



# INTERNATIONAL JOURNAL OF ADVANCE RESEARCH, IDEAS AND INNOVATIONS IN TECHNOLOGY

ISSN: 2454-132X

Impact factor: 4.295

(Volume 4, Issue 6)

Available online at: [www.ijariit.com](http://www.ijariit.com)

## Four way cutting operation in hacksaw machine

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### ABSTRACT

As we know that in large manufacturing industries, the cutting operation is very required for raw material, for this purpose they use conventional hacksaw machine for cutting operation. In that type of machine single piece can cut at a time by using an electric motor. Also, one labor utilizes for same. So it is time-consuming and comparatively costly. Therefore we have manufactured a four-way hack-saw machine which is used for cutting job simultaneously, this four-way hack-saw machine uses single motor four cutting job at the same time while in conventional hack-saw machine single motor is used for cutting one job only. Conversion of rotary motion of dc motor into reciprocating motion is obtained by using the eccentric cam. By making such type of machine, cutting operation time as well as labor working time can be reduced. Since such a hack-saw machine gives more productivity than a conventional cutting hack-saw machine, it can be used in manufacturing industries where automation is required. It can be also used in industries where labor availability is less. In this present work, we manufactured a model of four-way hacksaw machine, so we use light duty of structural parts and crank mechanism, the capacity of the electric motor is also very low. But in future, if we want to use such type of machine in industry, we can manufacture it by using heavy duty of body structure and all other required parts.

**Keywords**— Four-way cutting, Hacksaw machine, Multi operation

### 1. INTRODUCTION

In present condition many electrically operated power hacksaw machines of different companies with different specifications are available for the use in the shop floor. These machines are so precise that they can cut metal with minimum time made up of different materials but they have one and major disadvantage that those are able to cut a single piece of the bar at a time. For industries to achieve the mass production, it is necessary to cut metal bars with high rate. So it is impossible to depend upon conventional single frame power hacksaw machines and need the improvement in technology and design of such machines.

By using this four-way hacksaw machine the four metal bars can be cut simultaneously to get the high-speed cutting rate and to achieve mass production for maximum profit in manufacturing industries. As this machine overcomes all the limitations and drawbacks of conventional hacksaw machines, it is also helpful for small-scale industries due to its simple working and operating conditions along with its compatibility, efficiency and affordable price.

The setup of the four-way hacksaw machine is very simple, it operates with the mechanism of eccentric cam disc arrangement. The disc rotates with DC motor, the rotary motion of the wheel is converted into the reciprocating motion of the cutting tool (hacksaw). This reciprocating motion is used to obtain the linear motion of blades and material is cut.

The size and shape of this setup are small. The bed is provided for placing the workpiece to be cut. A low power DC motor is required for its operation. Length of the crank and connecting rod is selected using trial and error method. The motion of hacksaw is guided by guiding rods placed over the hacksaw frame. The vertically downward motion is occurred due to self-weight of the frame, so it can be called as gravity feed hacksaw.

### 2. LITERATURE REVIEW

- Nitinchandra R. Patel, Ravi Thakkar, Miteshkumar Rathwa in his research paper “Material selection and testing of hacksaw blade based on mechanical properties” stated that the appropriate saw blade must be selected for better operation and fine cutting by selecting a number of teeth per inch.[1]

- There are four types of blades based on material namely High Carbon steel, Alloy Steel, Bi-metallic strip and High-speed steel blades. Out of these four the best suitable for cutting hard materials like a Mild steel bar and Aluminum is a Bi-metallic blade on the basis of Properties of materials, Wear resistance and Cutting performance.[2]
- Kshirsagar Prashant R. in his research paper "Theoretical Analysis of Multi-Way Power Hacksaw Machine" proposes the model of multi-way hacksaw machine which is able to cut four pieces simultaneously without any jerk and minimum vibrations.[3]
- D. V. Sabarimala, V. Siddhartha, T. Mohanraj in their paper "Design and Fabrication of Automated Hacksaw Machine" (April 2014) gives an idea about the various components required for fabrication of the proposed model. These components will help to get smooth working condition and future automation of different mechanical actions as well as linkages.[4]
- The vast review of literature will help to understand the concepts, theorems and different factors affecting the performance of the machine. R. S. Khurmi, J. K. Gupta in their book "Theory of machines" (Velocities in mechanisms) helps to find Velocity diagrams of slider crank mechanism.[5]

### 3. PROPOSED METHODOLOGY

This project consists of single phase vertical electric motor rigidly placed at the centre of metallic foundation provided. The shaft of gearbox rotates at 80- 90 rpm with the motor power 1 HP. The circular disc is mounted on the shaft of the motor with the help of key and key slot arrangement. The eccentric point on the plane of the disc is provided such that the desired cutting stroke is achieved. One end of each connecting rod is pivoted at this eccentric point by the use of the suitable bearing. Another end of each rod is connected to the hacksaw blade frame with the help of a universal joint to get vertical and horizontal Degree of Freedom of rotation for the proper cutting operation. The hacksaw frame slides on the guideways provided. When the motor is ON and disc starts rotating, due to the reciprocating motion of hacksaw frame the metal rod is cut which is firmly fixed in a vice.

### 4. DESIGN CALCULATIONS

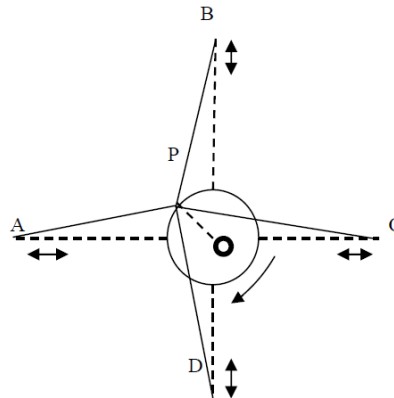


Fig. 1: Space diagram of the mechanism of four-way hacksaw machine

#### Velocity Calculations:

From Velocity Diagram,

Considering cutting stroke length = 125 mm

As we know  $l = 2r$ ; where  $r$  = crank radius

Therefore

$$r = 62.5 \text{ mm}$$

The length of connecting rod = 300 mm

Speed= 80 rpm

So angular velocity  $\omega = 2\pi N/60 = 9.067 \text{ rad/sec}$

Here OP= crank radius

OA = OB = OC = OD = connecting rod

Velocity of point p is

$$\begin{aligned} V_p &= OP \times \omega \\ &= 0.0625 \times 9.067 \\ &= 0.567 \text{ m/sec} \end{aligned}$$

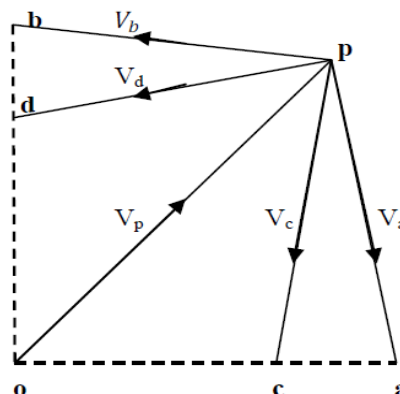


Fig. 2: Velocity Diagram (Scale 0.567 m/sec = 50mm)

From velocity diagram, we get velocities of slider

$$V_{ap} = 44 \text{ mm} = 0.499 \text{ m/sec}$$

$$V_{bp} = 41 \text{ mm} = 0.465 \text{ m/sec}$$

$$V_{cp} = 44 \text{ mm} = 0.499 \text{ m/sec}$$

$$V_{dp} = 41 \text{ mm} = 0.465 \text{ m/sec}$$

**Torque calculations:**

We know forces at A, B, C, D

$$F_A = F_B = F_C = F_D = 300 \text{ N}$$

$$\text{Power output} = T \times \omega$$

$$\text{Power input} = (F_A \times V_A) + (F_B \times V_B) + (F_C \times V_C) + (F_D \times V_D)$$

$$= (300 \times 0.499) + (300 \times 0.465) + (300 \times 0.499) + (300 \times 0.465)$$

$$= 578.4 \text{ Nm/sec}$$

Neglecting losses power input is equal to power output

So,  $578.4 = T \times \omega$

$$T = 63.79 \text{ Nm}$$

**Available Torque**

Where,

$$N = 80 \text{ rpm}$$

$$P = 1 \text{ HP} = 746 \text{ watt}$$

$$T_A = 89.1 \text{ Nm}$$

$$P = 2\pi N T_A / 60$$

**5. EXPERIMENTAL WORK**

Manufacturing of the project starts with the fabrication of frame as per design and mounting motor on the frame. Now rotary motion is converted into reciprocating motion so connecting rods are connected with a hacksaw blade.

This project consists of a single phase vertical electric motor rigidly place at the center of the metallic foundation. The shaft of gearbox rotates at 80- 90 rpm with the motor power 1 HP. The output shaft of the gearbox is connected to disc and connecting rod is attached to the disc. Gearbox is attached to the motor to increase torque of the motor. The eccentric point on the plane of the disc will drill such that the desired cutting stroke will be achieved. One end of each connecting rod will be pivoted at this eccentric point by the use of the suitable bearing. Another end of each rod will be connected to the hacksaw blade fame with the help of a universal joint to get vertical and horizontal Degree of Freedom of rotation for the proper cutting operation. The hacksaw frame will slide on the guideways. Now rotary motion is converted into reciprocating motion with the help of connecting rods connected to the hacksaw blade.

When the motor is started and the disc will start rotating, due to the reciprocating motion of the hacksaw frame and the material will be cut which is fixed in the vise.



**Fig. 3: Four-way hacksaw machine**

**List of components with materials:** Multi-way power hacksaw requires following parts together to perform the cutting action. List of components requires is as follows.

**Table 1: list of the component required for the project**

S. no.	Components	Material	No.
1	Single phase electric motor	-	1
2	Crank	MS	1
3	Hacksaw Blade	Bi-metallic	4
4	Hacksaw Frame	Cast Iron	4
5	Guideways	M.S.	4
6	Connecting rods	M.S.	4
7	Material holding vise	Cast Iron	4
8	Base	M.S.	1
9	Universal joints	Alloy Steel	4

## **6. FURTHER SUGGESTED WORK AND CONCLUSION**

- By increasing the motor power and dimensions of the eccentric cam the size of the material to be cut can be increased.
- By using limit switches or sensors Automatic feeding mechanism for material can be introduced.
- Automatic lifting up mechanism for the frame when cutting operation can be by using hydraulic piston and cylinder.

## **7. CONCLUSION**

As per the above discussion, we concluded that to overcome problems in conventional hacksaw machines, due to high efficiency, easy to operate and affordable price the proposed model of four-way hacksaw machine is helpful and completes all the expectations needed in the mini-industries. Future scope of proposed research work to increase the production rate cuts the metal bars easily. It can withstand the vibrations, no hazards from a jerk, no special training required to operate it.

## **8. ACKNOWLEDGEMENT**

We want to thank Uka Tarsadia University, Bardoli for providing us with the open door to utilize their assets and work in such a challenging environment. First and foremost we take this opportunity to express our deepest sense of gratitude to our guide Prof. Lalji Godhani Sir for his able guidance during our project work. This project would not have been possible without his help and the valuable time that he has given us amidst his busy schedule.

We are also grateful to the teaching faculties of Mechanical Engineering Department for their valuable suggestions and instruction regarding my work. We are also thankful to the relevant staff of our workshop for helping in any kind of work to develop such attachment. Also, they are providing workshop equipment like lathe machine, welding machine, etc. to develop our project and our practical knowledge. We have also received a tremendous amount of help from our friend's insight and outside the institute.

Last but not least we wanted to express our gratefulness to our parents who helped us throughout our work.

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