

MENG2520 Pneumatics and Hydraulics

Module 6 – Pneumatic Equipment

-Ancillary Equipment

Pneumatic Equipment – Ancillary Equipment

In addition to the core equipment in a pneumatic system, there are a number of ancillary equipment which are required to support the operation of the system including the preparation of the air

In this Module we will study

- Filters, Regulators/Relief Valves, Lubricators
- Aftercoolers, Moisture Removal, Heaters
- Silencers, Valves, Accumulators

Pneumatic System

Air Compressor – reduces volume of atmospheric air and hence increases its pressure

Air Dryer – reduces moisture from air after compression

Air Tank – stores compressed air and acts an 'infinite' supply for the systems

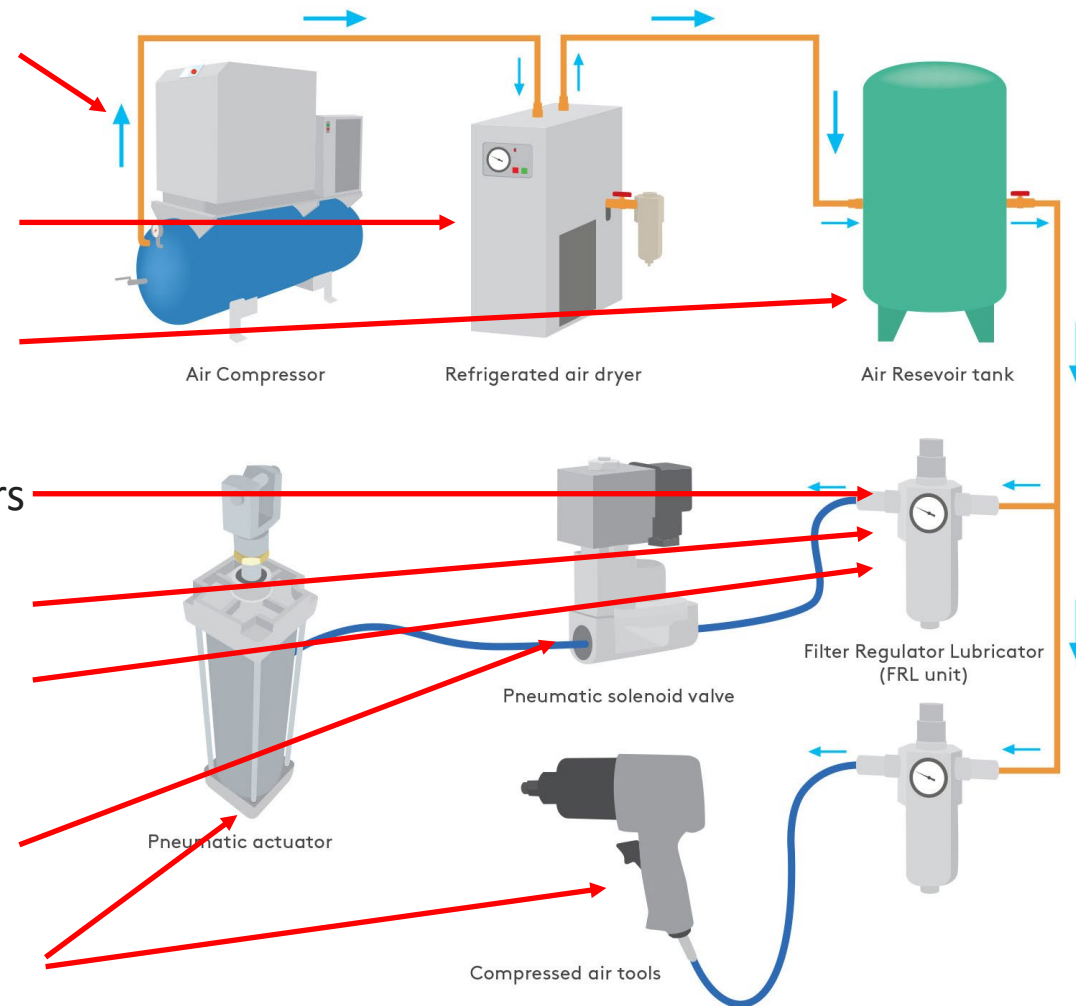
Filter – removes contaminants that can damage DCVs and actuators

Regulator – reduces the pressure to the actuator

Lubricator – adds a fine mist of oil for lubricating the DCV and actuator's moving parts

Valve – controls the direction and movement of the air

Actuator – converts the pneumatic power into mechanical power

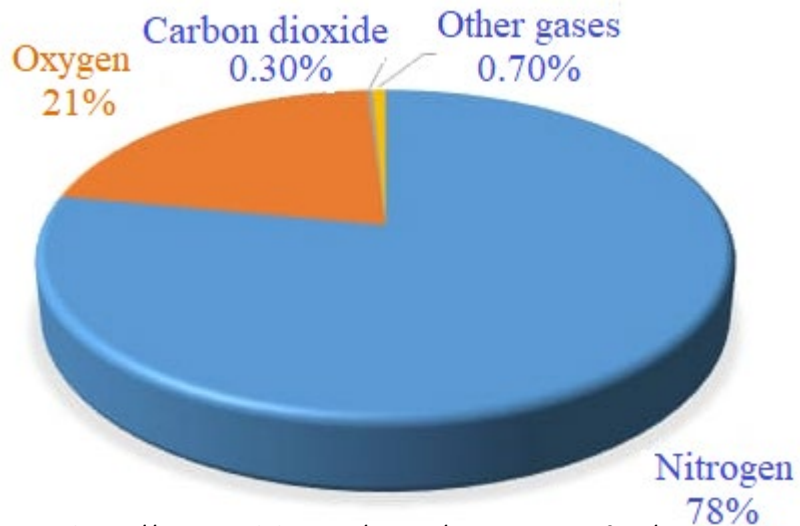


Properties of Air

Air is a composition of various gases and is present everywhere in our atmosphere.

Air also includes water vapours, otherwise known as humidity

Air can also include contaminants such as dust, soot, or other polluting gases



<https://www.embibe.com/exams/composition-of-air/>



<https://ychef.files.bbci.co.uk/976x549/p06zbdgm.jpg>

Air Preparation

The goal of the air preparation equipment is to condition the atmospheric air for use in a pneumatic system

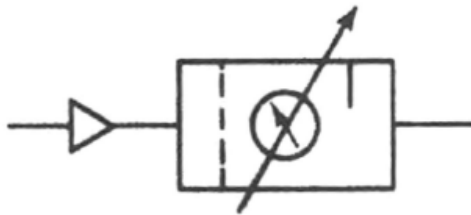
- Remove contaminants: filter(s)
- Set system pressure: regulator
- Add lubrication: lubricator
- Remove moisture: dryer
- Cool air: cooler
- Heat air: heater

<https://ychef.files.bbci.co.uk/976x549/p06zbdgm.jpg>

FRL Unit – Filter Regulator Lubricator

Often an FRL Unit is used which is a package set of

Filter
Regulator
Lubricator



Schematic Symbol



https://static.pipestock.com/media/catalog/product/cache/53f7e7bf262f1a75275189d121ad7ff7/p/2/p21560719_8.jpg

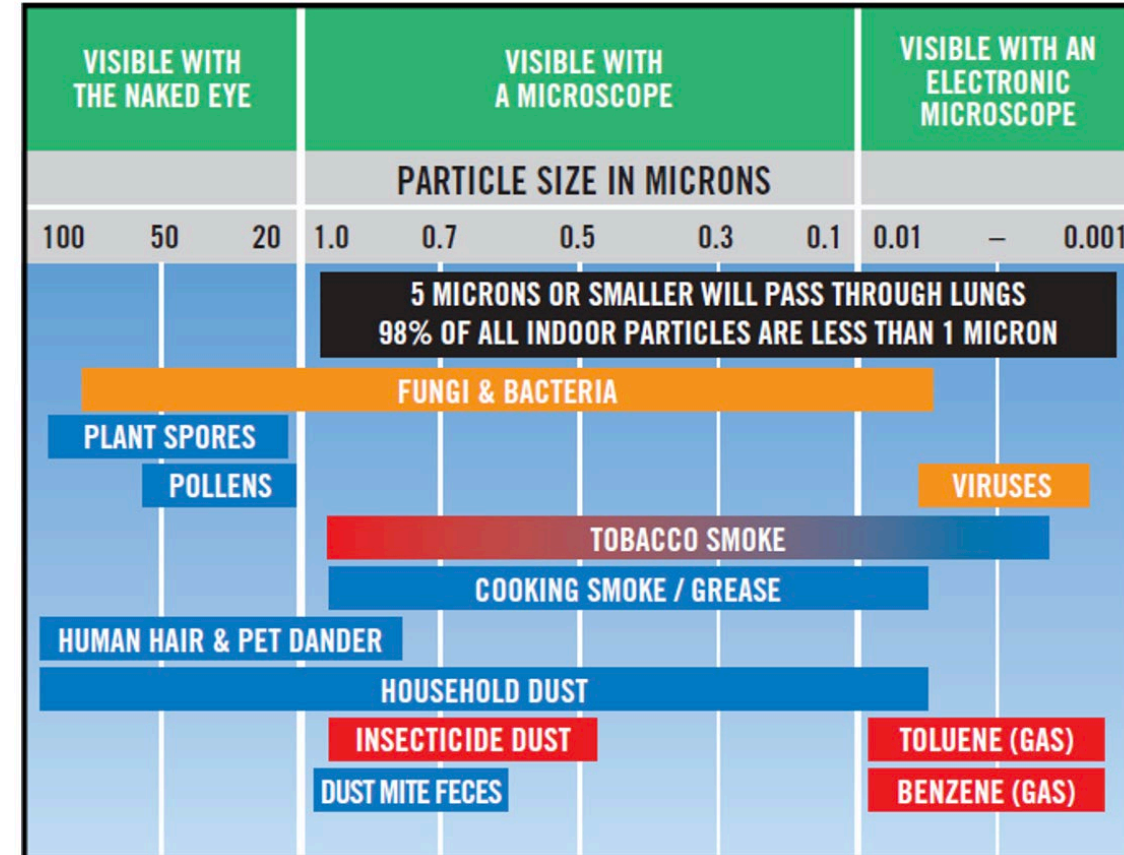
Filters

Atmospheric air contains a mixture of contaminations which can affect the efficiency and working life span of pneumatics systems, these include:

- Dust
- Fumes
- Bacteria

Other contaminations can be added during compression of the air. These includes:

- Compressor lubricant
- Fragments arising from the wear and tear of compressor distribution system
- Filters need to work to remove particles on a microscopic scale.



<https://myniagaraonline.com/wp-content/uploads/2023/02/airquality.jpg>

Filters - Breather

The first stage of filtering occurs at the inlet of the compressor, or the 'breather'

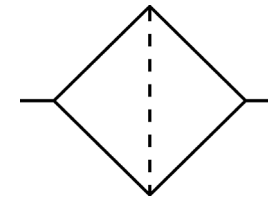
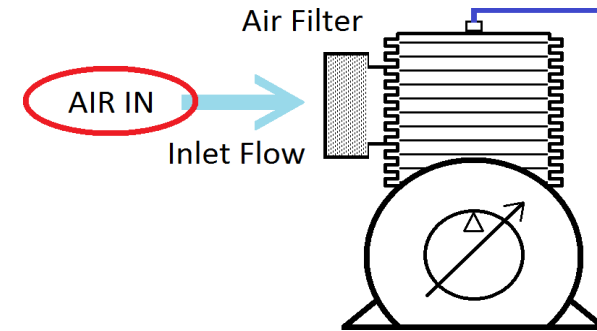
These filters come integral to the compressor assembly

Usually the amount of contaminate removal depends on the requirements of the compressor

Many dry or oil bath filters are available. Most are made of cotton or felt material held in an open mesh screen



<https://www.tenaquip.com/images/large/t/tyt024.webp?1631565127>



Schematic Symbol

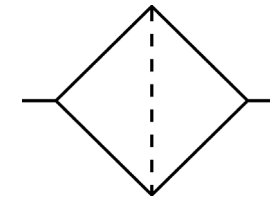
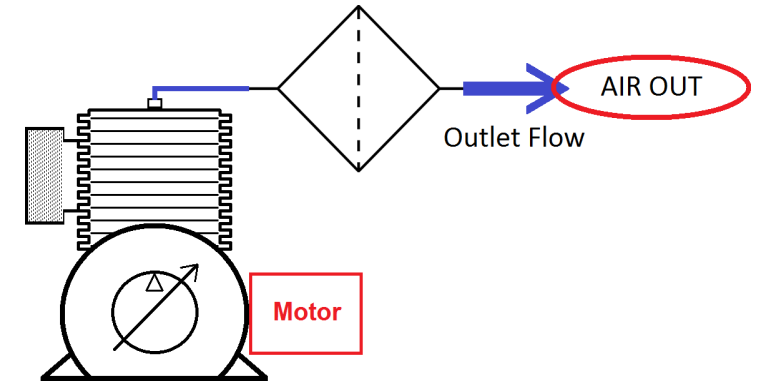
Filters - Strainer

The second stage of filtering occurs at the outlet of the compressor, or the 'strainer'

These filters are design to remove very small contaminants that may be introduced by the compressor

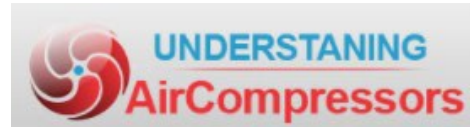
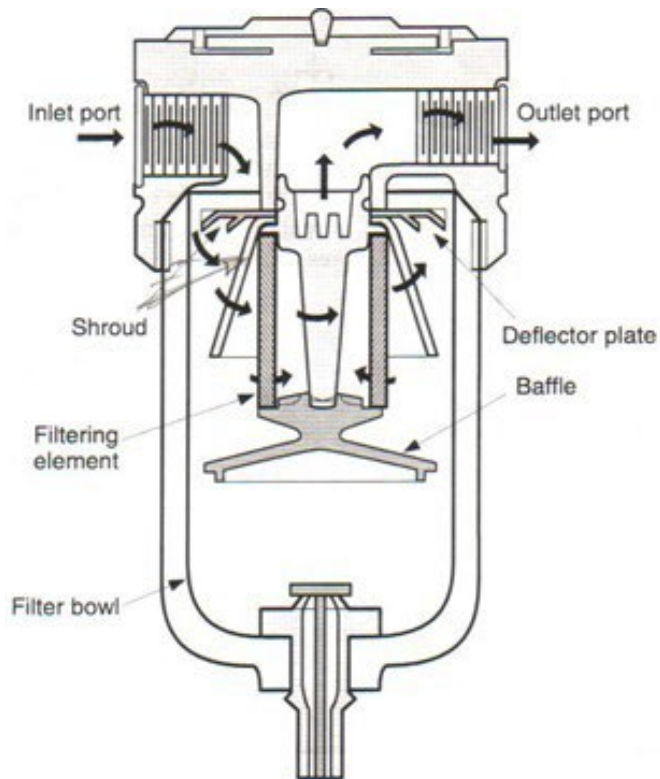
- Compressor lubricant
- Fragments arising from the wear and tear of compressor distribution system

They must operate at system pressure



Schematic Symbol

Filters - Strainer



Air Flow Is Only One Way
Make sure you install it with
air moving in the direction of
the arrow on the cap.

Mini air filter typically
has a 1/8 NPT female
thread on both sides



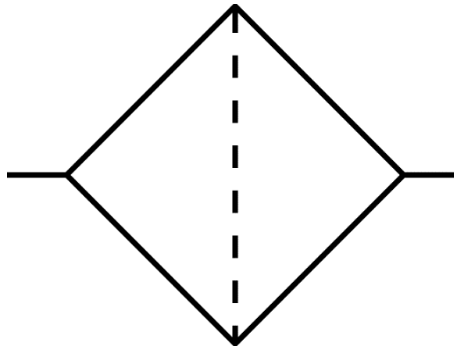
This element is sintered
bronze or brass. It could
also be made of sintered
plastic. Typical size is
30 - 40 micron air passage.
Much finer filtration is
available if needed.

Filter bowl is typically
polycarbonate. We would
pick one with a metal shield
for greater protection.

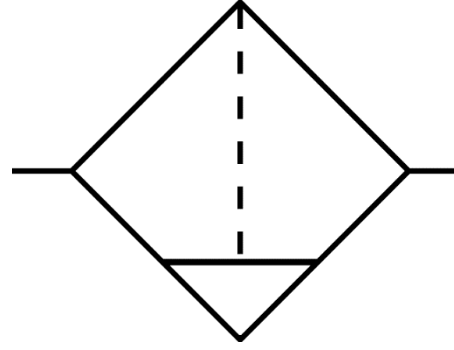
Bowl drain is necessary to
rid the bowl of water and debris.
Bowl can be removed, **ONCE AIR
IS DUMPED**, to empty as well.

<https://understanding-air-compressors.com>

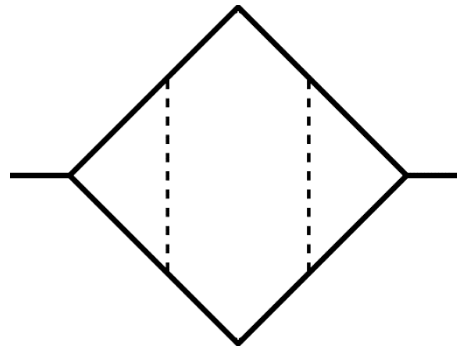
Filters - Symbols



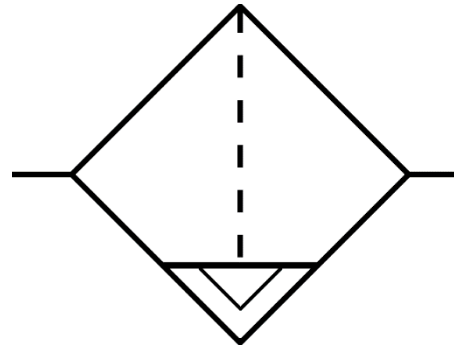
Basic filter



Filter with drain



Micro filter



Filter with automatic drain

Pressure Regulator

A Pressure Regulator provides a constant pressure to a pneumatic system

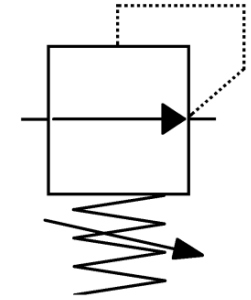
Adjusting the handle applies variable force on the diaphragm.

That force is counteracted by the force created by the Outlet Pressure.

The equilibrium between the two forces sets the position of the Poppet Valve.

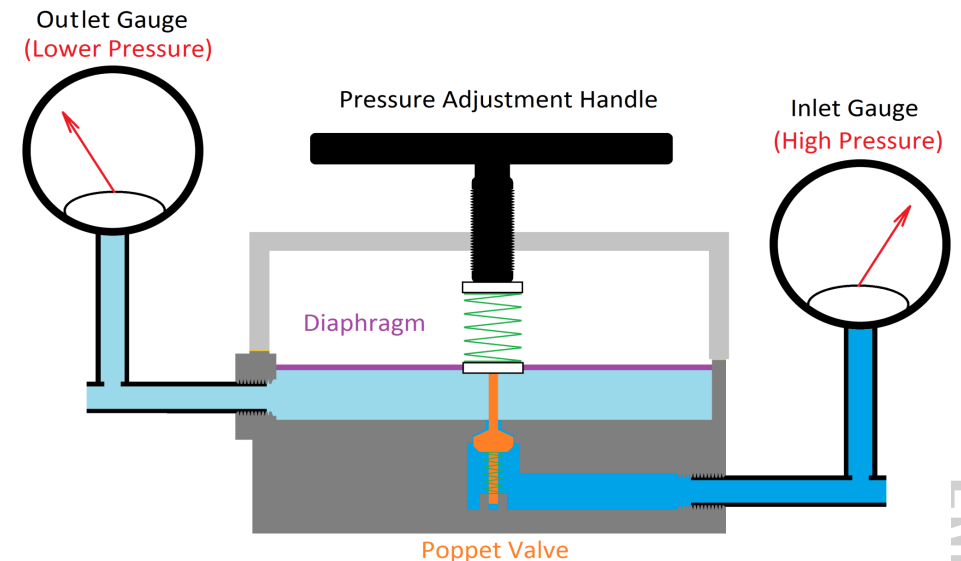
If the Outlet Pressure is higher than the set pressure, the Poppet valve closes and blocks the air flow until the equilibrium is established again.

If the Outlet Pressure is too low; the Poppet opens and allows the air to flow until the equilibrium is established.



Schematic Symbol

https://www.festo.com/media/pim/070/D15000100143070_488x366.jpg

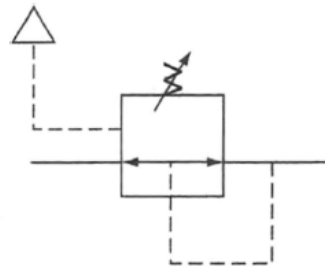


Pressure Relief Valve (PRV)

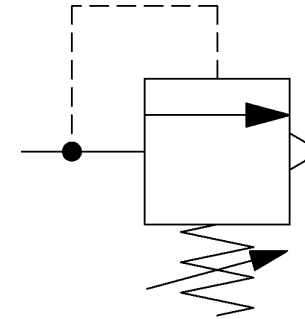
In the case of 'over-pressure' in a pneumatic circuit, a PRV is used to vent extra pressure to atmosphere.

Used for:

- Compressor runaway
- Back-load pressure development (When a load on a cylinder has unexpected back force, back pressure is developed in the system and the PRV releases it. Set pressure in maintained)
- When a load on a cylinder has unexpected back force, back pressure is developed in the system and the PRV releases it. Set pressure in maintained
- A combination Pressure Regulator and Pressure Relief Valve is shown



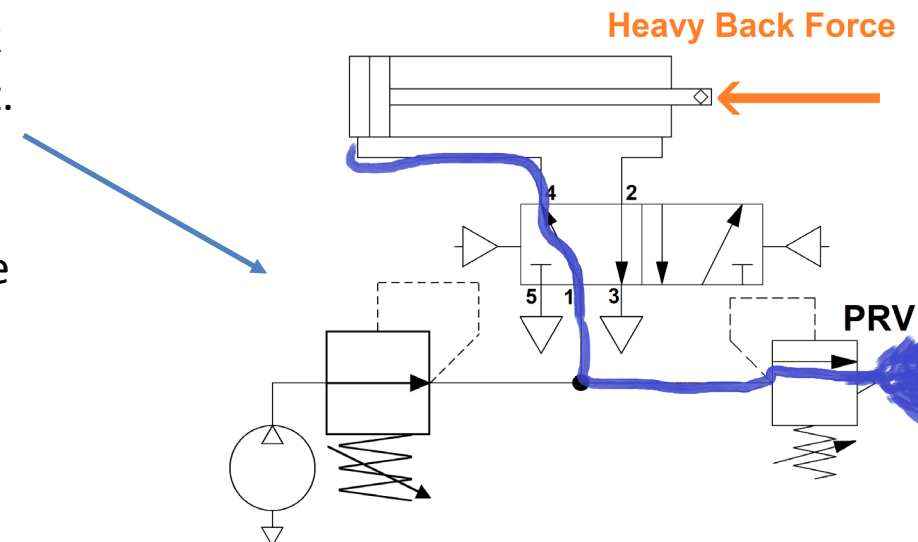
Schematic Symbol



Schematic Symbol



<https://cdn.shopify.com/s/files/1/0572/1787/6152/collections/pressure-relief-valves.jpg?height=188&v=1677041555&width=188>



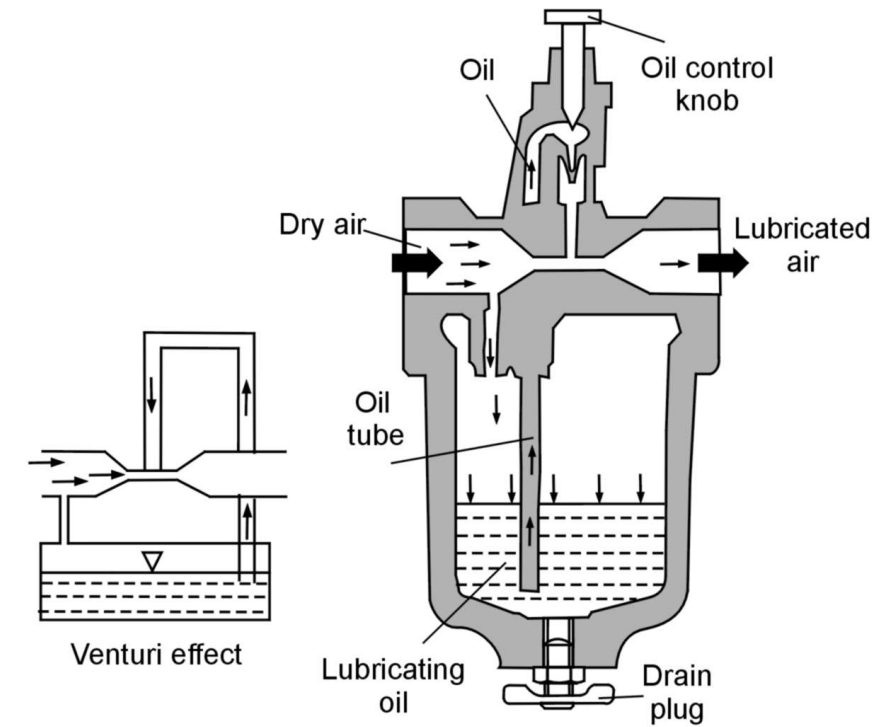
Lubricator

Some pneumatic system require a small amount of lubrication for smooth and effective operation of the moving actuators and control devices

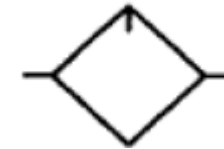
A lubricator is used to add a fine oil mist into the compressed air

Through the venturi effect, the passing air siphons oil from a reservoir and through a control needle valve orifice, the oil is metered and misted before being mixed with the passing air.

Most pneumatic systems in automation *do not* require lubrication
Most pneumatic hand held tool applications *do* require lubrication



<https://mechdiploma.com/sites/default/files/7777777777777777.jpg>



Schematic Symbol

Moisture Removal

During the compression process, the water vapor in the air compresses to moisture which can condense in the receiver, be separated in the filter, but moisture will still remain and needs to be further removed

Moisture in a pneumatic system can

- wash away lubricants resulting in high friction of moving parts (actuators and control equipment) impacting performance and longevity of components
- result in rusting and cause damage to plumbing and fittings
- dilute paint in spray painting applications-
- freeze and cause blockages

Moisture Separators

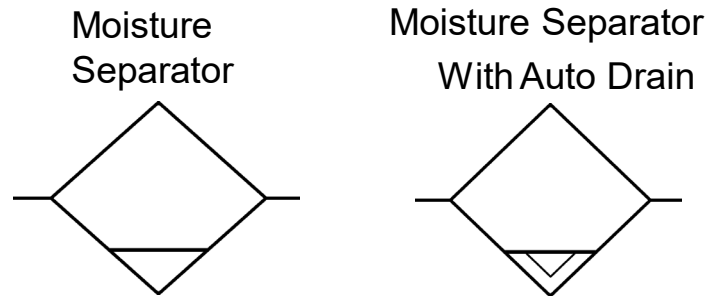
Aftercoolers

Air Dryer

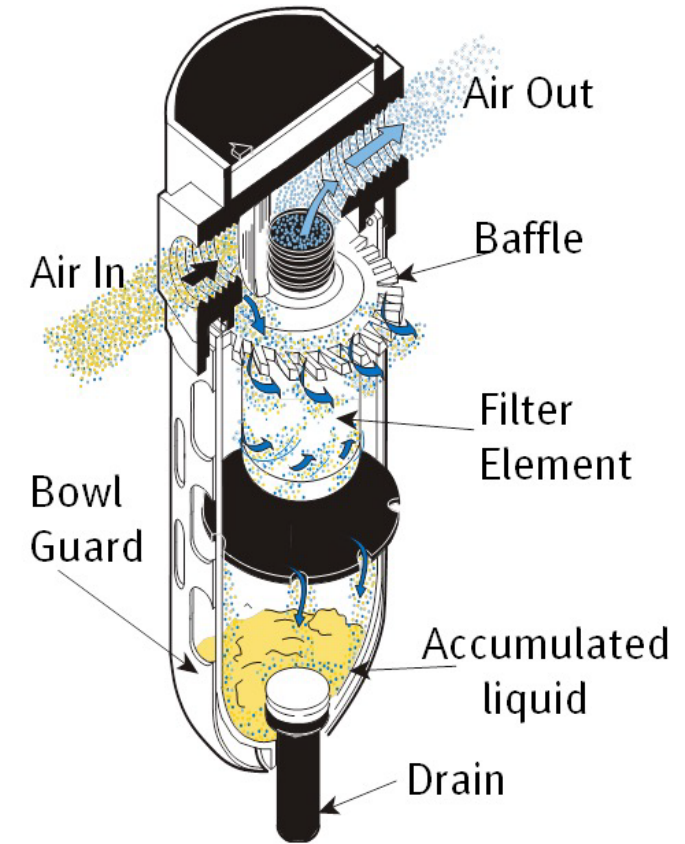
Moisture Separators

Moisture separation occurs through a mechanical means where air is passed through a baffle which causes the air to spin, and through centrifugal acceleration the water particles accelerate in a radial outward movement and collect on the filter body and drain into the bowl.

Moisture separators are commonly found integral with a filter



Schematic Symbol



<https://www.airbestpractices.com/sites/default/files/ParticulateFilter.jpg>

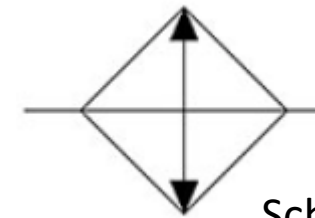
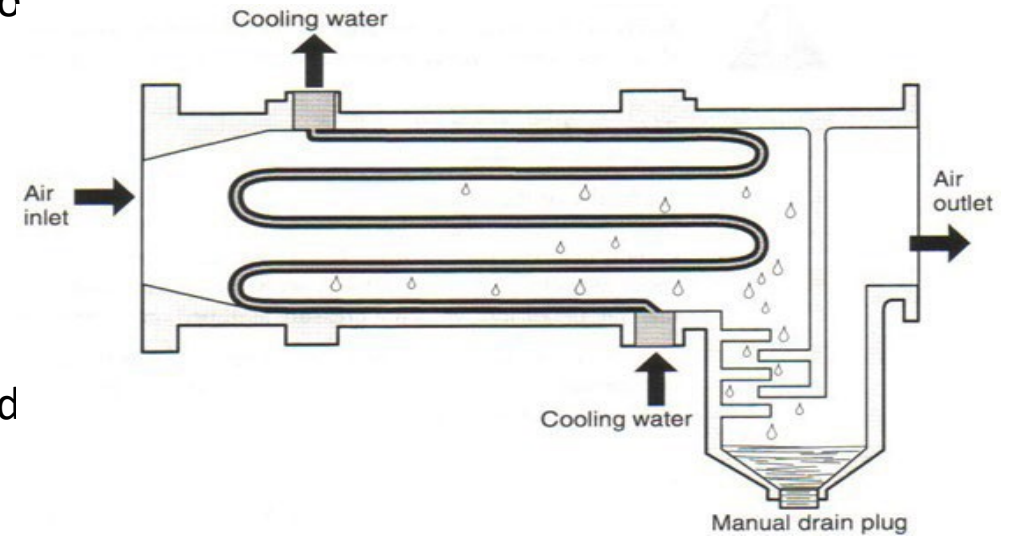
Aftercoolers

An aftercooler is a heat exchanger that has two functions

- it serves to cool the hot air discharged from the compressor to a desirable level (about 80 to 100°F)
- it removes most of the moisture from the air by virtue of cooling the air to a lower temperature.

moist air flows around a series of pipes in which is flowing cooling water. Through the heat exchange process, the air is cooled and the water vapor condenses to liquid and the cooled air enters the moisture-separating chamber, which effectively traps out condensed moisture.

Aftercoolers can remove up to 85% of the moisture



Schematic Symbol

Air Dryer

There are three basic types of air dryers:

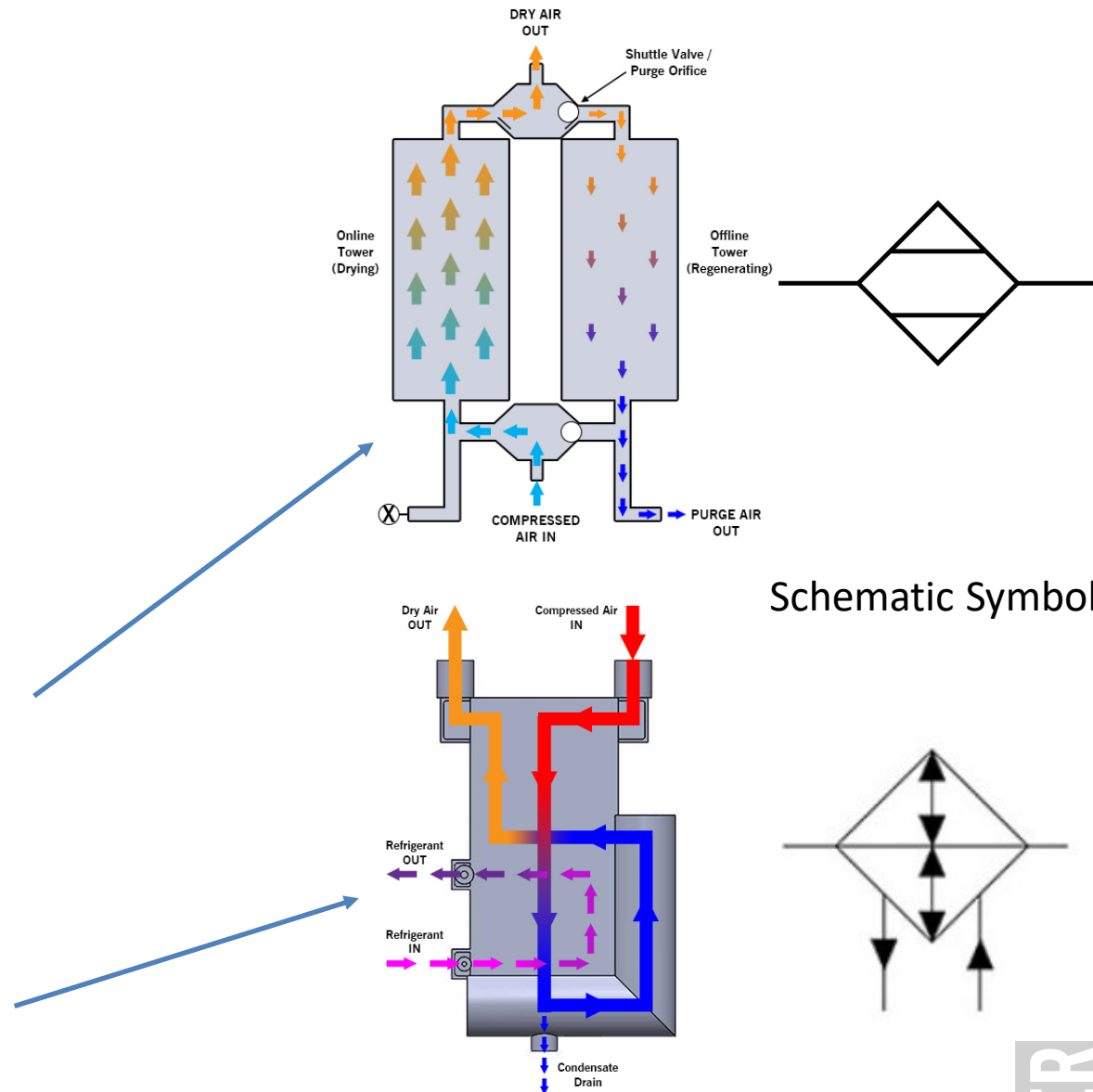
Chemical dryer: moisture is absorbed by pellets made of dryer agent materials, such as dehydrated chalk or calcium chloride. A chemical process turns the pellets into a liquid that is drained from the system. The pellets are replaced on a planned maintenance schedule.

Adsorption dryer: moisture is removed using beds of desiccant materials such as activated alumina or silica gel. This is a mechanical process that involves the capturing of moisture in the pores of the bed material. The beds are replenished or reactivated by the application of heat and a dryer gas.

Refrigeration dryers: through industrial refrigeration, air is cooled as it flows around coils containing a liquid refrigerant. Refrigeration dryers can remove virtually all moisture by lowering the temperature of the pressurized air to a dew point of 40°F.

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<https://www.altecair.com/industrial/desiccant-or-refrigerated.html>



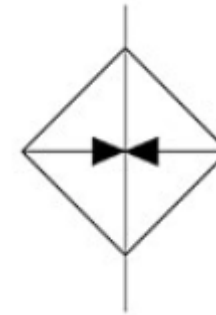
Air Heater

When compressed air has a reduction in pressure, the temperature also decreases (recall the Gas law).

This can occur in pressure regulators, valves, actuators and anywhere there is an exhaust

This reduction in temperature can result in condensing of residual moisture in the air and can cause ice to form in these components

In cases where pneumatic systems are used in cooler environments, in-line heaters are used to heat the compressed gas



Schematic Symbol

Silencer

Pneumatic systems produce a loud sound when exhaust air is rapidly discharged into the atmosphere

Silencers (mufflers) are added directly to exhaust ports of cylinder, motors and control valves

Most common materials are sintered brass, sintered plastic, sintered stainless steel.

Sintering or frittage is the process of compacting and forming a solid mass of material by pressure or heat without melting it to the point of liquefaction (Wikipedia)



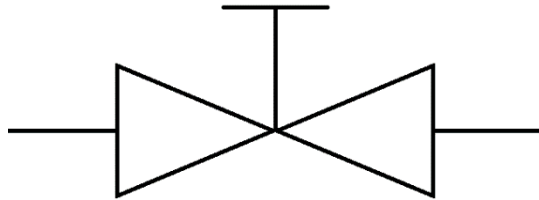
Schematic Symbol



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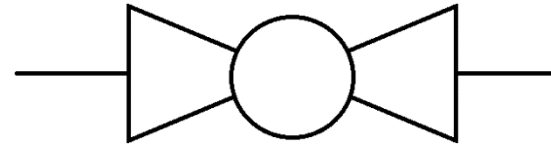
Shut Off/On Valves (Supply Control)

Basic Manual Valve



Controlled Shut Off/On

Ball Valve



Quick Shut Off/On

Accumulators

Accumulators are small air tanks used in pneumatic circuit much like capacitors are used in electronic circuits.

Used for:

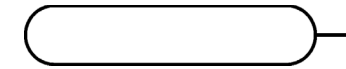
Emergency pressure source

Shock absorption

Pulsation dampening

Pneumatic timers

To maintain system pressure during idle time. (Small leaks in an isolated section of a pneumatic circuit can cause low pressures when the system is brought back from idle time)



Schematic Symbol



<https://www.festo-didactic.com/ov3/media/customers/1100/00982338001288688282.jpg>

Chapter Reading

Chapter 13

13.5-13.6