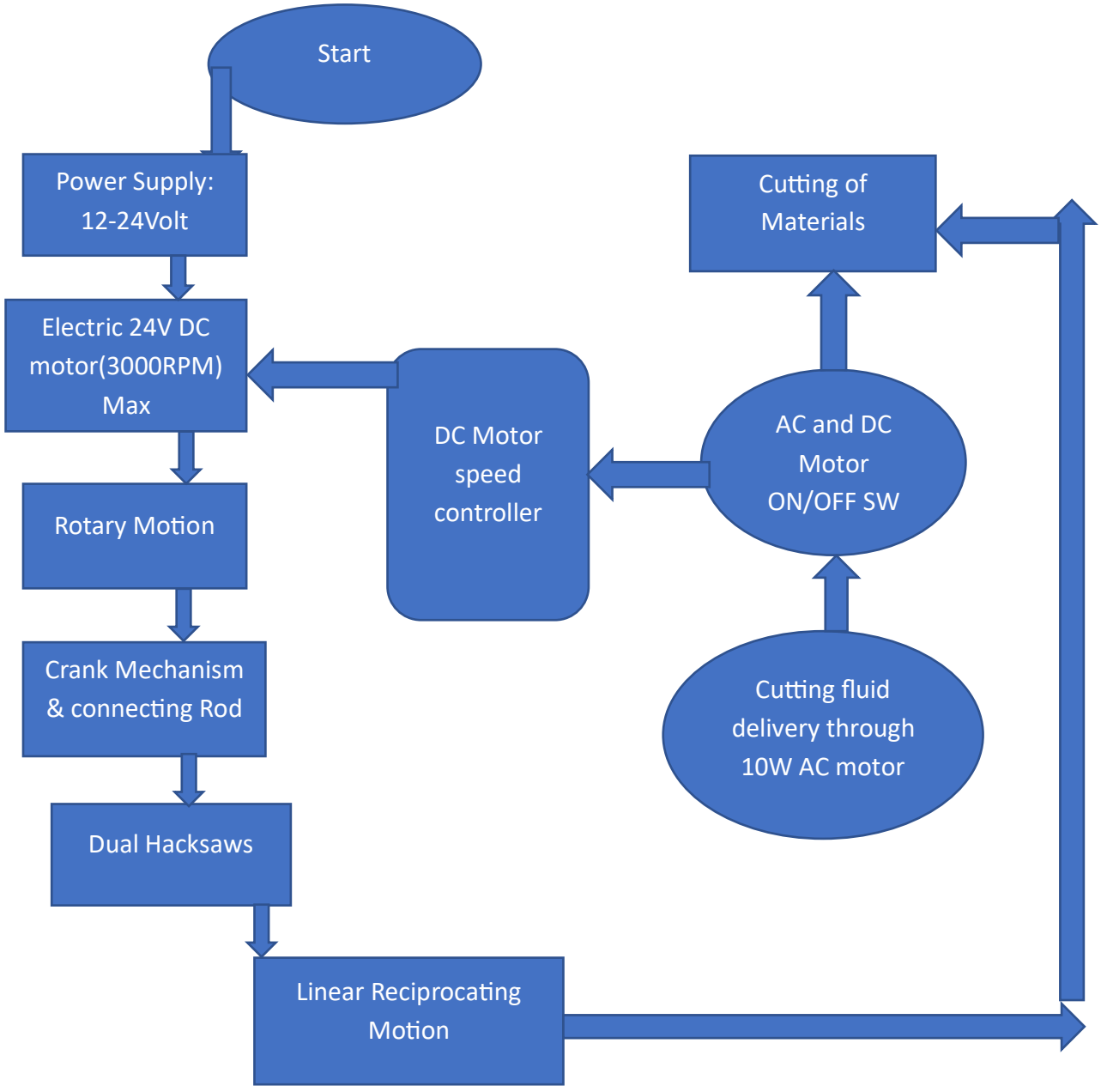
- The mechanical parts, including the main frame, connecting rod, and blade holder, are assembled ensuring proper alignment and tension of the hacksaw blade.
- The DC motor is mounted securely on the frame and connected to the linkage mechanism to convert rotary motion into reciprocating motion.
- The automatic cutting fluid system is connected to the fluid reservoir and circulation motor, with tubing directed to nozzles positioned near the cutting area.
- The motor speed controller and power supply (Switched Mode Power Supply - SMPS, 12V–24V) are integrated to provide stable and adjustable power to the DC motor.

3.5 Block 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.



3.6 Flow Chart Diagram: Work Mechanism



3.7 Components 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
9. DC Motor Speed Controller
10. 10W AC motor
11. Cutting Fluid reservoir
12. Cutting Fluid Delivery and Return Pipe
13. AC and DC motor ON/Off SW Etc.

3.9Summary

The double-acting power hacksaw machine marks a notable improvement in mechanical cutting technology, designed to boost efficiency by allowing the saw blade to cut during both forward and backward strokes. This dual-action feature significantly increases cutting productivity compared to conventional single-stroke hacksaws.

The machine utilizes a crank and slider mechanism to convert rotary motion into steady, linear reciprocating motion, ensuring smooth and continuous blade movement. Key components include a sturdy frame, precisely machined guideways for accurate blade alignment, and a reliable clamping system that firmly secures the workpiece during operation. These elements collectively enhance the machine's stability, cutting accuracy, and operational safety.

Engineered to reduce cycle time, lower operator fatigue, and improve energy efficiency, the system is cost-effective and capable of processing a range of materials such as metals, plastics, and wood. This makes it well-suited for use in workshops, educational institutions, and small-scale manufacturing setups. Its integration into these environments offers a reliable and efficient solution for repetitive cutting tasks.

CHAPTER-4

HARDWARE ANALYSIS

4.1 DC Motor:

DC Motor Function in the Automatic Double-Acting Hacksaw Machine
In the automatic double-acting hacksaw machine, the DC motor functions as the main power source, transforming electrical energy into mechanical motion to operate the crank-slider mechanism. The chosen motor operates within a 12V to 24V range, providing up to 250 watts of power and a torque of 0.80 N·m. This performance is sufficient for cutting various materials such as mild steel, aluminum, and plastic rods.

DC motors are particularly suitable for this application due to their high efficiency, broad speed control capabilities, and consistent torque output. The motor delivers a stable rotary motion, which is then transformed into a linear reciprocating motion through the mechanical linkage system, enabling the hacksaw blade to perform cutting actions during both forward and return strokes.



Figure 4.1: 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 of the Hacksaw Operation

The automatic double-acting hacksaw machine incorporates several key performance features that enhance its cutting efficiency, reliability, and adaptability across a variety of materials and operating conditions:

- **Consistent Torque Delivery:**
  The DC motor provides steady torque output, ensuring smooth reciprocating motion even under high load conditions such as cutting mild steel (MS) or stainless steel (SS) rods.
- **Dual-Stroke Efficiency:**
  The machine performs cutting during both the forward and return strokes, significantly reducing idle time and effectively doubling productivity compared to single-stroke systems.
- **Speed Control Flexibility:**
  Equipped with a variable speed DC controller, the system allows operators to fine-tune motor speed based on the material type and blade specifications. This helps minimize tool wear and prevents overheating, thereby extending blade life.
- **Thermal Performance:**
  The motor includes integrated heat sinks for effective heat dissipation and can be paired with a thermal cutoff switch to protect against overheating during prolonged use.

In addition to the above, the system's **material removal rate** is optimized due to its dual-action cutting and precise speed-torque control. By adjusting the motor's voltage input or using an electronic controller, the system can easily adapt to varying material hardness and cutting requirements.

DC motors are particularly advantageous for automated systems due to their **rugged construction**, **fast response time**, and ease of integration with **sensors and control units**. In this project, the DC motor is essential for enabling

automation, maintaining cutting consistency, and boosting overall productivity in the operation.

4.2 Switched Mode Power Supply (SMPS)



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

Switch Mode Power Supply (SMPS) in the Automatic Hacksaw System

The **Switch Mode Power Supply (SMPS)** plays a critical role in powering the automatic double-acting hacksaw machine by efficiently converting electrical energy from the AC mains into a stable DC voltage—typically **24V DC**—suitable for operating the DC motor and control circuitry.

Unlike traditional linear power supplies, SMPS operates using **high-frequency switching** along with energy storage components such as **inductors, transformers, and capacitors**. This method minimizes energy loss, improves **conversion efficiency**, and reduces the overall size and heat output of the power unit.

Key Features and Benefits of SMPS in This Project:

- **Efficient Power Conversion:**
  Converts high-voltage AC input into a regulated DC output with minimal energy loss, ensuring optimal operation of the motor and electronics.

- **Compact and Lightweight:**
  The use of high-frequency components makes SMPS significantly smaller and lighter than linear counterparts, ideal for compact machine designs.
- **Stable Output Under Load:**
  Maintains consistent voltage even with fluctuating load demands, which is essential for the stable operation of motors and sensitive control systems.
- **Improved Thermal Management:**
  Reduced heat generation leads to lower cooling requirements and enhanced system reliability.
- **Safety and Reliability:**
  SMPS often includes built-in protections like overvoltage, overcurrent, and thermal shutdown, contributing to the safe operation of the machine.

In the context of this automatic hacksaw system, the SMPS ensures a **reliable and consistent power supply** to all essential components, thereby enhancing overall **system stability, efficiency, and safety** during cutting operations.

For a more in-depth understanding of SMPS design and application, you may refer to ON Semiconductor's SMPS Reference Manual.

4.3. Hacksaw Blade:

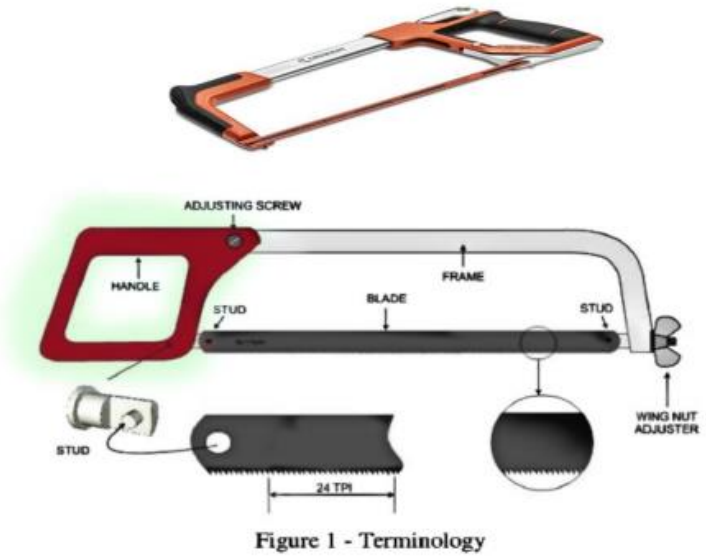


Figure 1 - Terminology

Figure 3.3: Hacksaw [24]

The hacksaw blade is a vital cutting element in the automatic double-acting hacksaw, designed as a narrow, straight blade crafted from durable materials such as high-speed steel (HSS), bi-metal, or carbon steel. These materials enable the blade to endure the repeated mechanical stresses generated by continuous reciprocating motion.

Blades are classified by their **teeth per inch (TPI)**, which determines their suitability for cutting different materials:

- **Low TPI (14–18):** Best for softer materials like plastics and wood.
- **Medium TPI (20–24):** Suitable for general-purpose cutting of aluminum and mild steel (MS).
- **High TPI (24–32):** Designed for harder materials such as stainless steel (SS) and thin-walled tubing.

The blade is securely mounted on the blade frame under proper tension and carefully aligned to ensure straight, precise cuts while minimizing vibration. In the double-acting hacksaw, the blade cuts during both forward and backward strokes, necessitating high fatigue resistance and maintained sharpness throughout operation.

To enhance performance and durability, blades may be coated with wear-resistant materials or used alongside cutting fluids, which help reduce friction, lower cutting temperatures, and extend the tool's lifespan.

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:

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

4.4 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

4.5 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.

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

4.6 Table Vice:



Figure 4.6: 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 work piece 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.

4.7 Construction:

The double-acting power hacksaw is designed to improve cutting efficiency by allowing the blade to perform cutting operations during both the forward and return strokes. This approach minimizes idle time during the return motion and boosts overall productivity.

Main-Frame

The base structure is fabricated using durable and rigid materials like mild steel (MS) to provide reliable support and stability. The machine is assembled using components such as steel angle bars, connecting rods, a table vice, a hacksaw blade, and standard fasteners like nuts and bolts, forming a fully functional double-acting power hacksaw system.



Figure 4.7: Base Frame before modification.

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.

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

4.8 Working Principle:

The Automatic Hacksaw Machine is designed to convert rotary motion into linear reciprocating motion using a connecting rod mechanism. To further enhance its performance, the machine includes an integrated fluid delivery system and a motor speed controller. The complete working process is as follows:

1. **Motor Activation:**
   The operation starts by switching on the DC motor, which initially runs at around 800 revolutions per minute (RPM).

2. **Speed Control:**
   A DC motor speed controller is installed to regulate and reduce the motor's RPM. This allows for smoother operation, improves cutting quality, and significantly reduces the likelihood of blade breakage due to excessive speed or vibration.

3. **Conversion of Motion:**
   The rotary motion from the motor is transferred to a connecting rod that links the motor shaft to the hacksaw frame.

4. **Reciprocating Movement:**
   As the connecting rod rotates, it transforms the rotary motion into a back-and-forth reciprocating motion. This drives the hacksaw blade in a linear path across the workpiece.

5. **Guidance Mechanism:**
   The main frame of the machine acts as a linear guide, ensuring that the blade moves in a straight and constrained path. This maintains the precision and accuracy of the cutting process.

6. **Cutting Fluid Delivery System:**
   A separate 10W DC motor powers a fluid delivery system that supplies cutting fluid directly to the cutting area via a delivery pipe. This coolant helps to reduce friction and temperature during operation, enhancing cutting efficiency and extending blade life. The used fluid is collected through a return pipe and recirculated back to the reservoir, ensuring continuous cooling and lubrication.

CHAPTER-5

Temperature Generation During Material Cutting

5.1 Heat Generation During Cutting:

During the cutting operation, considerable heat is produced due to friction between the cutting blade and the workpiece. The extent of temperature rise is influenced by several key factors, including:

- **Material Type:** Harder and denser materials tend to generate more heat during cutting.
- **Workpiece Diameter:** Larger diameters increase the contact area and cutting load, resulting in higher friction and heat.
- **Cutting Duration:** Prolonged cutting times allow more heat to accumulate in the blade and workpiece.

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

Material	Diameter (mm)	Without Fluid Temp (°F or °C)	With Fluid Temp (°F or °C)	Fluid Usefulness
Plastic	10–20mm	95°F / 35 °C	Not need use	Not needed unless high-speed, large diameter
Wood	10–20 mm	102°F / 39 °C	Not need use	Air cooling/pauses only. Not needed cutting fluid.
MS Rod	10–14 mm	101°F / 38°C	90°F / 32 °C	Need cutting fluid



Fig: Temperature Reading Taking

5.3 Use of Cutting Fluid

The application of cutting fluid during machining plays a crucial role in enhancing performance, protecting equipment, and improving the quality of the final product. Its benefits include:

1. **Heat Reduction:**
   Cutting operations generate high friction, resulting in significant heat. Cutting fluids absorb and carry away this heat, helping to protect both the cutting tool and the workpiece.
   - Friction and material deformation cause intense heat buildup.
   - Cutting fluids help reduce temperatures by approximately **30–45%**.
   - This minimizes risks such as thermal expansion, material distortion, and tool failure.
2. **Extended Tool Life:**
   By maintaining lower temperatures, cutting fluids reduce tool wear and preserve blade sharpness, thereby extending the tool's service life.
3. **Improved Surface Finish:**
   The fluid minimizes built-up edges and friction, resulting in a smoother, cleaner surface on the finished workpiece.
4. **Lubrication:**
   Cutting fluids provide a lubricating layer between the tool and the material, reducing friction and making the cutting process more efficient.
5. **Chip Removal:**
   The fluid helps to flush metal chips away from the cutting area, preventing recutting, blade damage, and potential jamming.
6. **Oxidation Prevention:**
   Especially when machining metals, cutting fluids help prevent surface oxidation, discoloration, or rust formation during high-temperature operations. Fig: Use of Cutting Fluid



Fig: Use of Cutting Fluid

5.4 Fluid Selection Based on Workpiece Material

The performance of a cutting fluid is highly dependent on the type of material being machined. Since different materials generate heat and friction in varying ways, the selection of an appropriate fluid is essential for effective cooling, lubrication, and tool life extension.

Carbon Steel / Mild Steel:

These materials are relatively easy to machine but still benefit from the use of cutting fluids to improve efficiency and surface finish.

- **Recommended Fluids:** Soluble oils, synthetic coolants, or water-based emulsions containing adequate lubricants.
- **Applications:** Suitable for general milling, turning, and sawing operations.
- **Note on Cast Iron:** Cast iron contains free graphite, which offers some degree of self-lubrication. In certain operations, the use of compressed air or even dry machining is acceptable.
  Source: americanmachinist.com

Stainless Steel / Tough Alloys:

Stainless steels and high-strength alloys present greater challenges due to their tendency to work-harden and their low thermal conductivity.

- **Recommended Fluids:** High-performance coolants with excellent heat dissipation and corrosion resistance.
- **Key Requirements:** Fluids must efficiently carry away heat while protecting both the tool and the workpiece from corrosion and thermal damage.

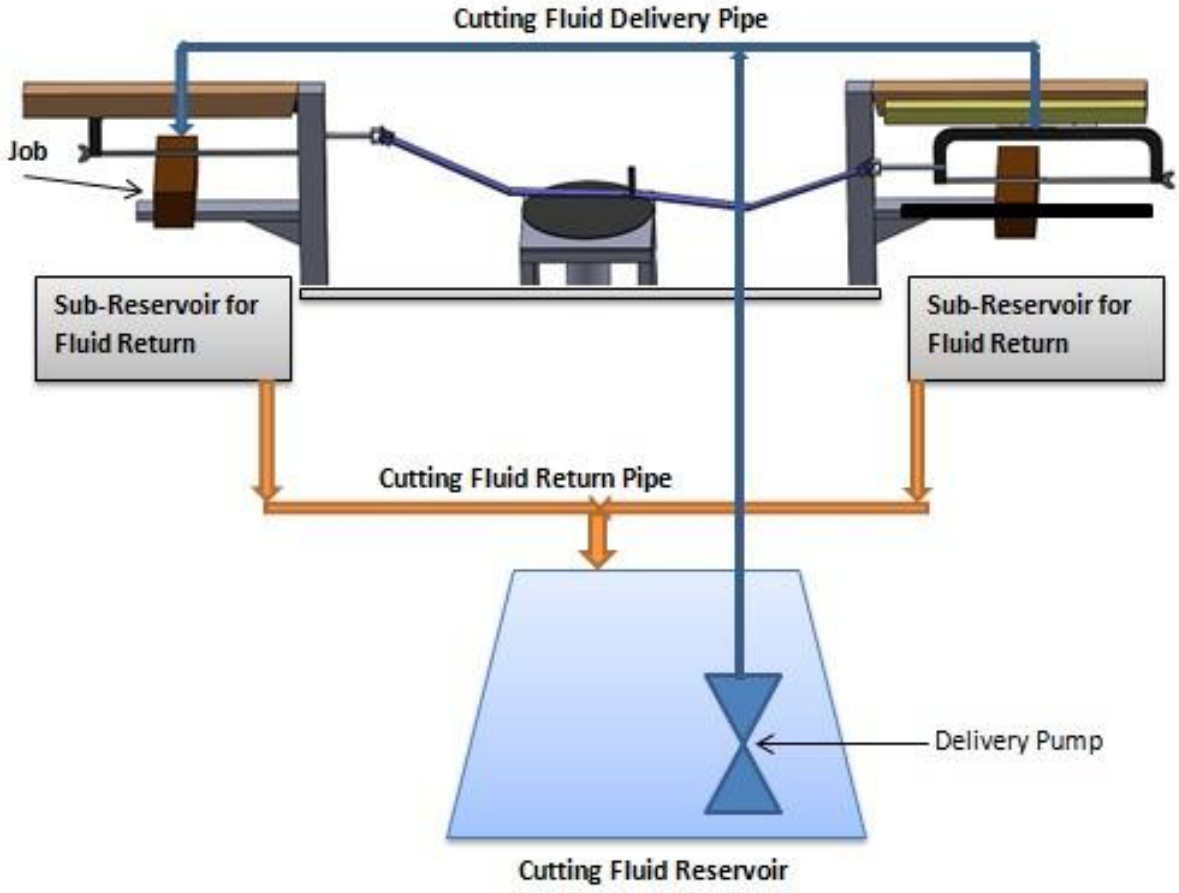


Fig: Automatic Recirculating Cutting Fluid System.

5.5 Flow Rate Measurement and Coolant Control:

To calculate the fluid delivery flow rate per workpiece, we'll use the motor's total flow rate and the cutting times. We have used the motor as following specification below;

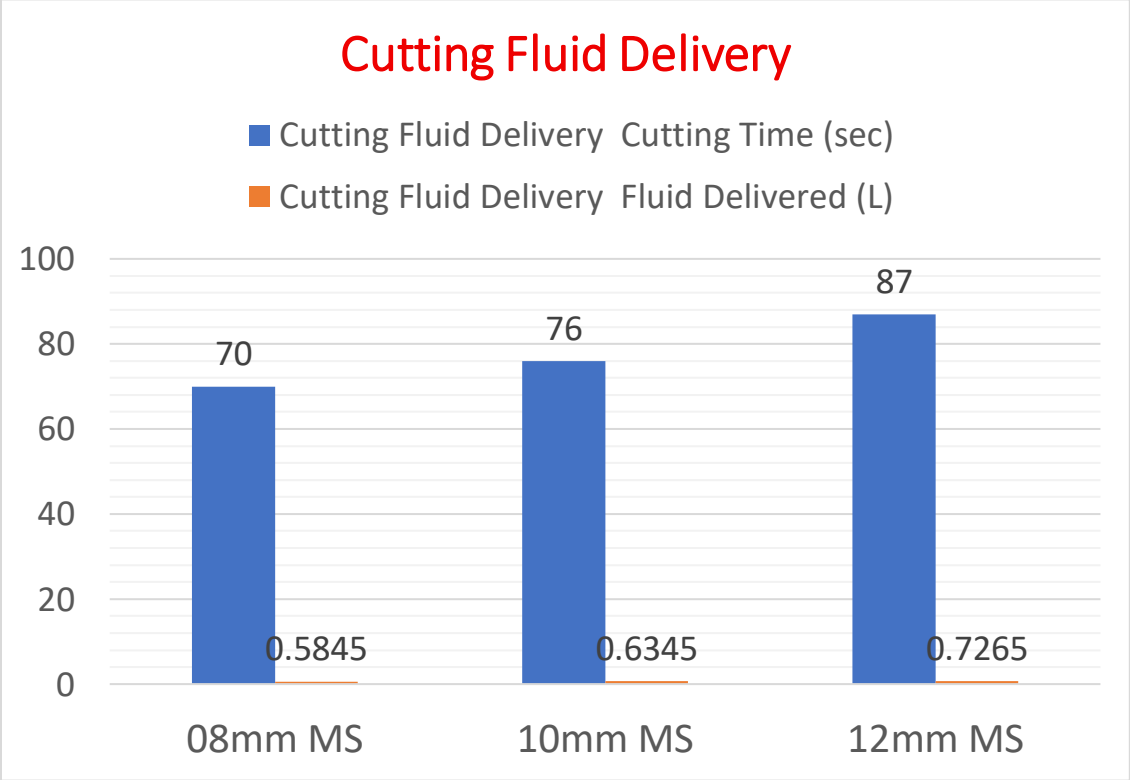
Motor Power: 10 W AC

Flow Rate: 60 L/hr

Max Head: 0.8 m

Flow Rate= 60L/3600 sec = 0.01667L

Cutting Fluid Delivery		
MS	**Cutting Time (sec)**	**Fluid Delivered (L)**
08mm MS	70	0.5845
10mm MS	76	0.6345
12mm MS	87	0.7265



5.6 Temperature generation flow chart:



CHAPTER-6

Modification of the machine

In this project, a conventional dual-acting automatic hacksaw machine has been successfully modified to enhance its operational efficiency, automation, and user control. One of the key improvements includes the integration of a variable speed controller equipped with an ON/OFF switch, allowing the operator to precisely control the cutting speed based on the type and thickness of the material being processed. This ensures optimized cutting performance and reduced wear on the cutting blades. Furthermore, an AC motor with a power rating of 10 watts has been installed specifically for automating the cutting fluid delivery system. The motor operates at a flow rate of 60 liters per hour and is capable of delivering fluid up to a maximum head of 0.8 meters, which is sufficient for consistent lubrication and cooling during the cutting process. This automated system provides a steady supply of cutting fluid throughout the operation, significantly improving heat dissipation, reducing friction between the blade and workpiece, and extending the lifespan of both the blade and machine components. Overall, these modifications contribute to a more efficient, reliable, and user-friendly cutting process, making the machine better suited for continuous or semi-automated industrial applications.

6.1 Components Installed for Machine Modification:

01. DC Motor speed controller
02. DC motor ON/OFF Switch
03. 10W AC Motor
04. Cutting Fluid Reservoir
05. Cutting Fluid Delivery and return line.
06. Angle for increase the Hight.

6.2 DC Motor speed controller:



Fig: DC Motor speed controller [27]

6V 12V 24V Digital Display LED DC Motor Speed Controller PWM Stepless Speed Control Switch HHO Driver - Black CCM5D RED

About this item

- Digital DC speed controller Input supply voltage: 6V-30V DC
- Digital DC motor speed controller PWM frequency: 16kHz; Duty Cycle adjustable: 0%-100%
- Digital DC motor speed adjuster size: 3.1*1.6*0.9 inches ; Net weight: 2.1 ounces
- The maximum output power: 240W
- The maximum continuous output current :5A;(Peak current 8A),The LED display the duty ratio 0-100%

6.3 10W AC Motor:

RS Electrical RS-3100A, (10Watt & 60L/H)



Fig: 10W AC Motor [27]

Key specifications:

- Power: 10W
- Water flow rate: 60 L/H (liters per hour)
- Maximum height (H-Max): 0.8 meters, which is the maximum height the pump can push water.
- Input supply: 220V–240V at 50Hz.

6.4 Cutting Fluid Reservoir:



Fig: Cutting Fluid Main Reservoir

This the main reservoir of cutting fluid. The it can contain maximum 2 liters of cutting fluid. It is connected with the delivery and return pipe with the sub reservoir.



Fig: Sub-Reservoir for Fluid Return

The sub-reservoir stores and returns used cutting fluid, ensuring smooth recirculation and flow.



Fig: Project Final View after modification.

6.5 Comparison Between Original and Modified Hacksaw Machine:

Parameter	Original Project	Modified Project	Figure of modified item
Cutting Fluid System	No automation; fluid applied manually or irregularly	Automatic fluid delivery using a 10W AC motor	
Fluid Flow Rate	Inconsistent, uncontrolled	Controlled flow rate of 60 L/hr with return system via sub-reservoir	
Speed Control	Fixed cutting speed, not adjustable	Variable speed via PWM controller with ON/OFF switch	
Cooling Efficiency	Poor cooling, leading to overheating	Continuous coolant flow ensures efficient heat dissipation	
Blade Life	Frequent blade breakage due to heat and poor lubrication	No blade breakage observed; improved lubrication and cooling	
Automation Level	Low; manual intervention required	High; fluid and speed fully automated	
Maintenance	Frequent due to manual coolant handling	Reduced, thanks to closed-loop coolant return system	
User Control	Limited control; no adjustment features	Enhanced control through digital display and adjustable settings	
Suitability	Suitable for light, short-term operations	Capable of longer, more consistent operation with less supervision	
System Reliability	Less reliable; prone to overheating and wear	Improved reliability and consistent performance	

6.6 Advantages of the Modified Hacksaw Machine

1. **Improved Blade Life**
   No blade breakage observed due to consistent lubrication and cooling.
2. **Automated Cutting Fluid Delivery**
   Ensures constant flow of coolant (60 L/hr) without manual intervention.
3. **Variable Speed Control**
   Allows speed adjustment according to material type and thickness, improving cutting quality.
4. **Higher Efficiency**
   Reduced cutting time and better heat dissipation enhance overall performance.
5. **Reduced Operator Fatigue**
   Automation minimizes manual input, making the machine easier to operate.
6. **Cleaner Operation**
   Sub-reservoir collects returning coolant, reducing spillage and mess.
7. **Energy Efficient**
   Low-power 10W AC motor is sufficient for fluid delivery, minimizing power consumption.
8. **Reliable for Continuous Operation**
   Suitable for longer or repeated cutting cycles without overheating or failure.

6.7 Challenges of the Modified Hacksaw Machine

1. **Increased Initial Cost**
   Additional components like the motor, controller, and plumbing increase setup cost.
2. **More Complex System**
   Requires basic knowledge of electronics and wiring for installation and troubleshooting.

3. **Maintenance of Additional Parts**
   Pump, reservoir, and wiring may require periodic inspection and servicing.

4. **Power Dependency**
   System is fully electric—requires consistent power supply for optimal operation.

5. **Space Requirement**
   Added components like the sub-reservoir and motor take up additional space on the machine.

6.8 Applications of the Modified Dual-Acting Automatic Hacksaw Machine

1. **Metal Cutting Workshops**
   Ideal for small to medium-scale workshops that require precise and efficient cutting of metal rods, pipes, and bars.

2. **Manufacturing Units**
   Suitable for mass production environments where repetitive cutting operations are required with minimal supervision.

3. **Educational Institutions**
   Can be used in engineering colleges and technical institutes for practical demonstrations of automation and machining processes.

4. **Maintenance Departments**
   Useful in factory or plant maintenance sections for quick and reliable cutting of spare parts and metal stock.

5. **Tool Rooms**
   Efficient for cutting stock materials to specific lengths before machining operations.

6. **Fabrication Industries**
   Enhances productivity in fabrication units that deal with frame structures, supports, and machine bases.

7. **Automotive Workshops**
   Helpful in cutting chassis components, brackets, and structural elements during vehicle modifications.

6.9 Cost Analysis

In the below table we have summarized our project expenditure

SL	Product Name	Specification	Qty.	Unit Price (Taka)	Total Price (Taka)
1	DC Motor speed controller	Digital Display LED DC Motor Speed Controller PWM	01pc	1800/-	1800/-
2	10W AC Motor	Rs-3100	01pc	1750/-	1750/-
3	Angle Bar	40 X 40 X 3mm	14Feet	90/-	1260/-
3	Fluid Reservoir	2.5 Liter	01pc	120/-	120/-
4	Fluid Sub-Reservoir	100x250mm	02pc	200/-	400/-
5	Connector		02 pc	150/-	300/-
6	‘’T’’		01 pc	100/-	100/-
7	Saline Set Pipe		02 pc	100/-	200/-
8	Plastic pipe	10mm	10 Feet	50/-	500/-
9	Others				4000/-
				Total=	**10430/-**

6.10 Discussion

The modified dual-acting hacksaw machine features automated cutting fluid delivery using a 10W motor and a PWM speed controller for adjustable blade speed. This ensures consistent lubrication and cooling, which eliminated blade breakage observed in the original model. Improved cutting precision and reduced mechanical stress were achieved. While the system is more complex and slightly costlier, these enhancements greatly improve performance, reliability, and ease of operation for various industrial applications.

CHAPTER-7
Test and Results

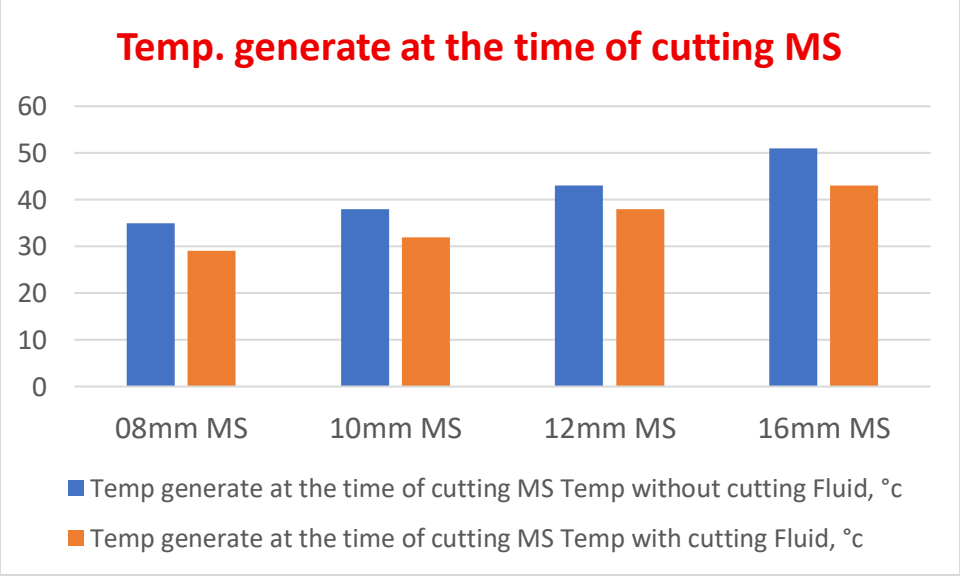
7.1 Test and Results

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.

Temp. generate at the time of cutting MS

MS	Temp without cutting Fluid, °c	Temp with cutting Fluid, °c
08mm MS	35	29
10mm MS	38	32
12mm MS	43	38
16mm MS	51	43

Note:
Fluid normal temp-26 °C/ 79° F
RPM, N=100
Speed Volt%=42



Effect of Cutting Fluid Application Time on the Time Required to Cut Mild Steel Rods of Different Diameters Using an Automatic Double-Cutting Hacksaw Machine

Cutting time of different MS

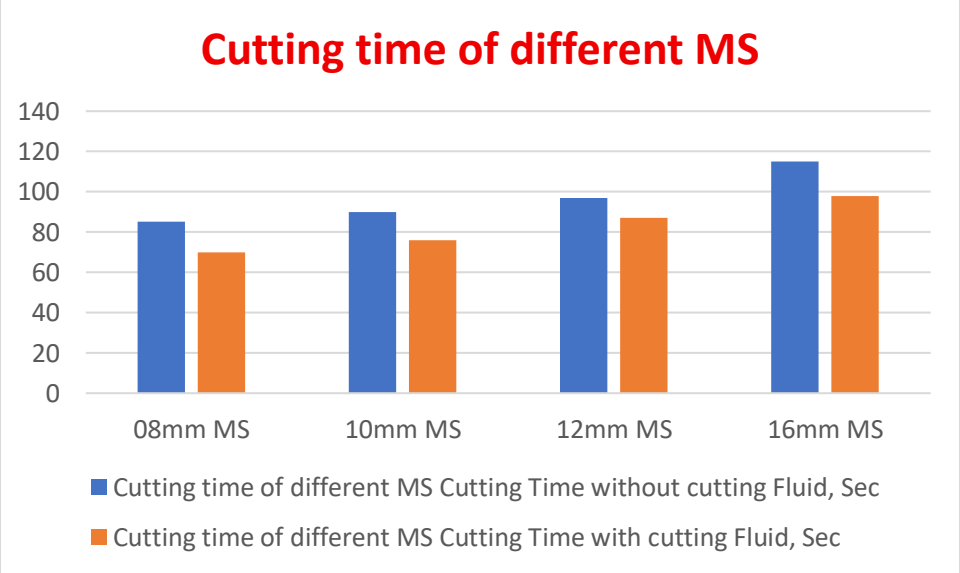
MS	Cutting Time without cutting Fluid, Sec	Cutting Time with cutting Fluid, Sec
08mm MS	85	70
10mm MS	90	76
12mm MS	97	87
16mm MS	115	98

Note:

Fluid normal temp-26 °C/ 79° F

RPM, N=100

Speed Volt%=42

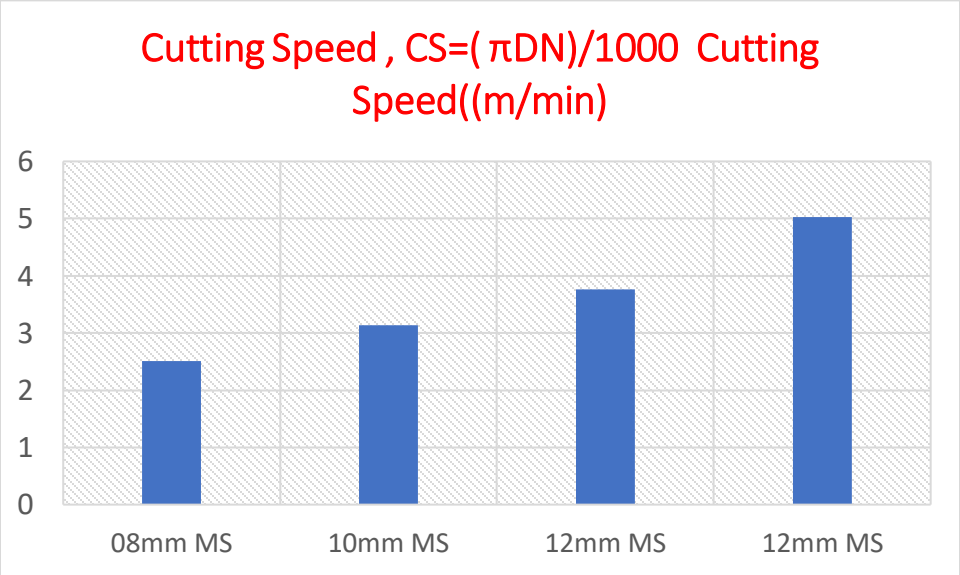


Cutting Speed: We can find the cutting speed of the machine using following formula

Cutting Speed, CS= (πDN)/1000

Cutting Speed, CS=(πDN)/1000	
MS	**Cutting Speed((m/min)**
08mm MS	2.51
10mm MS	3.14
12mm MS	3.76
16mm MS	5.03

Note:
Fluid normal temp-26 °C/ 79° F
RPM, N=100
Speed Volt%=42



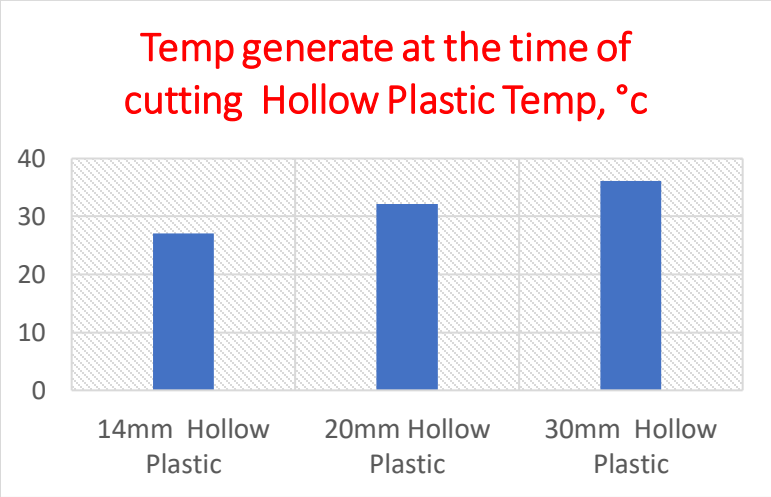
Plastic:

Temperature: Temp. generate at the time of cutting Hollow Plastic.

Temp. generate at the time of cutting Hollow Plastic

Plastic	Temp, °c
14mm Hollow Plastic	27.1
20mm Hollow Plastic	32.2
30mm Hollow Plastic	36.1

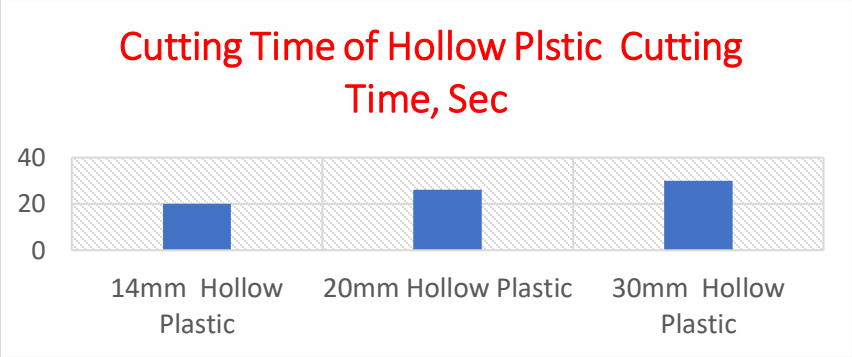
Note:
Fluid normal temp-26 °C/ 79° F
RPM, N=100
Speed Volt%=42



Cutting Time: Time required for cutting.

Cutting Time of Hollow Plastic

Plastic	Cutting Time, Sec
14mm Hollow Plastic	20
20mm Hollow Plastic	26
30mm Hollow Plastic	30

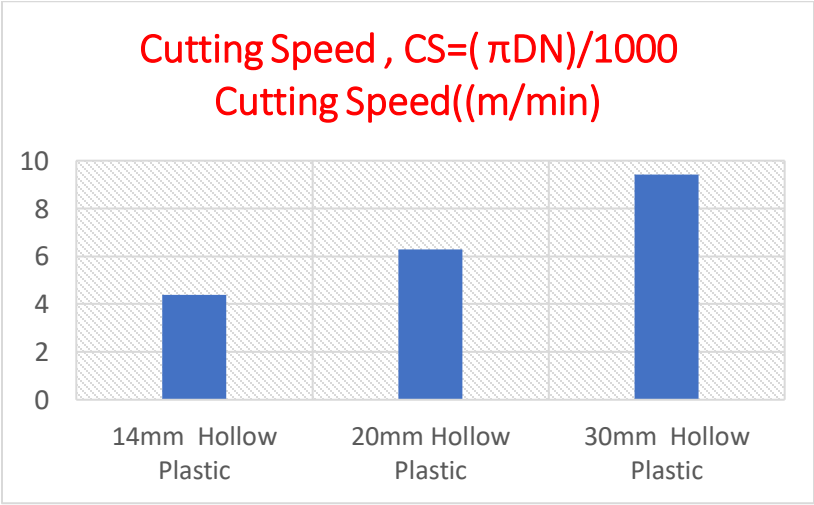


Cutting Speed: We can find the cutting speed of the machine using following formula

Cutting Speed, CS= (πDN)/1000
Where, N=100

Cutting Speed, CS=(πDN)/1000	
Plastic	**Cutting Speed((m/min)**
14mm Hollow Plastic	4.39
20mm Hollow Plastic	6.28
30mm Hollow Plastic	9.42

Note:
Fluid normal temp-26 °C/ 79° F
RPM, N=100
Speed Volt%=42



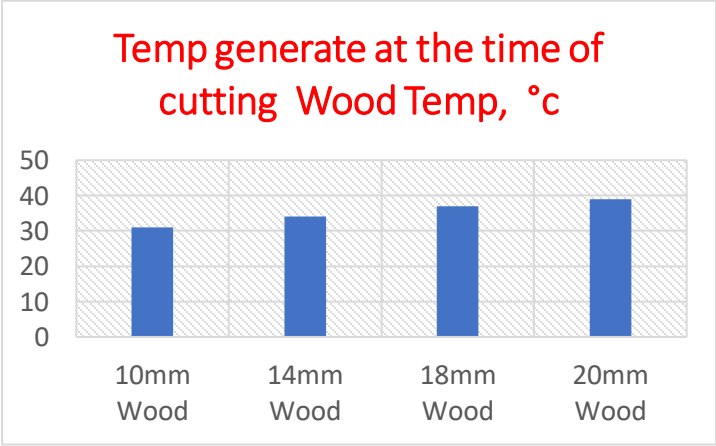
Wood:

Temperature: Temp. generate at the time of cutting wood.

Temp generate at the time of cutting Wood

Wood	Temp, °c
10mm Wood	31
14mm Wood	34
18mm Wood	37
20mm Wood	39

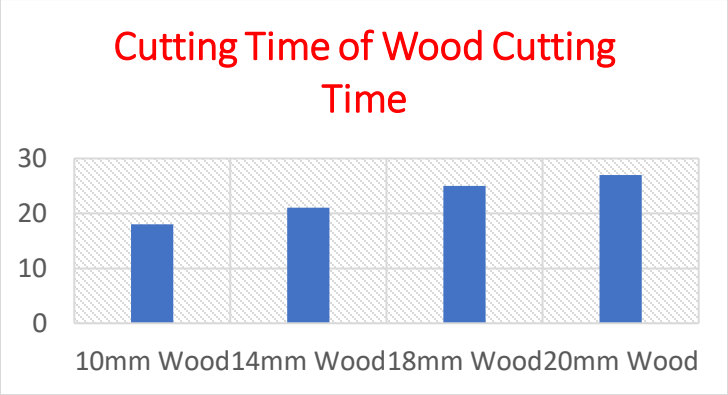
Note:
Fluid normal temp-26 °C/ 79° F
RPM, N=100
Speed Volt%=42



Cutting Time:

Cutting Time of Wood

Wood	Cutting Time
10mm Wood	18
14mm Wood	21
18mm Wood	25
20mm Wood	27



Cutting Speed:

Cutting Speed, CS=(πDN)/1000	
Wood	**Cutting Speed((m/min)**
10mm Wood	3.14
14mm Wood	4.39
18mm Wood	5.65
20mm Wood	6.28

Note:

Fluid normal temp-26 °C/ 79° F

RPM, N=100

Speed Volt%=42

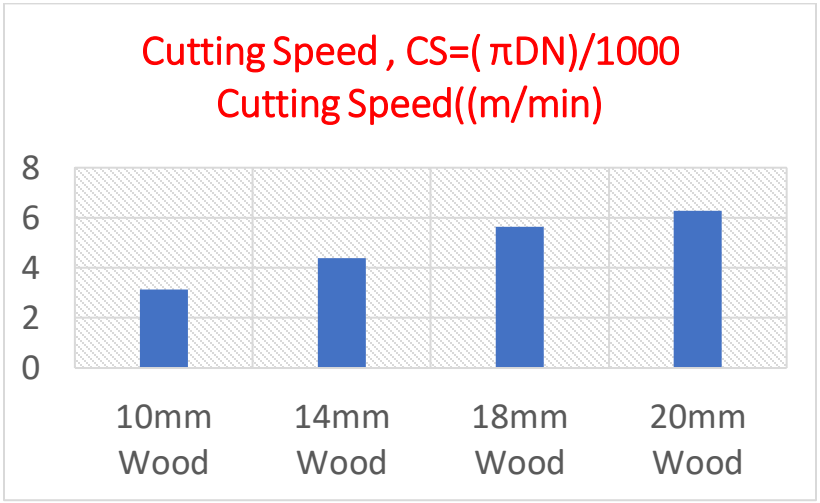




Fig: Taking RPM Reading by

PHOTO TYPE DIGITAL TACHOMETER

CHAPTER-8
Conclusion

8.1 Conclusion

This study focused on the effects of cutting fluid application time, cutting speed, material type, and rod diameter on the cutting performance of mild steel (MS), wood, and plastic rods using an automatic double-cutting hacksaw machine.

The experimental results demonstrated that cutting time, surface finish, and blade wear are all influenced by the combination of these factors:

- For mild steel, continuous and correctly timed cutting fluid application significantly reduced cutting time, controlled heat generation, and improved blade life. Increasing rod diameter naturally increased cutting time, but this was effectively managed with appropriate fluid usage and speed adjustments.

- In the case of wood, dry cutting at moderate speeds gave the best results. Excessively high cutting speeds led to rough surfaces or chipping, while too low speeds caused inefficient cutting.
- Plastic rods showed sensitivity to both speed and heat. At high speeds without lubrication, plastic tended to melt or stick to the blade. Controlled cutting speed, combined with minimal fluid application, prevented this and produced cleaner cuts.

The role of cutting speed control was particularly important across all materials. Matching the appropriate speed with the material type and diameter not only improved the quality of the cut but also reduced energy consumption and prolonged the service life of the blade.

8.2 Future Scope for Improvement:

Smart Speed Control:

Add automatic feedback control so the machine can adjust speed by itself depending on material and rod size.

Better Cutting Fluid System:

Use sensors to control fluid flow more precisely, reduce wastage, and add a filtration system to reuse fluid longer.

Blade Improvement:

Try stronger or coated blades for longer life and better cutting efficiency.

Energy Saving:

Use more efficient motors and reduce power use during idle time.

User Safety & Comfort:

Add safety covers, emergency stop, and a simple digital display for easy operation.

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