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Pneumatic Sheet Cutting Machine- A Review

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ABSTRACT- This is an industrial era and in order to have better surface finish and obtain a high degree of flexibility in the manufacturing processes in the industries, a lot of work is done on sheet metal. To ensure the adequate demand, sheet metal is cut and bent into variety of shapes. This is a review of the previous work done on the sheet metal where the cutting and bending of the sheets has been studied under various conditions. The pneumatic sheet cutting machines are one of the modern techniques which are used efficiently to make the sheet cutting and bending an efficient process. This work reviews the reliability, performance and the possibilities of simplifying the design of the pneumatic sheet cutting machines. The present work also reviews the energy lost in the pneumatic cylinder while it is made to impart the force on the cutting blade. The energy efficiency of pneumatic and compressed air systems is an important element in the overall development of sustainable production. The objective of this cross-discipline review is to update production and life cycle engineering researchers on state of art in energy efficiency for pneumatic production and associated compressed air infrastructure.

Keyword- Efficiency, manufacturing, Pneumatic sheet cutting machine etc.

Sheet metal industries use the sheet cutting machine, as these are used to carry out most of the operations in the sheet metal industry. The sheet cutting machines require human effort to cut down the sheets but it can be replaced by the pneumatic cutting machine. A pneumatic cutting machine is a pneumatically powered sheet cutting machine which can cut the sheets at a faster and convenient way. It also reduces the effort required during handling the cutting. In sheet cutting operation, the pressure exerted by the punch causes the plastic deformation of the metal. There is very small clearance between the punch and the die where the plastic deformation takes place.

Pneumatic system is used for the automation of machine and to solve industrial labour problems. Sheet metals have a variety of applications in making car bodies, roofs for buildings, medical tables etc. Now a day's sheet metal is also used in making furniture and cupboard.

separated by applying enough force to cause the material to fail. The most common process is shearing process as in this the cutting processes are performed by applying shearing force. The shear stress in the material will exceed the ultimate shearing strength when a greater shearing force is applied and the material will fail and separate at the cut location. This shearing force is applied by two tools, one above and one below the sheet.

These tools can be upper and lower blades or a punch and die. The tool above the sheet delivers a quick downward blow with certain force to the sheet metal that rests over the lower tool. A very small clearance is present between the blades i.e. edges of the upper and lower tools, which facilitates the fracture in the sheet metal. An attempt has been made to review the literature in pneumatic systems in sheet cutting, based on various criteria. Pneumatic is a branch of engineering that makes use of pressurized air or gas.

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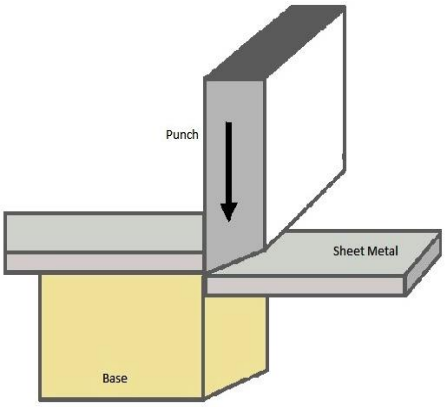

Fig 1: - Shearing of sheet metal

Pneumatic systems are used extensively in industries and are mostly powered by compressed gases or compressed air. An electrically powered and centrally located compressor powers air motors, cylinders and other pneumatic devices. A pneumatic system can be either controlled through manual or automatic solenoid valves which are selected because they provide low cost, more flexibility and safer alternative to electric motors and actuators. Pneumatic systems also have applications in mining, dentistry, construction, and other areas.

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A lot of authors and researchers have worked on pneumatic systems as well as on sheet metal experiments. The work done by various authors are explained below.

Perduijn et al [1] in their research, reported a simple explicit bending couple curvature relation for small and larger curvatures and they have also verified and stated their experimental results.

Sanchez et al [1] has focused on a systematic analysis of testing equipment as a measurement system of the friction phenomenon on sheet metal under plane strain. It has also provided experimental references in order to optimize the usage of sheet metal and lubricants.

Mutoh et al [10] Energy consumption of pneumatic system results into losses. They also proposed that the exhaust pressure of the cylinder hold middle level 0.2 - 0.5 MPa. If exhaust flow is used effectively, losses can be reduced in pneumatic systems. They reported if exhaust pressure is set near 0.2 MPa, it reduces the losses by 15% of total consumption.

COMPONENT USED

A. Pneumatic Cylinder

These are the devices which produce a reciprocating linear motion by making use of power from compressed gas. [1] The working fluid used in pneumatic cylinders is compressed air. The pneumatic cylinder is a mechanical device and the compressed air is converted into kinetic energy. [1] Pneumatic cylinders can produce large amount of force by making use of different ranges of velocities. [3] They work at high speeds and run continuously without getting overheated or any internal damage. [3] They come in different sizes and configurations. A hole is provided at one end of the cylinder of piston rod in order to connect it to the mechanism. [4] It is fitted with a gland In order to ensure prevention of leakage of working fluid. [4]

B. Direction Control Valve

The direction of air flow can be controlled in the pneumatic system by making use of direction valve. It is also called as DCV. It consists of a solenoid which is used for the conversion of electrical energy into straight line motion as well as force. It can be of two types i.e. pushing type of pull type. A plunger is pushed in push type solenoid

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where as in pull type; plunger is energized when the plunger is pulled inwards. [1] A cylinder is fitted with a spool inside it which can be controlled electrically or mechanically. To ease the operation, we have used the electrically controlled DCV. The flow is controlled or redirected by the movement of the spool. In fluidics, solenoid valves are most commonly used as control devices.

C. Pneumatic Compressor

These are the devices that are used for the conversion of power into potential energy. This potential energy is stored in the form of compressed air. The pressure of the storage tank is increased by compressing more and more air into it. After this, the compressor shuts off automatically when the upper limit of tank pressure is reached [1]. The air is also held in it until it is used. The stored energy can be utilized for numerous applications. The air compressor again turns on when pressure in the tank decreases [1]. In our project we are also studying the role of advection of compressed air and the losses associated with it which also leads to the study of convective heat transfer.

D. Rotary Screw Compressor

Rotary screw compressor makes use if the positive displacement compression. This is done by correctly arranging the two helical screws so that the volume of the chamber is decreased by turning the screws. [3]

E. Polyurethane Tube

It is used to pass substances which can flow through it. It can be used for various applications. The hollow pipes are generally stiffer than solid pipes. [1] It generally consists of a nominal diameter and schedule that defines the thickness.

F. Cutting Blade

It is one of the main components which cut the metallic sheets. Generally it is made of high carbon steel because there is huge resistance in the metallic sheets which are to be sheared. It is used to cut the sheets of metal of varying sizes; generally thickness may vary from 1 *mm* to 5*mm*. A compressor of size nearly 8-14 Kg/cm^2 is enough to cut down the sheet having thickness up to 5 *mm*. [1]

ADVANTAGES [2]

1. More effective in cutting process.
3. Simpler in construction
4. Easier maintenance and repair
5. Continuous operation is possible.
6. Cutting without bending is achieved.
7. Compact size and less floor space is used.
8. Human effort is reduced.

APPLICATIONS [3]

1. Automobiles and aeroplanes
2. Medical tables, architectural use
4. for Paper cutting
5. for sheet cutting
6. for stamping operating
7. Oil and gas industry

FUTURE SCOPE

Pneumatic sheet cutting machine is a very versatile machine and has a lot of applications because of it flexibility and ease of doing operations. This machine can be converted into a punching machine by removing the blade and adding punching die to the end of the piston. [5] By increasing the pressure, we can cut more sheets collectively. Because of it enormous use in industries higher production rate can be achieved by balancing the forces and making the design more compact. [5] Software and advance controlling systems can improve the machine's performance. [5] By replacing the pneumatic circuit with rack and pinion arrangement, it can be converted into rack and pinion operated machine. The electric motor air compressor can also be replaced by an IC engine installed compressor where we are deprived of electric energy. [6] In this machine, the ideal stroke wastes the air which moves out through the out port of control unit. In future, mechanism can be developed to use the air again for the working of cylinder. [6]

CONCLUSION

This study revealed that the Pneumatic cutting machine is effective as compared to manual sheet cutting and bending approaches. The range of this cutting machine is that it can cut thick sheets by arranging a high pressure compressor. Efficiency of

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the machine can further be enhanced by suitably selecting the cutting blade material. This machine is advantageous to small sheet metal cutting industries because of its versatility and compactness. The literature survey also revealed that energy losses can be minimised by optimising the pressure in the cylinder. It can also be inferred that by using pneumatic system, minimum losses occur and hence are more reliable.

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