# DESIGN OF PNEUMATIC VICE

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***Abstract: Pneumatic systems are safer than electromotive systems because they can work in inflammable environment without causing fire or explosion. Apart from that, overloading in pneumatic system will only lead to sliding or cessation of operation. Unlike electromotive components, pneumatic components do not burn or get overheated when overloaded. The operation of pneumatic systems does not produce pollutants. The air released is also processed in special ways. Therefore, pneumatic systems can work in environments that demand high level of cleanliness. One example is the production lines of integrated circuits.***
***Keywords: pneumatic systems, pneumatic components, control valve, actuators type***

## I. INTRODUCTION

An incredible range of manufacturing systems use the force and power of fluids such as water, oil and air. Powered clamps open and close with the force of pressurized air or oil, large presses shape and form metal with hydraulic pressure, and assembly torque tools fasten components with pressurized air. In each example, fluid power provides the energy necessary to exert significant mechanical forces. Systems that use air are called pneumatic systems while systems that use liquids like oil or water are called hydraulic system. The pneumatic systems will be the subject of the first three sessions in the course starting from this session.

Pneumatics is all about using compressed air to make a process happens. Compressed air is simply the air we breathe squeezed into a small space under pressure. You might remember that air under pressure possesses potential energy which can be released to do useful work.

Their principle of operation is similar to that of the hydraulic power systems. An air compressor converts the mechanical energy of the prime mover into, mainly, pressure energy of the compressed air. This transformation facilitates the transmission, storage, and control of energy. After compression, the compressed air should be prepared for use.

## II. PROBLEM STATEMENT

1. To design and develop a model prototype of pneumatic power vice.
2. To fabricate the model of same.
3. To test the model under different conditions of load, and pressure of compressed air.
4. To design a system which will be able to clamping and unclamping the job using compressed air.

## III. OBJECTIVES

1. Supply elements: these elements are the sources of power that drives the system which are the compressors
2. Input elements: these elements are used to send signals to the final control elements and come in two forms; either as components that is actuated by the operator like push buttons or sensors that determine the status of the power elements such as limit switches and proximity sensors.
3. Processing elements: these elements may perform operations on the input signals before sending the signal to the final control elements such as non-return valves, directional control valves and presser control valves.
4. Final control elements: to control the motion of actuators such as directional control valves.
5. Power elements (actuators): these are the outputs of the pneumatic system which use the stored potential energy to perform a certain task such as pneumatic cylinders and motors.

## IV. METHODOLOGY

The methodology behind this project is using the double acting cylinder with compressed air to optimize the work of holding the job rigidly and operation has easy accesses to clamping and unclamping the job.

The reciprocating motion of the piston is converted into the pressure energy.

Pneumatic System & Components

Pneumatic components can be divided into two categories:

1. Components that produce and transport compressed air.
2. Components that consume compressed air.

All main pneumatic components can be represented by simple pneumatic symbols. Each symbol shows only the function of the component it represents, but not its structure. Pneumatic symbols can be combined to form pneumatic diagrams. A pneumatic diagram describes the relations between each pneumatic component, that is, the design of the system.

(a) Compressor

A compressor can compress air to the required pressures. It can convert the mechanical energy from motors and engines into the potential energy in compressed. A single central compressor can supply various pneumatic components with compressed air, which is transported through pipes from the cylinder to the pneumatic components. Compressors can be divided into two classes: reciprocator and rotary.

Fig. 4.1 (a) Compressor

  

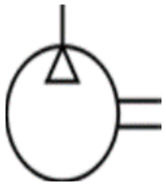

Fig. 4.1 (b) Pneumatic symbol of Compressor

b) Pressure regulating component

Pressure regulating components are formed by various components, each of which has its own pneumatic symbol:

(i) Filter – can remove impurities from compressed air before it is fed to the pneumatic components.

(ii) Pressure regulator – to stabilize the pressure and regulate the operation of pneumatic components

(iii) Lubricator – To provide lubrication for pneumatic components.


Fig. 4.2 (a) Pressure regulating component

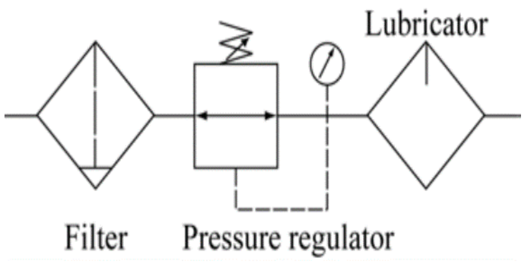


Fig. 4.2 (b) Pneumatic symbols of the pneumatic components within a pressure regulating component

## V. WORKING PRINCIPLE

Examples of components that consume compressed air include execution components (cylinders), directional control valves and assistant valves.

5.1 Execution component

Pneumatic execution components provide rectilinear or rotary movement. Examples of pneumatic execution components include cylinder pistons, pneumatic motors, etc. Rectilinear motion is produced by cylinder pistons, while pneumatic motors provide continuous rotations. There are many kinds of cylinders, such as single acting cylinders and double acting cylinders.

(i) Single acting cylinder

Therefore, it can only produce thrust in one direction. The piston rod is propelled in the opposite direction by an internal spring, or by the external force provided by mechanical movement or weight of a load.

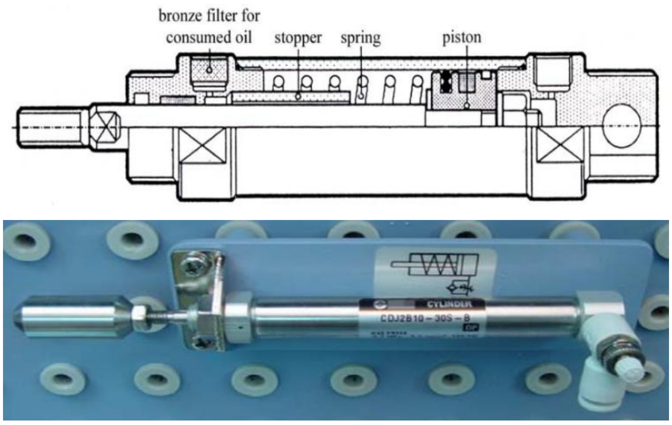


Fig-5.1 (a) Single acting cylinder

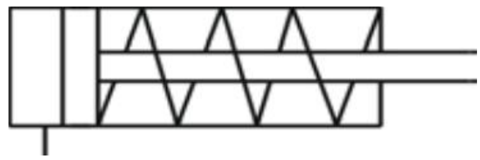

Fig-5.1 (b) Pneumatic symbol of a single acting cylinder

The thrust from the piston rod is greatly lowered because it has to overcome the force from the spring. Therefore, in order to provide the driving force for machines, the diameter of the cylinder should be increased. In order to match the length of the spring, the length of the cylinder should also be increased, thus limiting the length of the path. Single acting cylinders are used in stamping, printing, moving materials, etc.

(ii) Double acting cylinder

In a double acting cylinder, air pressure is applied alternately to the relative surface of the piston, producing a propelling force and a retracting force. As the effective area of the piston is small, the thrust produced during retraction is relatively weak. The impeccable tubes of double acting cylinders are usually made of steel. The working surfaces are also polished and coated with chromium to reduce friction.

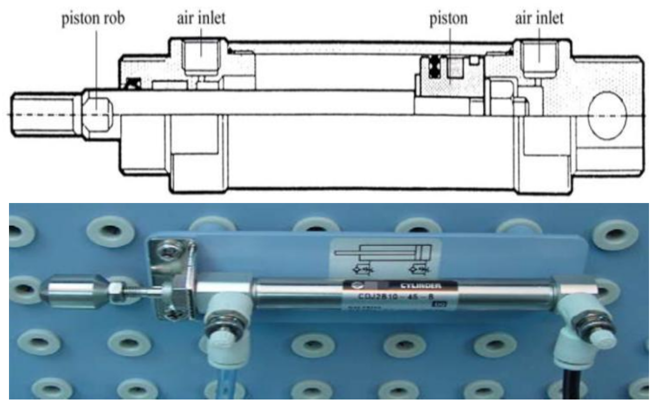


Fig. 5.1 (c) Double acting cylinder

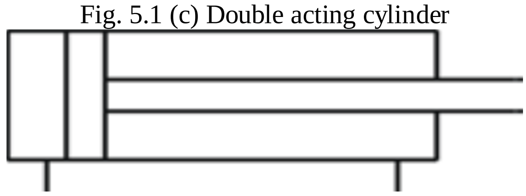

Fig.5.1 (d) Pneumatic symbol of Double acting cylinder acting cylinder

  

5.2 Directional control valve

Directional control valves ensure the flow of air between air ports by opening, closing and switching their internal connections. Their classification is determined by the number of ports, the number of switching positions, the normal position of the valve and its method of operation. Common types of directional control valves include 2/2, 3/2, 5/2, etc. The first number represents the number of ports; the second number represents the number of positions. A directional control valve that has two ports and five positions can be represented by the drawing in, as well as its own unique pneumatic symbol.

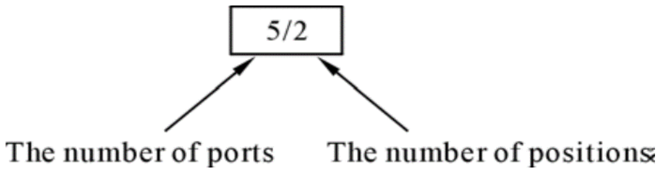

Fig 5.2(a) Describing a 5/2 directional control valve

(i) 2/2 Directional control valve

The structure of a 2/2 directional control valve is very simple. It uses the thrust from the spring to open and close the valve, stopping compressed air from flowing towards working tube 'A' from air inlet 'P'. When a force is applied to the control axis, the valve will be pushed open, connecting 'P' with 'A'. The force applied to the control axis has to overcome both air pressure and the repulsive force of the spring. The control valve can be driven manually or mechanically, and restored to its original position by the spring.

(ii) 3/2 Directional control valve

A 3/2 directional control valve can be used to control a single acting cylinder. The open valves in the middle will close until 'P' and 'A' are connected together. Then another valve will open the sealed base between 'A' and 'R' (exhaust). The valves can be driven manually, mechanically, electrically or pneumatically. 3/2 directional control valves can further be divided into two classes: Normally open type and normally closed type

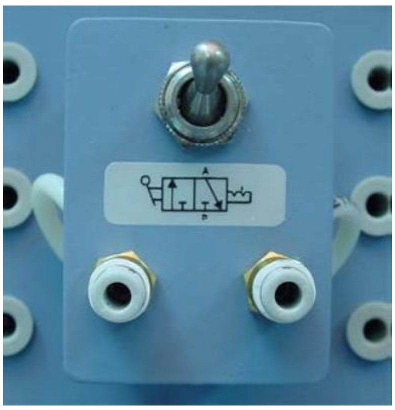
Fig. 5.2 (b) 3/2 directional control valve

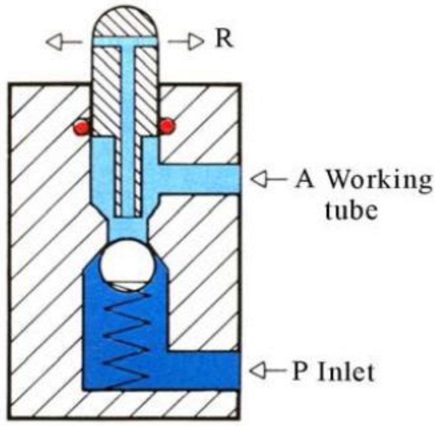

Fig. 5.2 (c) Cross section


Fig. 5.3 (c) Normally closed type

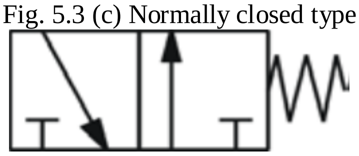
Fig. 5.2(d) Normally open type

(iii) 5/2 Directional control valve

When a pressure pulse is input into the pressure control port 'P', the spool will move to the left, connecting inlet 'P' and work passage 'B'. Work passage 'A' will then make a release of air through 'R1' and 'R2'. The directional valves will remain in this operational position until signals of the contrary are received. Therefore, this type of directional control valves is said to have the function of 'memory'.

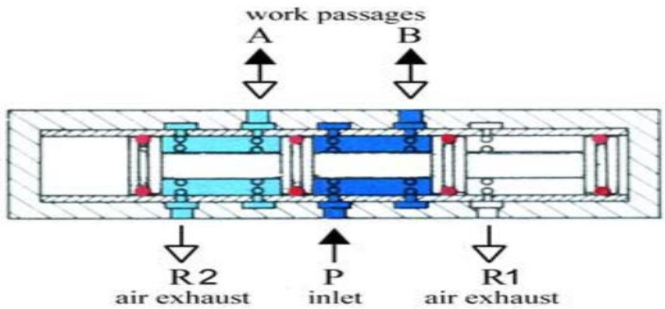

Fig. 5.2 (e) Cross section

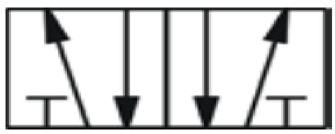
Fig. 5.2(f) Pneumatic symbol

5.3 Control valve

A control valve is a valve that controls the flow of air. Examples include non-return valves, flow control valves, shuttle valves, etc.

  

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(i) Non-return valve
A non-return valve allows air to flow in one direction only. When air flows in the opposite direction, the valve will close. Another name for non-return valve is poppet valve.

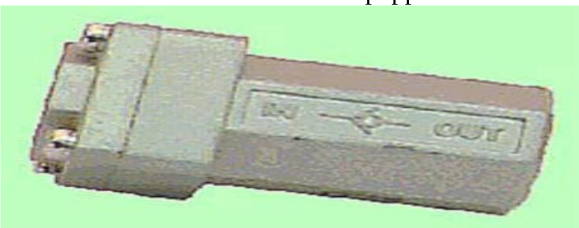


Fig. 5.3 (a) Non-return valve

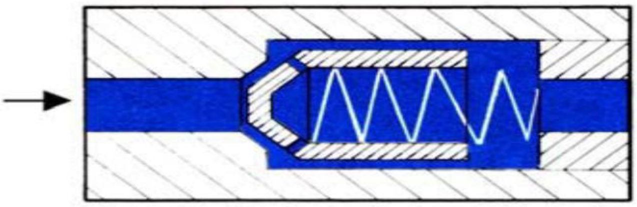


Fig. 5.3 (b) Pneumatic symbol

(ii) Flow control valve
A flow control valve is formed by a non-return valve and a variable throttle

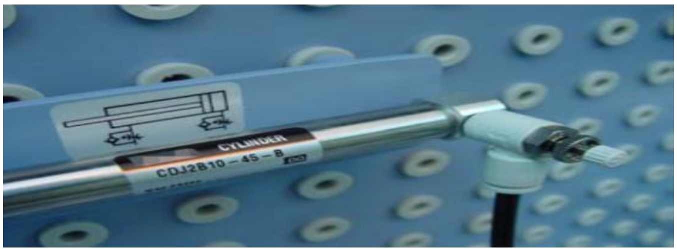


Fig. 5.3 (c) Flow control valve

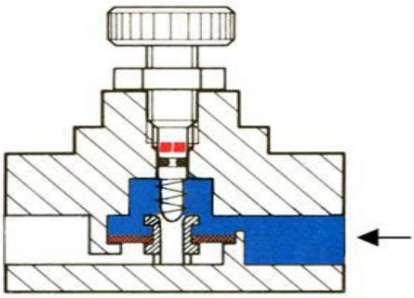


Fig. 5.3 (d) Cross section

## IV. DESIGN& SOLIDE MODEL

The machine should be such that it should be adopted by the farmers who produce the corn in small scale. It should be cost effective, which separates the corn seeds from its stem which every individual farmer needs in their periodical agricultural activities. Machine is portable so that it can be easily transported from one place to another. Bigger corn deseeding machine have disadvantages like higher cost and bulkier in size.

5.1 Design procedure
Before we proceed to the process of manufacturing, it's necessary to have some knowledge about the project design essential to design the project before starting the manufacturing. Maximum cost of producing a part of product is established originally by the designer.
When a new product or their elements are to be designed, a designer may proceed as follows:
•Make a detailed statement of the problems completely; it should be as clear as possible & also of the purpose
•for which the machine is to be designed.
•Make selection of the possible mechanism which will give the desire motion.
•Determine the forces acting on it and energy transmitted by each element of the machine
•Select the material best suited for each element of the machine.
•Determine the allowable or design stress considering all the factors that affect the strength of the machine part
•Identify the importance and necessary and application of the machine
•Problems with existing requirement of the machine productivity and demand.

5.2 Base frame design
A basic frame for a prototype is designed by mild steel channel (L beam), L Channel- MS Angles are L-shaped structural steel represented by dimension of sides & thickness. For e.g. 50x50x6 means, both the sides of angles are 50mm & thickness is of 6mm. There are various sizes of angles which are as follows :-( there are also equal & unequal angles). Equal angles: - They are angles having both the sides of equal dimensions. For e.g. refer below given diagram, in which both the sides are of dimensions "a".

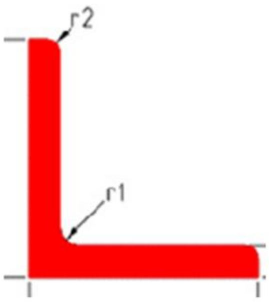


Fig. 6.1 L-angle bardimensions

| Size (mm) | Weight (Kgs) | Gauge (per m ) | Thickness (mm) |
|---|---|---|---|
| 20x20x3 | 0.274 | 0.899 | 3mm |
| 25x25x3 | 0.335 | 1.099 | 3mm |
| 25x25x5 | 0.548 | 1.798 | 3mm |
| 31x31x3 | 0.390 | 1.280 | 3mm |

Table:-5.1 Sizes With Section Weight of Equal Angles

By standard available sizes selected 1 inch = 25.4 mm so because that will be easily available and have appropriate size for frame

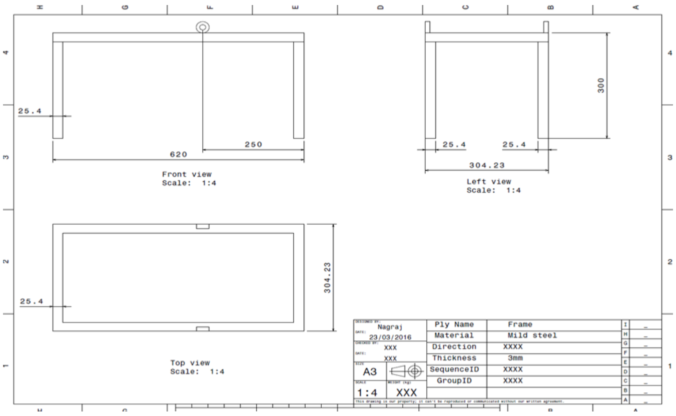


Fig. 6.2Drawing of table

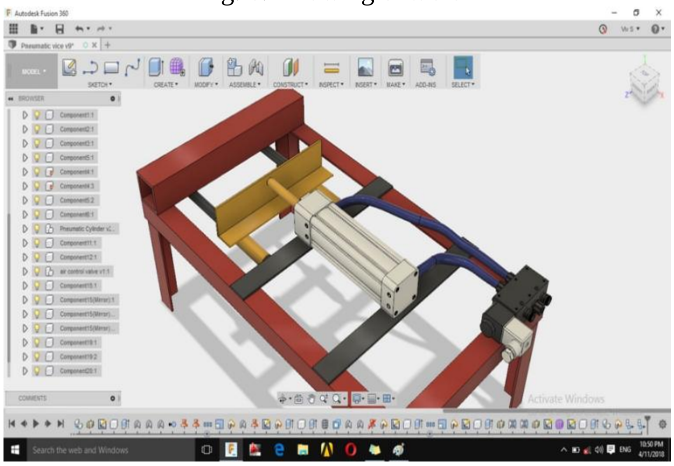


Fig. 6.33-D Solid model of pneumatic vice

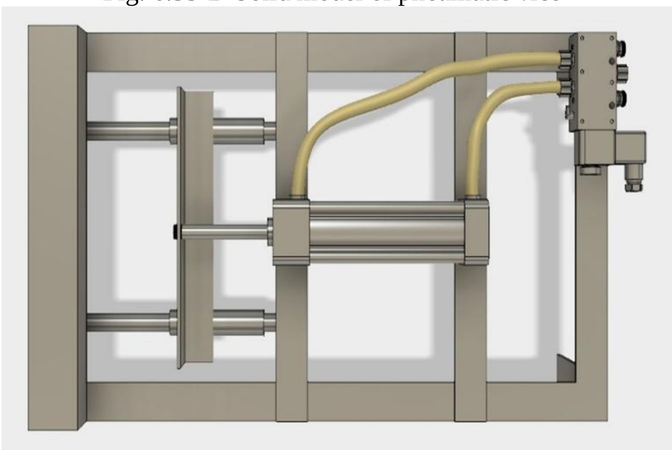


Fig. 6.4Top View Of Pneumatic Vice

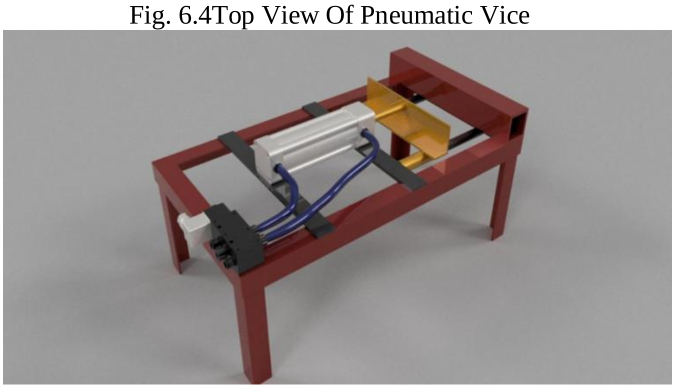


Fig. 6.53-D Model of pneumatic vice

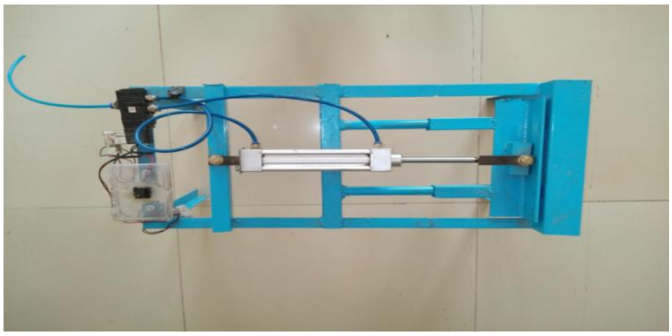
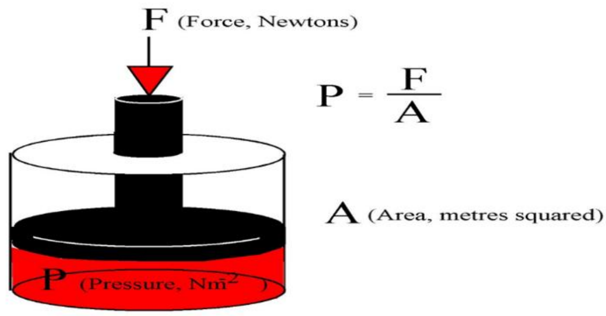


Fig. 6.6Experimental Setup

## VII. CALCULATION

Pressure Measurement
1 Bar = 100Kpa = 100KNm-2 = 14.5 PSI




Equation: P= F/A
P= 10 bar = 1.01 N/mm2
Diameter of piston = d = 50mm

A= (3.14 / 4) * (d *d)
= (3.14 / 4) * (50 * 50)
= 1963 mm2

P= F / A
1.01 = F / 1963
F = 2000 N
F= 200 Kg.
Selected pneumatic cylinder move 200 Kg. of force at 10 bar pressure

## VIII. SAFETY MEASURES WHEN USING PNEUMATIC CONTROL SYSTEMS

(i) Compressed air can cause serious damage to the human body if they enter the body through ducts like the oral cavity or ears.
(ii) Never spray compressed air onto anyone.
(iii) Under high temperature, compressed air can pass through human skin.
(iv) Compressed air released from the exhaust contains particles and oil droplets, which can cause damage to eyes.
(v) Even though the pressure of compressed air in pipes and reservoirs is relatively low, when the container loses its entirety, fierce explosions may still occur.
(vi) Before switching on a compressed air supply unit, one should thoroughly inspect the whole circuit to see if there are any loose parts, abnormal pressure or damaged pipes. (vii) A loose pipe may shake violently due to the high pressure built

up inside it. Therefore, each time before the system pressure is increased, thorough inspection of the entire circuit is required to prevent accidents.
(viii) As the force produced by pneumatic cylinders is relatively large, and the action is usually very fast,.

## IX. ADVANTAGES& DISADVANTAGES

**The Advantages of Pneumatic Systems**

Pneumatic control systems are widely used in our society, especially in the industrial sectors for the driving of automatic machines. Pneumatic systems have a lot of advantages.

(i) High effectiveness
Many factories have equipped their production lines with compressed air supplies and movable compressors. There is an unlimited supply of air in our atmosphere to produce compressed air. Moreover, the use of compressed air is not restricted by distance, as it can easily be transported through pipes. After use, compressed air can be released directly into the atmosphere without the need of processing.

(ii) High durability and reliability
Pneumatic components are extremely durable and cannot be damaged easily. Compared to electromotive components, pneumatic components are more durable and reliable.

(iii) Simple design
The designs of pneumatic components are relatively simple. They are thus more suitable for use in simple automatic control systems.

(iv) High adaptability to harsh environment
Compared to the elements of other systems, compressed air is less affected by high Temperature, dust, corrosion, etc.

(v) Safety
Pneumatic systems are safer than electromotive systems because they can work in inflammable environment without causing fire or explosion. Apart from that, overloading in pneumatic system will only lead to sliding or cessation of operation. Unlike electromotive components, pneumatic components do not burn or get overheated when overloaded.

(vi) Easy selection of speed and pressure
The speeds of rectilinear and oscillating movement of pneumatic systems are easy to adjust and subject to few limitations. The pressure and the volume of air can easily be adjusted by a pressure regulator.

(vii) Environmental friendly
The operation of pneumatic systems does not produce pollutants. The air released is also processed in special ways. Therefore, pneumatic systems can work in environments that demand high level of cleanliness. One example is the production lines of integrated circuits.

(viii) Economical
As pneumatic components are not expensive, the costs of pneumatic systems are quite low. Moreover, as pneumatic systems are very durable, the cost of repair is significantly lower than that of other systems.

**Advantage of Pneumatic Vise**

Quick operation.
Stable and rigid design.
Extremely high clamping force.
High accuracy and repeatability.
Reduces production costs.
Design is compact and very simple to operate requiring almost no maintenance.
Can be mounted horizontally or vertically.

**Disadvantage of Pneumatic Systems**

Although pneumatic systems possess a lot of advantages, they are also subject to many limitations.

(i) Relatively low accuracy
As pneumatic systems are powered by the force provided by compressed air, their operation is subject to the volume of the compressed air. As the volume of air may change when compressed or heated, the supply of air to the system may not be accurate, causing a decrease in the overall accuracy of the system.

(ii) Low loading
As the cylinders of pneumatic components are not very large, a pneumatic system cannot drive loads that are too heavy.

(iii) Processing required before use
Compressed air must be processed before use to ensure the absence of water vapor or dust. Otherwise, the moving parts of the pneumatic components may wear out quickly due to friction.

(iv) Uneven moving speed
As air can easily be compressed, the moving speeds of the pistons are relatively uneven.

(v) Noise
Noise will be produced when compressed air is released from the pneumatic components.

## X. CONCLUSIONS

The project thus gives a system that can easily fixed the work piece & work on it. The pneumatic vice provide extremely high clamping force & high accuracy and repeatability. Pneumatic system can get high production rate. When compressed air is released from the pneumatic components then noise can produced. The operation of pneumatic systems does not produce pollutants.
So, the pneumatic vice can be use easily.

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