International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 04 | April - 2023 Impact Factor: 8.176 ISSN: 2582-3930

Design, Fabrication, and Analysis of Pneumatic Sheet Metal Cutting Machine

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Abstract: The use of aluminum is increasing nowadays in many industries like automobile, packaging, medical, etc. The reason behind this is that aluminum made things quite easier to manufacture, handle, and be reliable. So the manufacturing of aluminum goods is striving hard to produce good quality products at a large scale and cheaper cost. Normally the sheet metal cutting machine is manually hand-operated for medium and small-scale industries. Automation in the modern world is inevitable. Any automatic machine aimed at the economical use of man, machine, and material is worth the most. Hydraulically operated machines are too costlier for small-scale and medium-scale industries. To address this issue a pneumatically operated sheet metal cutting machine was designed and fabricated by using a double-acting cylinder, air compressor, shear cutter, pipes, and DCV.
Keywords: Pneumatic, compressor, DCV

1. INTRODUCTION:

Sheet metal cutting refers to the process of cutting large sheets of metal into smaller pieces or specific shapes. This can be done using a variety of tools and techniques, such as shearing, sawing, laser cutting, plasma cutting, or waterjet cutting[1]. Sheet metal cutting is a crucial step in the manufacturing of many products that require metal components, such as automobiles, appliances, and industrial equipment. Accurate and precise cutting is necessary to ensure that the finished product meets the required specifications and functions properly.

Traditionally, this method is manually operated, but this method is not suitable for the mass production of parts. Therefore, several experiments have been conducted to improve the preciseness and reduce the time required for the cutting process. One such idea is the pneumatically actuated cutter, which is entirely controlled using pneumatic controls, and its cutting time is reduced to an effective duration[2].

In a pneumatically actuated cutter, compressed air is directed to a direction control valve, which is operated using manual control. A double-acting cylinder is used for the cutting operation and is capable of generating a force of 981N for a 50mm bore diameter and 100mm stroke length. The extending and retracting of the cylinder are controlled using a pneumatic circuit that is actuated by a 5/3-way direction control valve.

2. PROBLEM DEFINITION:

One of the major issues in a manual metal sheet shearing machine, a large force is required which may tire a worker who continuously works thereon for production[3]. Additionally, in manual cutting, accuracy decreases and results in an increase in the wastage of material and time. Thus, this pneumatically actuated cutting machine removes human involvement increasing the efficiency and accuracy of cutting operations. The machine is made by observing the factors to enhance accuracy and time management. Further, it saves labor costs and decreases the time required for production, ultimately benefiting the manufacturer.

3. OBJECTIVE:

The main objective of this paper is to design and fabricate a metal sheet-cutting machine that is pneumatically operated and does the precise cutting, in order to reduce the labor and time needed for production. Additional objectives are,

- Using a Pneumatic control system to operate the cutting machine accurately.
- Get a consistent cutting result without any breaks.
- To generate a considerable amount of force while being cost-effective.
- To ensure the safety of human health by decreasing the interaction with the machine

4. WORKING OPERATION:

Initially, the air compressor started and allowed the receiver tank air pressure reaches up to 8 bar. The supply air is then passed to the manifold through the flow control valve. The compressed air is delivered to a double-acting cylinder from then, the piston moves in a forward direction which leads to the downward movement of the blade which cuts the sheet metal. Then air travels in the reverse direction where the

blade moves to its initial position. Change in position is achieved by using 5/3 manually operated DCV.

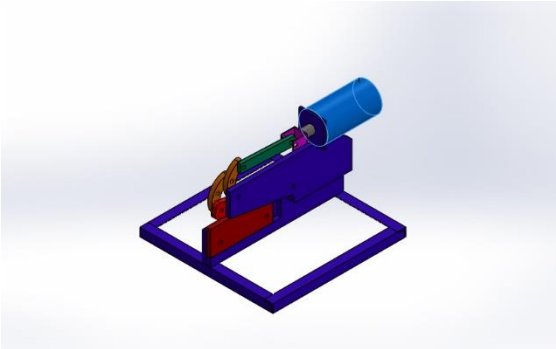

Fig.-1: Solidworks Model

Fig. -2: Fabrication of Pneumatic Sheet Metal Cutting Machine

5. CALCULATIONS:

i. Dimension of cylinder:
Diameter Bore D_2 = 50mm = 0.05m Diameter Shaft D_1 = 20mm = 0.02m Radius (R) = 25mm = 0.025m
Bore Length (L) = 100mm = 0.1m
Material: Aluminium[3]

ii. Air pressure of compressor:

$$P = 5bar = 5 \times 10^5 N$$

Forward Direction:

i. Area of Cylinder: $A_2 = \pi r^2$

$$= \pi \times (0.25)^2$$

$$= 0.001962m^2$$

ii. Force applied on the shaft:
$F = P \times A$

$$= 5 \times 10^5 \times 0.001962$$

$$= 981N$$

$$= 100.034kgf$$

Reverse Direction:

i. Area of Cylinder:
$A = A_2 - A_1$
$= \pi[D_2^2 - D_1^2]$

$$= 0.00165m^2$$

ii. Force applied on the shaft: $F = P \times A$

$$= 5 \times 10^5 \times 0.00165$$

$$= 825N$$

$$= 84.1266kgf$$

6. ANALYSIS:

Bore diameter of the Cylinder (in mm)	Force Generated by Cylinder (in N)	Sheet thickness (in mm)
25	245.43	0 – 0.5
50	981	0.5 – 1.5
70	1924.43	Upto 3
85	2837.32	Upto 5.5

Table 1: Analysis of Force

7. ADVANTAGES

- Labor cost and machining cost decreases.
- Precise cutting is done without any bending
- Time for production is greatly reduced.
- Easy to use.

DISADVANTAGES

- Cutting operation on a metal sheet having a thickness of 5mm or more is difficult.
- This system depends on compressed air only.
- Safety major is concerned in this operation.

8. CONCLUSION

This pneumatically operated cutting machine is easy to use without any discomfort. Specialized skills are not required to operate it, and the operation is quick, saving time and reducing costs. For these reasons, it is widely used in manufacturing industries. Its affordability and ease of handling make it suitable for both large and small-scale industries. Due to its precise cutting without any bending, it increases efficiency and reduces labor costs. It is easy to transport and maintain resulting in economic benefits.

ACKNOWLEDGEMENT

We would like to express our sincere appreciation to everyone who has contributed to the successful completion of this technical paper. Our gratitude goes out to our colleagues and mentors, whose guidance and support have been invaluable throughout the research process.

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