

DIESEL MECHANIC



MINING QUALIFICATIONS AUTHORITY

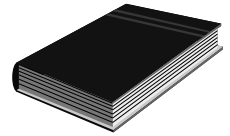
CODE: PN - 1

PRINCIPLES OF PNEUMATICS

INDEX

The following elements are contained in this learning guide:

TOPIC	PAGE NUMBER
Index	2
Source reference	3
Objective	4
Hazard Identification and Control (HIAC) form	5
Basic principles of pneumatics	6 – 7
Basic pneumatic system components	8 – 13
Self Test	14 – 15



SOURCE REFERENCES

Demonstration by a competent person, e.g. a Training Officer.

FESTO – Pneumatics Basic Level Textbook

OBJECTIVE

You will be learning towards the outcome “Principles of pneumatics”. Whilst learning towards the outcome you will be required to achieve the following:

- Know the important factors to consider when working with a pneumatic system.
- Know the five basic components in a pneumatic system and their functions.
- Know the factors that cause the force in an actuator and the speed at which the actuator moves.
- Know the daily maintenance done on a receiver.

On completion of this module, the learner must be able to:

- State the two most important factors to consider when working with a pneumatic system.
- State the five basic components in a pneumatic system and their functions.
- State the factors which cause the force in the actuator and the speed at which the actuator moves.
- State the daily maintenance which must be done on the receiver.

During this process you must adhere to certain specified requirements as listed in the Module.

ASSESSMENT AND EVALUATION CRITERIA

You will be assessed, when you are confident that you may achieve the outcomes as listed, to determine your competence as measured against the required criteria. This assessment will be in line with accepted best practices regarding assessment.

- A theoretical assessment will be set at the end of the module and must be completed without using reference.
- The learner will be required to answer all the questions without any reference.

HAZARD IDENTIFICATION AND CONTROL (HIAC) FORM**PN - 1****PRINCIPLES OF PNEUMATICS**

STEPS IN OPERATION / PROCESS	POTENTIAL ACCIDENT / INCIDENT	CONTROLS (BY RESPONSIBLE PERSON)
1. Construct a pneumatic circuit.	<ul style="list-style-type: none"> Improper or careless handling of pneumatic components and pipes can lead to damage of equipment. 	<ul style="list-style-type: none"> Always handle components and pipes correctly, and with great care.
2. Use of compressed air in a pressurised circuit.	<ul style="list-style-type: none"> Circuit under pressure. 	<ul style="list-style-type: none"> Wipe components and panel clean after use and store components. Ensure circuit is de-energized before removing components or pipes.
3. Insure work area is safe.	<ul style="list-style-type: none"> Dirt particles in eyes and laceration of skin. 	<ul style="list-style-type: none"> Wear correct PPE.

NOTE: Before doing the practical work contained in this module, the learner must study the content of the above HIAC form again and then sign the statement below.

The above risks, which will be encountered in this module, are fully understood and will be controlled during the practical work.

Signature of learner:

Signature of Training Officer:

Date:

1. BASIC PRINCIPLES OF PNEUMATICS

ITEM / TASK: Introduction.

DESCRIPTION:

- A. Industrial plants use a power system of one type or another. Work may be done by means of a substance under pressure. The substance can be either a gas, e.g. compressed air, or a liquid, e.g. oil. A system that uses gas for transmitting force is called a "pneumatic" system.
- B. Pneumatic systems are often used in the industry e.g. in rock drills and mechanical loaders in the mining environment and in the control system of the dragline in the open pits.
- C. When working with pneumatics there are two factors to consider, namely pressure and flow.

ITEM / TASK: Factors.

DESCRIPTION:

The factors considered for any pneumatic circuit are **pressure** and **flow**.

A. **Pressure:**

- Pressure is the continuous force applied on or against an object.
- Pressure is defined as force per area. It is measured and expressed in Pascal (Pa) or bar.



1 kPa = 1000 Pa. The unit kPa is used in pneumatics and hydraulics because the pressures are high. Blow up a balloon and you have created pressure. (Fig 1)

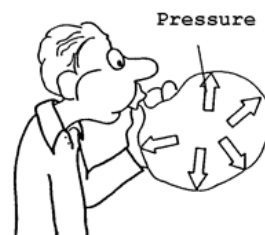


FIG 1.

B. **Flow:**

- Flow is the volume of air moved through a system in a certain time.
- Flow is expressed in terms of cubic meter per minute (m^3/min) or litres per second (l/s).



FIG 2.

- Flow and pressure are related but are obviously not the same. Pressure can cause flow. Let the air out of the balloon and you have caused it to flow. (Fig 3)

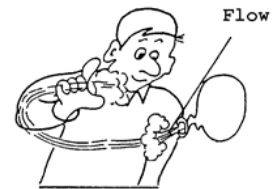


FIG 3.

- It is possible to have a high pressure and a relatively low flow. In Fig 4, a cylinder is filled very slowly through a small pipe at a high pressure. The piston will move very slowly but will be able to lift a heavy load due to the high pressure.
- Conversely, you can have a high flow and a low pressure. In Fig 5, a compressor is supplying a large volume of air at a very low pressure to a cylinder. You could stop this piston with one finger, but if the load is very small it will travel at an extremely high speed.

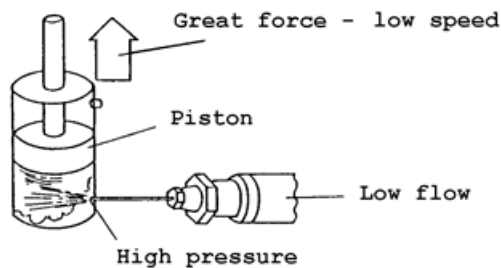


FIG 4.

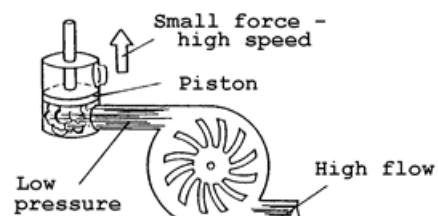


FIG 5.

You can see from the examples given that:

- PRESSURE** causes the **FORCE** in the actuator. The actuator can either be a cylinder or an air-motor.
- Flow causes the **SPEED** at which the actuator will move.

NB.

When a system is subject to a certain pressure, it is important to remember that there is equal force acting on every surface of that system. In Fig 6, a force of 10N is acting in all directions and on all surfaces.

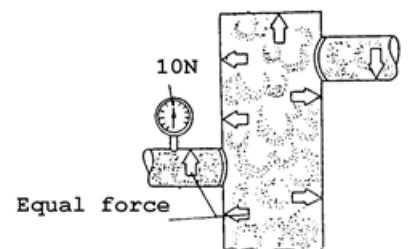


FIG 6.

2. BASIC PNEUMATIC SYSTEM COMPONENTS

ITEM / TASK: Basic pneumatic circuit.

DESCRIPTION:

- A. There are many types of pneumatic systems used in the industry. Briefly, a pneumatic system is a circuit in which air under controlled pressure is transmitted through piping thus creating force to do work.
- B. The basic pneumatic circuit consists of the following parts. (See Fig 1)
- Compressor.
 - Tank / Reservoir
 - Service unit.
 - Directional control valve.
 - Actuating unit.

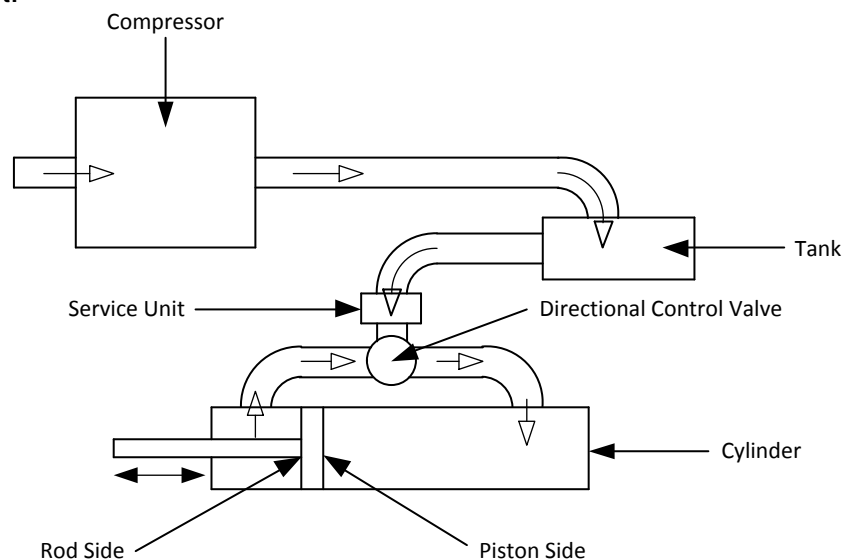


FIG 1.

a. **Compressor.**

- A compressor produces compressed air, i.e. air which is under pressure. The main function of the compressor is to take in air at atmospheric pressure (about 100 kPa) and compress it to the desired working pressure which can be as high as 1500 kPa.
- The type of compressor used depends on the working pressure and the volume of air which has to be supplied.

i. Piston Compressors.

- ✓ The piston compressor is a commonly used type (Fig 8). Its normal pressure range is from 100 kPa up to 1500 kPa.
- ✓ The piston compressor operates in the following manner:
 - When the crank shaft is rotating, the pistons are moved back and forth in the cylinder. The head end of the cylinder contains the valves.
 - As the piston moves back, the pressure in the cylinder will reduce to such an extent that air at atmospheric pressure will open the valves and enter into the vacant space.
 - On the return stroke of the piston the intake valve will close and the piston will compress the air in the cylinder. When the piston has almost completed its return stroke the air pressure will be high enough to force the discharge valve open.

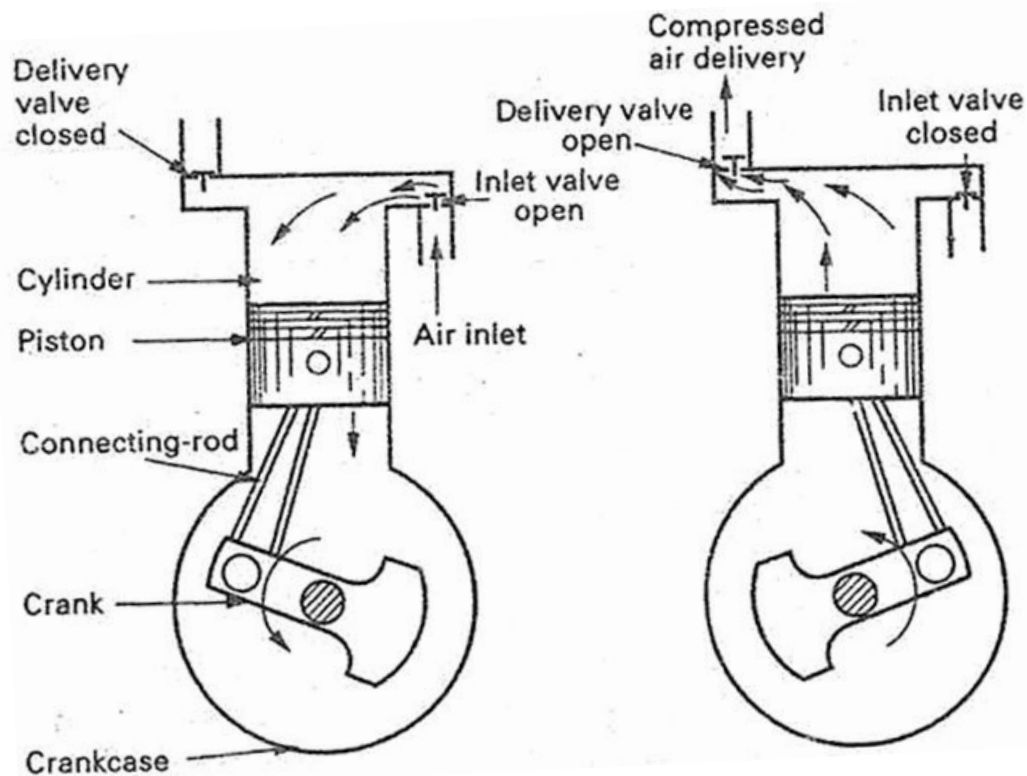


FIG 8.

ii. Sliding Vane Compressors.

- ✓ This compressor consists of a rotor with radial slots mounted off-centre in a round casing. (Fig 9)
- ✓ The sliding vane compressor operates in the following manner:
 - The rectangular vanes can slide in and out in the slots. The confined space formed between two consecutive vanes of the rotor and the casing forms a chamber.
 - As the rotor turns the volume of the chambers on the intake port side will increase and allow the air at atmospheric pressure to flow into the compressor.
 - As the rotor continues to turn, the chambers between the vanes gets progressively smaller. When the chamber approaches the outlet port the air is compressed and delivered to the receiver.

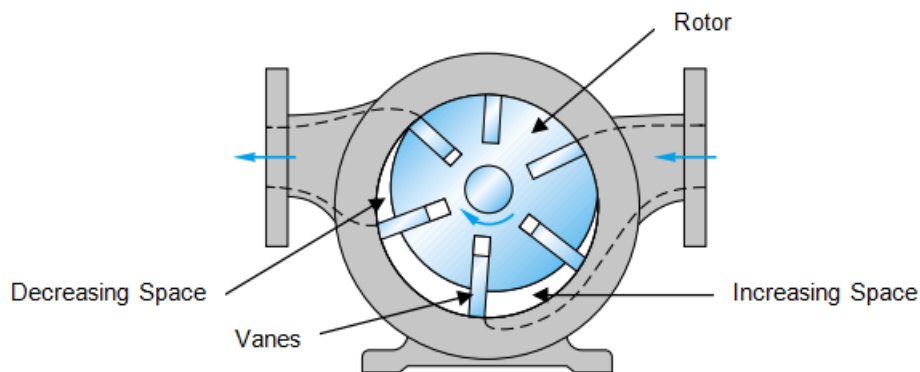


FIG 9.

iii. Screw Compressors.

- ✓ This compressor consists of two rotors. One with a concave (female) profile and the other with a convex profile. (Fig 10)
- ✓ The screw compressor operates in the following manner:
 - When the rotor is turning the air is drawn in at the inlet side. It is then trapped between the rotors and the casing. When the rotors mesh, the air is carried along in a progressively smaller space until it is discharged.

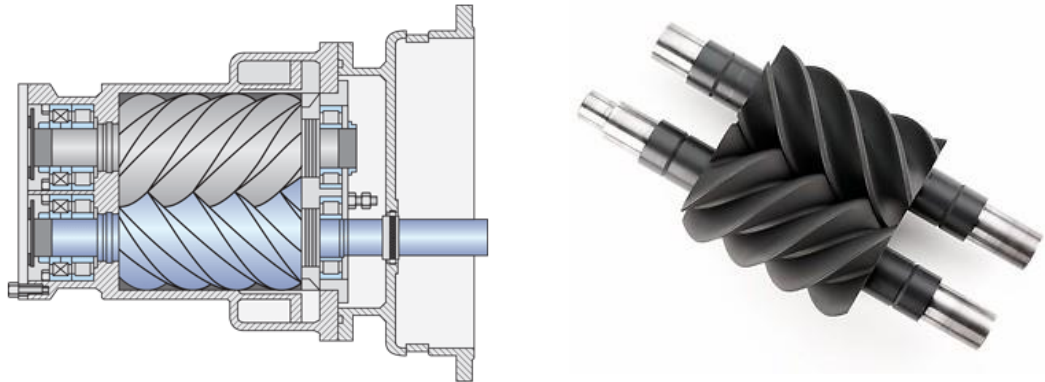


FIG 10.

iv. Turbo Compressors.

- ✓ This type of compressor is commonly used in the compressor houses on different mines. They are especially suitable for delivering large volumes of air and consist of a number of impellers of different sizes.
- ✓ The pressure of the air is raised in stages of approximately the same amount.

b. Receiver or Tank.

- The receiver stabilises and stores the compressed air supply. It smoothens out pressure fluctuations in the network when air is consumed. The large surface area of the receiver also helps to cool the air, thereby removing some of the moisture in the air.
- As a safety measure, the receiver must always be fitted with a pressure relief valve.
- This valve will discharge excess air when the system is over pressurized. It must be checked daily. The water in the receiver must be drained daily through the water drain cock. (Fig 11)

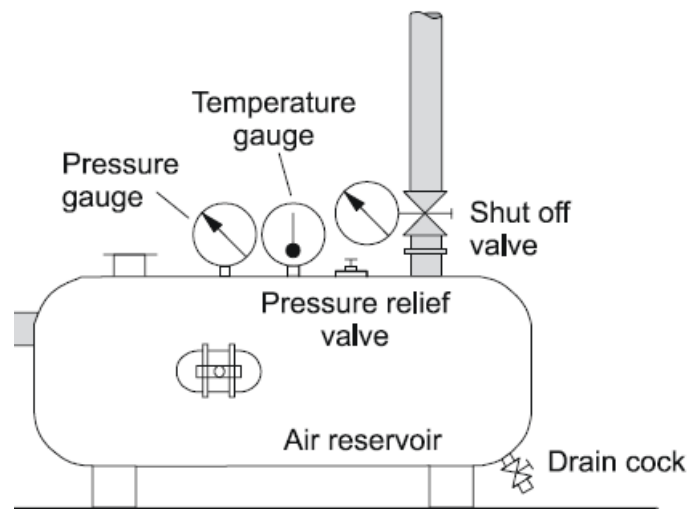


FIG 11.

c. **Service Unit.**

- The function of the service unit (Fig 12) is to prepare the air for use in the system.
- The air service unit is a combination of the following :
 - i. Compressed air filter (with water separator)
 - ii. Compressed air regulator
 - iii. Compressed air lubricator



FIG 12.

- i. The **compressed air filter** has the job of removing all contaminants from the compressed air flowing through it as well as water which has already condensed. The compressed air enters the filter bowl through guide slots. Liquid particles and larger particles of dirt are separated centrifugally collecting in the lower part of the filter bowl. The collected condensate must be drained before the level exceeds the maximum condensate mark, as it will otherwise be re-entrained in the air stream.
- ii. The purpose of the **regulator** is to keep the operating pressure of the system (secondary pressure) virtually constant regardless of fluctuations in the line pressure (primary pressure) and the air consumption.
- iii. The purpose of the **lubricator** is to deliver a metered quantity of oil mist into a leg of the air distribution system when necessary for the operation of the pneumatic system.

d. **Control valves.**

- These valves control the direction in which the air will flow and the amount of air that will flow in the circuit or in a portion of the circuit.

e. **Actuating unit.**

- The actuating unit may be a cylinder e.g. the air-leg on a rockdrill, an air motor, the motor used on a winch, or an air-operated pump.

**DO THE SELF TEST ON THE NEXT PAGE
BEFORE ATTEMPTING THE ASSESSMENT.**



SELF TEST 1

1. What are the two most important factors to consider in a pneumatic system?

2. What are the measuring units for the above factors?

3. What causes the force in the actuator?

4. What causes the speed at which the actuator moves?

5. State the five basic components in a pneumatic system as well as their functions?

<u>Component</u>	<u>Functions</u>

6. What daily maintenance must be done on the receiver?

Refer to your notes to check your answers.

Ask your Training Officer to check your work and if it is correct, to sign below.

LEARNER	TRAINING OFFICER
DATE :	DATE :
SIGNATURE :	SIGNATURE :



REMEMBER ALWAYS WORK SAFE

Once you have passed the entire practices, you are now at liberty to request a Formative Assessment from your Assessor.