

Chapter 10:

Air Preparation Units

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Filtering of compressed air

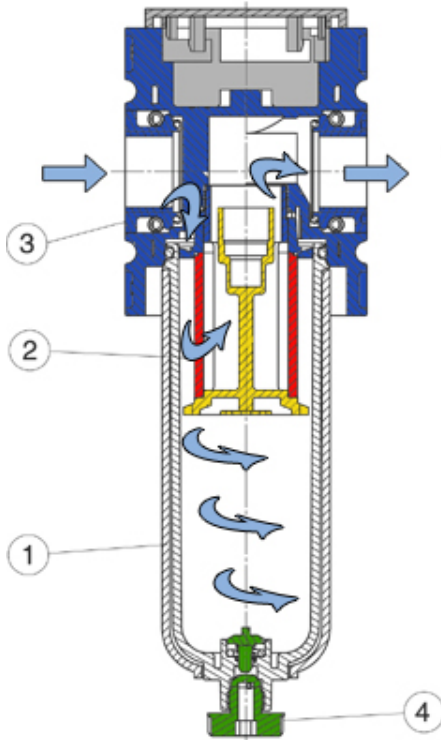
The task of the filter is to filter out particles and to remove the condensate released by the compressed air.

CAUTION! Filters (50 to 0,01 Micron) have no influence on humidity, they filter particles depending on the fineness of the filter elements. The water that is found in the condensate drain only consists of drops and is relatively irrelevant.

Sometimes several filters are necessary in a system because of different requirements:

- Pollution from the pipeline or condensate released during transportation has to be removed before reaching individual equipment.
- Different pieces of control or regulating equipment require different air quality.
- For specific applications (e.g. the packaging of food) standard filtration is insufficient. Activated-carbon filters are required. The air used in these filters has to be pre-filtered by fine-filters.

In pneumatics **cyclonic filtration** is often used to separate particles and condensate from the medium.



Cyclonic separator

1. Filter bowl
2. Filter element
3. Body
4. Condensate drain

A high-speed rotating (air) flow is established within a cylindrical or conical container, called a **cyclone**.

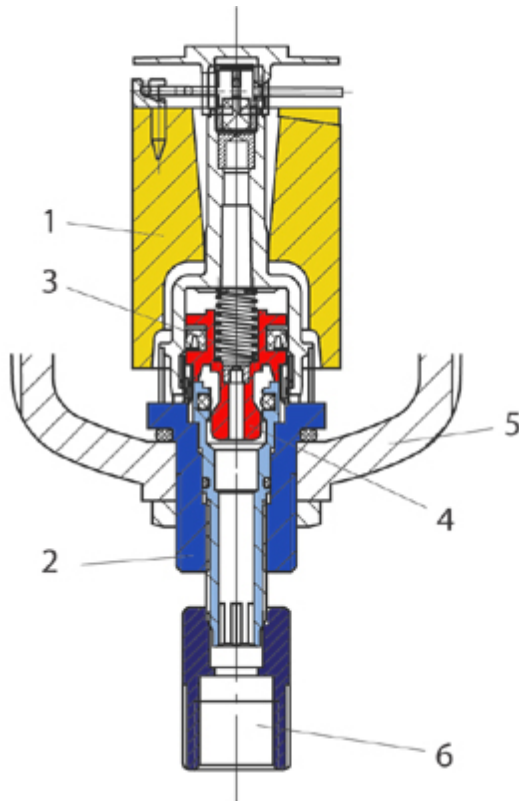
Due to the centrifugal force, particles and condensate fall towards the outside and drop to the bottom.

In addition, the medium flows through a filter element that catches smaller particles. The fineness of the filter element determines the max. size of particles. Polluted condensate can be drained from the bottom of the bowl.

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An automated drain valve works as a floating exhaust valve. As soon as the condensate reaches a certain level, the valve opens and drains the bowl.



Automated condensate drain

1. Float sensor
2. Body
3. Spring
4. Closing element
5. Bowl
6. Port for condensate – manual override

How it works:

Without pressure the closing element (4) is in an open position. The condensate that is concentrated at the bottom of the bowl (5) is drained.

At an operating pressure of around 1,5 bar the valve closes the drain.

In case that during operation (pressure in the filter element) the condensate rises high enough to lift the floater, the valve opens the drain and the condensate is blown out of the bowl. Thus the level of condensate is lowered and the drain closes again.

Automated drains can also be operated manually. By turning the knob at the bottom, the drain is on manual mode and the condensate is blown out of the bowl (if there is air pressure) / drips out of the bowl (without air pressure).



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Depending on the requirements inside the pneumatic system there are different filter elements offering different degrees of fineness and materials.

In pneumatics we typically use **filter elements with a finesses of 5 to 50 µm**.

In order to reach an air quality according to ISO 8573-1:2010 [7:4:4], the following is required:

- Concentration of particles: **5-10 mg/m³**
- Filter fineness: **20-50 µm**

In case of **higher requirements**, we recommend standard **ISO 8573-1:2010 [6:4:4]** which is still common in pneumatics:

- Concentration of particles: **Maximum 5 mg/m³**
- Filter fineness: **5 µm**

Based on make and fineness of the filter element, we differentiate between **filters**:

- **Classic filter unit**
 - Filter fineness: 5 µm, 20 µm, 50 µm
 - Material: sintered PE, sintered bronze on request
- **Pre-filter unit**
 - Filter fineness: 0,3 µm
 - Material: cellulose-acetate
- **Fine-filter unit**
 - Filter fineness: 0,01 µm
 - Material: glass fibre with acetate
- **Activated-carbon filter**
 - Material: activated-carbon

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Classic filter unit

Pre-filter unit

Fine-filter unit

Activated-carbon filter unit

(KFIL)

(KPFI)

(KCFI)

(KAFI)

Filter fineness: **5 µm**

Filter fineness: **0,3 µm**

Filter fineness: **0,01 µm**

Filter fineness: n.a.

Oil content: **0,1 mg/m³**

Oil content: **0,01 mg/m³**

Oil content **0,005 mg/m³**

Class 2 (ISO 8573-1)

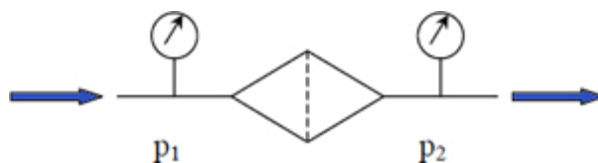
Class 1 (ISO 8573-1)

Class 0 (ISO 8573-1)



Durability of the filter elements

Filter elements need to be exchanged on a regular basis since their flow will be reduced over time due to pollution. The loss of air-pressure can be detected by measuring the differential pressure in front of and behind the filter.



$$\Delta p = p_1 - p_2$$

Measuring differential pressure with a gauge:

The dirtier the filter element, the larger the pressure drop inside the filter. The pressure difference is measured between 0 and 0,5 bar, which shows how much blockage there is in the filter element.

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Pressure regulation with a regulator

Normally the network supplies pressure between 6 and 10 bar, which can vary depending on the rate of air consumption.

In order to use compressed air efficiently, the required pressure should be set for each piece of equipment with an individual pressure regulator. The individual pressure can only be lower than the pressure supplied by the network.

It is the task of the pressure regulating valve to hold the level of the output pressure on a constant level, regardless of input pressure or fluctuations in air consumption.

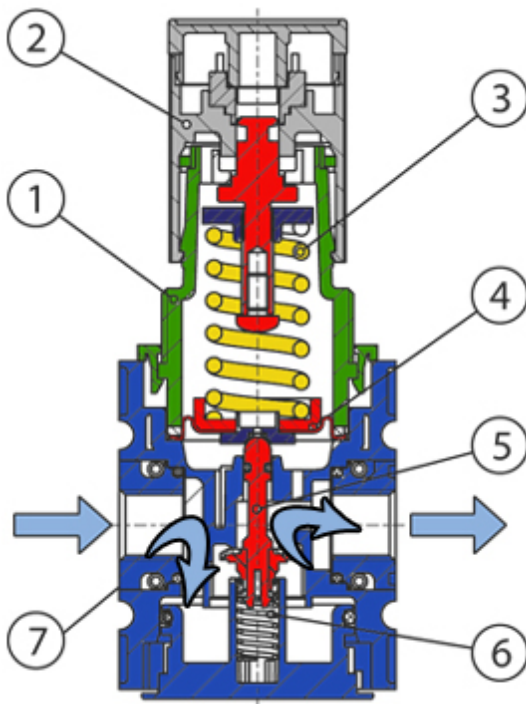
We differentiate between **regulators with secondary venting** and regulators **without secondary venting**.

Regulators with secondary venting can let out excess pressure on the secondary side, e.g. when the pressure P2 is reduced by the operator or when the pressure is increased by the equipment (high load on a large cylinder).

Regulators without secondary venting are usually used when the medium is not supposed to be released into the atmosphere.

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Regulator, with secondary venting

1. Body – spring casting
2. Knob to set pressure
3. Spring
4. Diaphragm
5. Seat with valve disc
6. Counter-pressure spring
7. Body

Essential for the pressure regulation is the diaphragm (4). On the surface below the diaphragm, the secondary pressure is in effect, against which the force of the set spring (2) works from the top.

If the force of the air pressure is weaker than that of the spring, the diaphragm is pushed down and the valve rod (5) is opening the poppet valve. Pressure is rising.

In case there is less consumption, pressure below the diaphragm builds up. The force of the air is larger than that of the spring, and the valve disc is gradually closing, eventually fully closing the valve seat.

If secondary pressure exceeds the pressure that was set, the diaphragm is pushed upwards and the secondary exhaust is opening up (if the regulator is equipped with a secondary vent).

Secondary pressure can be displayed by a pressure gauge.

CAUTION! Pressure regulation in pneumatics is a **regulation of volume**. The amount of compressed air behind the regulator needs to be large enough to build up an air pressure that is the same as set at the regulator (off-setting the force of the spring in the regulator). If the pressure drops, more air is fed into the system behind the regulator. There must be a balance between the force of the air-pressure and the force of the spring.

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Lubricating the compressed air

Neither control-elements nor actuators are separately lubricated in a pneumatic system. In order to avoid wear-out, lubrication can help. Unnecessary friction also increases energy consumption.

The goal of the manufacturers of the components is to design products that do not require any individual lubrication. This can be realized by selecting the right materials, choosing the right seal system, reducing friction, or supplying the product with **sufficient (life-long) lubrication** when initially sold. For this kind of lubrication, special types of grease are available. They are designed to constantly stay in the valves or cylinders. In order for the lubricant to avoid washing-out, the air needs to be dry since water has a negative effect on it as well.

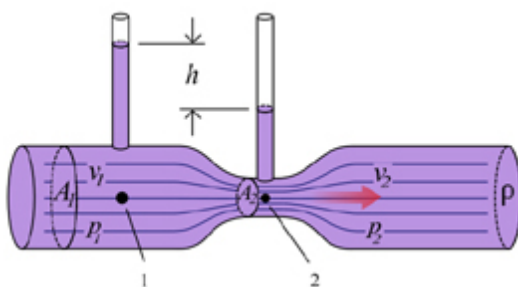
The same washing-out effect is true when lubricators are used. **Therefore, if lubricators are in use, they must not run dry!**

→ **The eternal question: "Should lubricators be used or not?"**

Answer: It always depends on the application!

In certain industries (e.g. food industry) lubrication is not allowed at all. In other industries with very big cylinders and strong forces, lubrication can be really beneficial, especially for the durability of the actuators.

The lubricators in pneumatic systems use the **Venturi principle**.

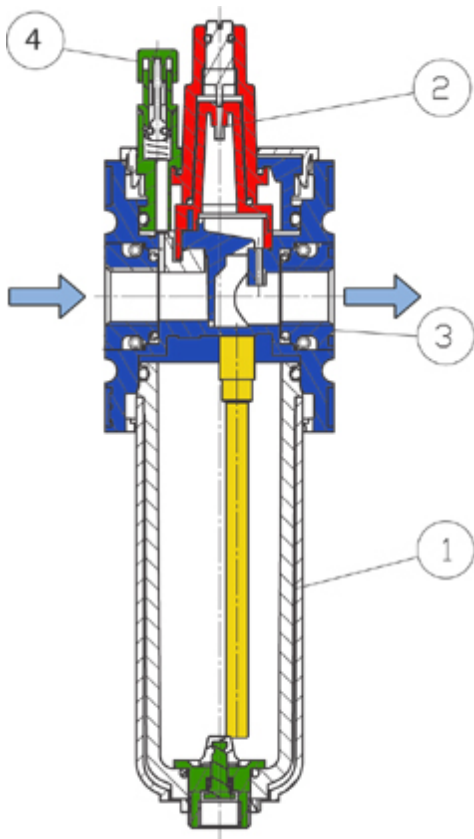


A pressure difference is generated by forcing the compressed air through a jet. Behind the jet the pressure is lower.

This pressure difference sucks oil from the container into the air stream where it is dispersed very finely. The same principle is used in a carburetor of a car running on petrol.

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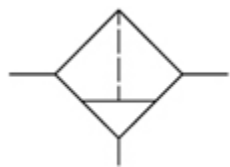

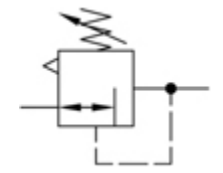

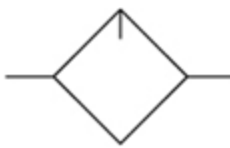

Lubricator

1. Oil container
2. Dosing unit
3. Body
4. Knob to activate sucking function for refill.

Some lubricators have a device that enables oil to be sucked in while the equipment is pressurized with the aid of a vacuum.

At the bottom of the body, a tube has to be connected. The end is to be held into the oil. Press the button (4) and the lubricator is refilled with oil.

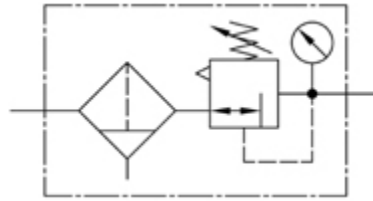
Air preparation units – pictures and ISO symbols

Filter unit		
Pressure regulator		
Lubricator		

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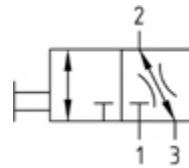
Filter regulator with pressure gauge



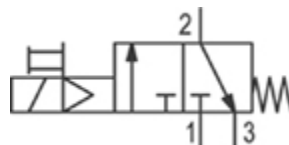
FRL-unit (filter, regulator, lubricator and pressure gauge)



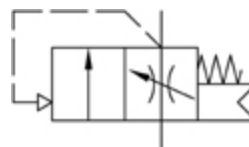
Manually-actuated main switch-on valve, 3/2-way



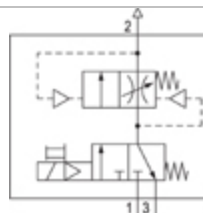
3/2-way solenoid valve with manual override



Soft starter valve



Soft starter valve with electric actuation



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CAUTION! It is insufficient to have only one filter and one pressure regulator for the entire system. Due to the volatile consumption of compressed air, the different pieces of equipment need individual air preparation (pressure, sometimes also different air quality, filtration / lubrication).

We recommend to locally prepare the compressed air for the different pieces of your equipment. This reduces wear-out and increases the durability of machines and equipment.

There are many products to choose from:



Futura



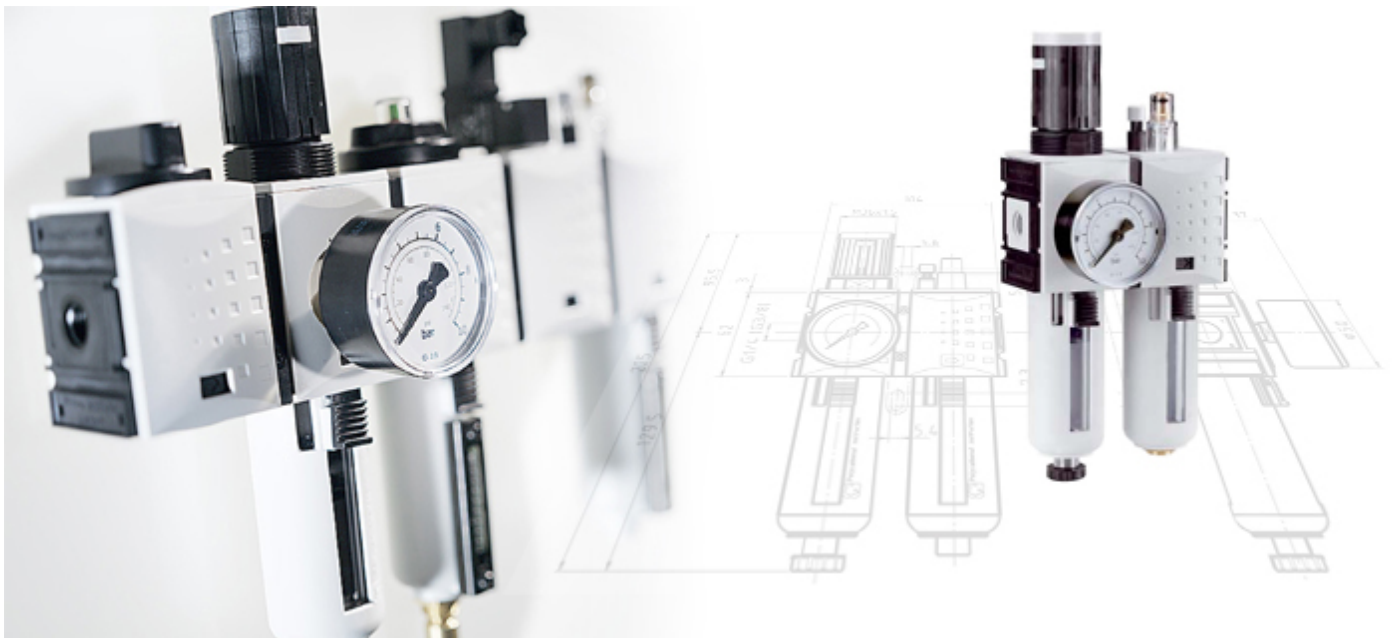
MultiFix



Standard



Classic



Further information can be found in the category “FRL-units” on our website.