

# EXPERIMENTAL INVESTIGATION OF THRUST, CUTTING FORCE & AIR CONSUMPTION FOR A PNEUMATIC SHEET METAL CUTTER

T. Paramesh<sup>1</sup>, B. Ashok Kumar<sup>2</sup>

Associate Professor<sup>1</sup>, Assistant Professor<sup>2</sup>

Department of Mechanical Engineering<sup>1</sup>, Department of Mechanical Engineering<sup>2</sup>

St Martin's Engineering College, Secunderabad<sup>1</sup>, St Martin's Engineering College, Secunderabad<sup>2</sup>

**Abstract:** *Metal cutting is one of the fundamental forms used in various small scale industries for cutting and bending of different metal sheets into different shapes. For cutting operation in the market we have a numerous procedures & approaches. Among them pneumatic hand operated sheet cutting tool is quite frequently and mostly used operation. In this paper, the design concept of a portable pneumatic hand lever cutter which is operated by a two way controlled valve and its safety values for cutting and bending force of sheets of variable thickness is discussed. Well there, some find outs are there between the manual and automated operated pneumatic cutting machine. The experiment was done to get the positive results and good comparison results for the future scope in the cost management also.*

**Keywords:** *metal cutting, manual, pneumatic, control valve, safety, portability.*

## I. Introduction

Cutting of thin and flat plates is a common thing carried out in the various metal industries, construction, architecting etc. to perform different operations to achieve the desired shapes. There are various cutting and bending operations which are used depending on the need and nature of metal. The factors observed for the designing of machine to improve the efficiency and reduction of cycle time<sup>[1]</sup>. The latest advancements in the current trends there is advancement in the cutting tools from manual operated to CNC operated to avoid the wastage of metal, time and heavy duty. The cost is also a factor for the growing industries so steps should also be forwarded in that direction. Keeping in mind about

the factors, a locally developed and cost effective machine for the cutting of metal sheets is the great need.

## II. Literature Review

Harry Franklin was referred to as the "Father of Business Hydraulics" by ASME.<sup>[3]</sup> mechanics was initial documented by Hero of Alexandria in sixty A.D, however the idea had existed before then. gas devices area unit utilized in several industrial applications. usually acceptable for applications involving less force than hydraulic applications, and generally less costly than electrical applications, most gas devices area unit designed to use clean dry air as associate energy supply.

The brake forming method has been thought-about as a possible technique for manufacturing fiber metal laminate (GLARE) stringer<sup>[2]</sup>. However, the spring-back developed throughout brake forming results in serious issues within the final dimensional tolerance of the stringer. A series of experiments were performed to look at the result of tool style and method parameters on the spring-back of GLARE. The parameters studied embrace punch radius, punch speed, forming load, and forming temperature.

## III. Methodology

The concept of widely used creative technique Brainstorming, principle is used for the design. The components required are tabulated as below in Table 1.

### 3.1 Components

Table 1: List of Components with their specifications and quantity required.

SI No	Component	Specification	Quantity
1	Pneumatic Cylinder	375mm x 40mm, Stroke: 200mm, Piston Rod Dia: 20mm, Working Pressure: 8 bar, Weight: 3 Kg	1
2	DC Valve	Type: Hand Lever, No of Ports: 5, Sliding Spool Type construction.	1
3	Pneumatic Pipe	Diameter : 8mm, Thickness: 1mm	3mts
4	Fork End Nut	M16	2
5	Cylinder Base Plate Bolts	M6	4
6	Blade Fixing Bolts	M10	3

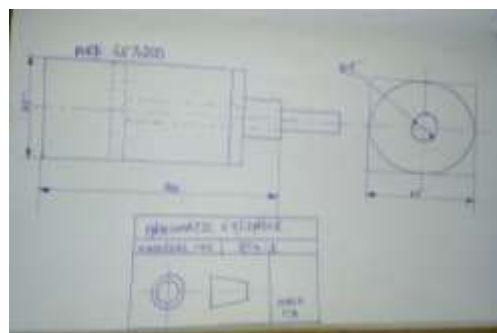


Fig 2: Pneumatic Cylinder Layout

Operating energy (kinetic energy and pressure) ends up in a gas system once the compressed gas is allowed to expand. as an example, a tank is charged to a hundred psi with compressed gas. once the valve at the tank outlet is opened, the air within the tank expands till the pressure within the tank equals the air pressure. Air growth takes the shape of flow of air

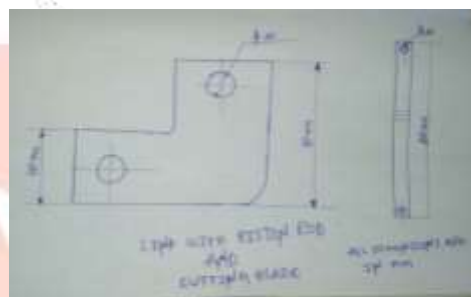


Fig 3: Link with Piston Rod and Cutting Blade

### 3.2 Drawings of the Linking System:

The Fig 1 gives the shearing blade and blade linking pictorial representation.

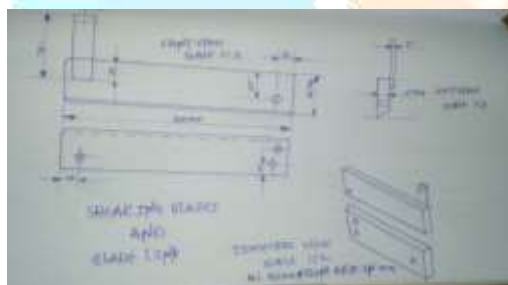


Fig 1: The Shearing Blade and Blade Link

The reason for Pneumatic mechanics, or the other variety of energy transmission on a machine, is to perform work. The accomplishment of labor needs the appliance of mechanical energy to a resisting object leading to the article moving through a distance. during a gas system, energy is keep during a potential state underneath the shape of compressed gas.

Directional management valves unit one amongst the foremost elementary parts in hydraulic machinery still and gas machinery. they allow fluid flow into utterly totally different methods from one or additional sources.



Fig 4: DC Valve

They usually embrace a spool in facet a cylinder that's mechanically or electrically controlled. The movement of the spool restricts or permits the flow, so it controls the fluid flow.

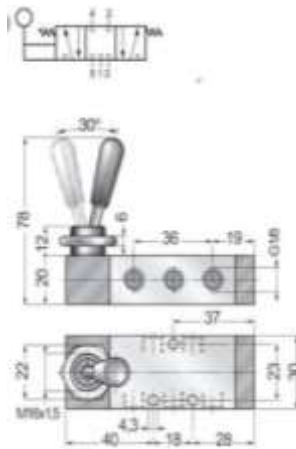


Fig 5: control valve view

A pipe may be a cannular section or hollow cylinder, sometimes but not essentially of circular cross-sectional, used mainly to convey substances which might flow liquids and gases (fluids), slurries, powders, plenty of tiny solids. It may be used for structural applications; hollow pipe is so much stiffer per unit weight than solid members. In common usage the words pipe and tube are usually lay to rest modification ready, but in industry and engineering, the terms square measure unambiguously outlined.



Fig 6: Air pipe

Sheet cutter square measure non-automatic cutting off tools. They encompass a combine of metal blades pivoted so the sharpened edges slide once more steach different once the handles (bows) opposite to the pivot closed. High-carbon, high stainless steel used production of sheet cutter



Fig 7: Sheet cutter Base Frame

It forms the sturdy supports to face the machine vertically. It holds the load of the vertical post and supports the direction management valve. it's fabricated from low-carbon steel. it's fabricated from rectangular base with the vertical post and therefore the horizontal channel gas hand lever to the middle position (i.e., traditional position) then the mechanical device is transitioned.

### 3.3 Working

The general layout is shown in the following figure 8

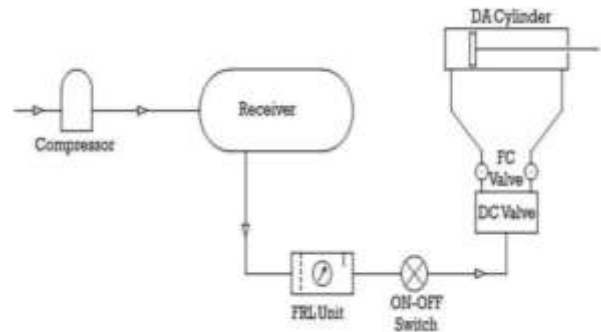


Fig 8: General Layout

- The gas machine includes a table with support arms to carry the sheet, stops or guides to secure the sheet, higher and lower straight-edge blades, a gauging device to exactly position the sheet.
- The table additionally includes the 2 manner directional valve. The two manner directional valve is connected to the mechanical device.
- The mechanical device incorporates a piston for a movable member and the piston is connected to a rotating shaft, that is successively connected to a main mover (electric motor, combustion engine).
- At recess and outlet ports, valves permit air to enter and exit the chamber.
- Once the mechanical device is switched ON, the compressed gas is flow to recess of the gas cylinder .The sheet is placed between the higher and also the lower blade.
- The lower blade remains stationary whereas the higher blade is forced downward. The higher blade is slightly off set from the lower blade, just about 5-1 zero capitalize on the sheet thickness.
- Also the higher blade is typically angulate so the cut progresses from one finish to the opposite, therefore reducing the desired force. once the gas

hand operated lever is stirred forward, the piston starts acquiring the forward direction.

#### IV. Results and Discussions

##### i. Force for Cutting operation

$$\text{Force required to cut the Sheet} = L * t * Z_{max}$$

For sheet of 0.7mm thickness,

$$\text{Force required} = 25 * 0.7 * 30 = 525 \text{ N}$$

This is the force required to cut the sheet metal, however the initial force required to cut the sheet is more and it is 10 to 20 % than we calculated.

##### ii. Thrust of Cylinder:

Cylinder thrust for double acting stroke,

$$F = \frac{\pi}{4} * (D - d)^2 * P$$

According to the equation after substituting the values we get maximum force exerted by the cylinder is 10382 N (Approx)

##### iii. Theoretical Air Consumption:

$$C = \{(\pi / 4) \times D^2 \times (P + 1) \times L\} / 1000 \quad \text{where,}$$

P= pressure in bar

D= Diameter of bore in cm.

L= Length of stroke in cm.

Theoretical Air Consumption of our pneumatic machine was, C= C = 23.56 litres.

#### Conclusion

Pneumatic systems are employed in dominant train doors, automatic production lines, and Mechanical clamps. The flat solid cutting method could be a main part of the all industries. Usually the flat solid cutting machine is manually hand operated one for medium and little scale industries. The flat solid cutting machine works with the assistance of gas double acting cylinder. The piston is connected to the moving cutting implement. Flat solid cutting machine will be accustomed cut the flat solid of minimum thickness while not manual labor. This machine may be used for the demonstration in the laboratory for clear understanding for the student and also can be put forth for operations of cutting of necessary use in workshops.

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