Contents

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Introduction

- When air is compressed it rises dramatically in temperature
- The natural water vapour content of air (relative humidity) is concentrated and carried through the compression process as a vapour in the high temperature
- As the air cools water condenses out making freshly compressed air very wet
- Solid particles will also be present, these can consist of fragments of burnt compressor lubricating oil and airborne dust inhaled by the compressor
- Preparation of compressed air consists of reducing temperature, removing water and solids, controlling pressure and in many cases adding lubricant

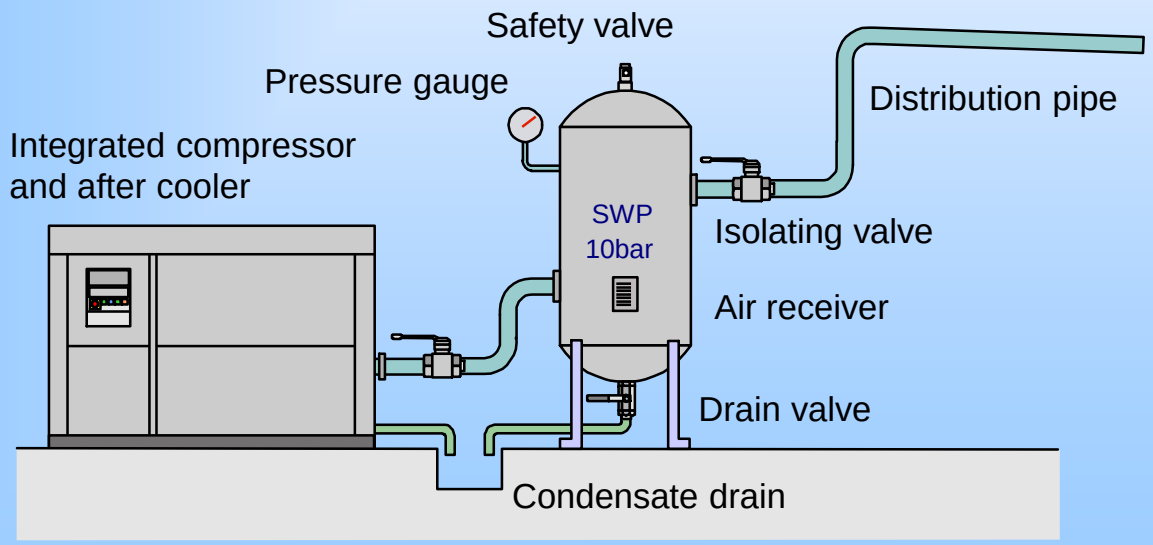
Pressure Producing Plant

Pressure producing plant

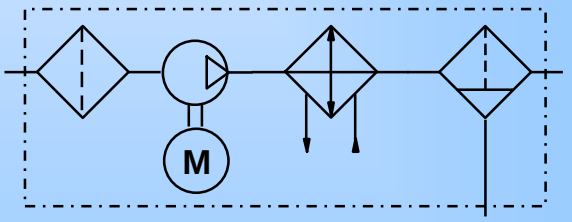
- **Compressor sizes range from less than 1 l/s with little or no preparation equipment, to multiple compressor plant installations generating hundreds of cubic meters per hour**
- **Sizes are defined as follows:**
  - **Small compressors are up to 40 litres per sec and input of no more than 15 kW.**
  - **Medium compressors are between 40 and 300 litres per second and input of between 15 and 100 kW.**
  - **Large compressors anything above the medium limit.**

Compressor installation

- **Typical medium size compressor installation**
- **Integrated compressor unit including inlet filter, electrically driven compressor, after cooler and water separator**
- **Air receiver to smooth demand surges, and provide additional cooling and water collection**



Symbol for contents of the Integrated compressor

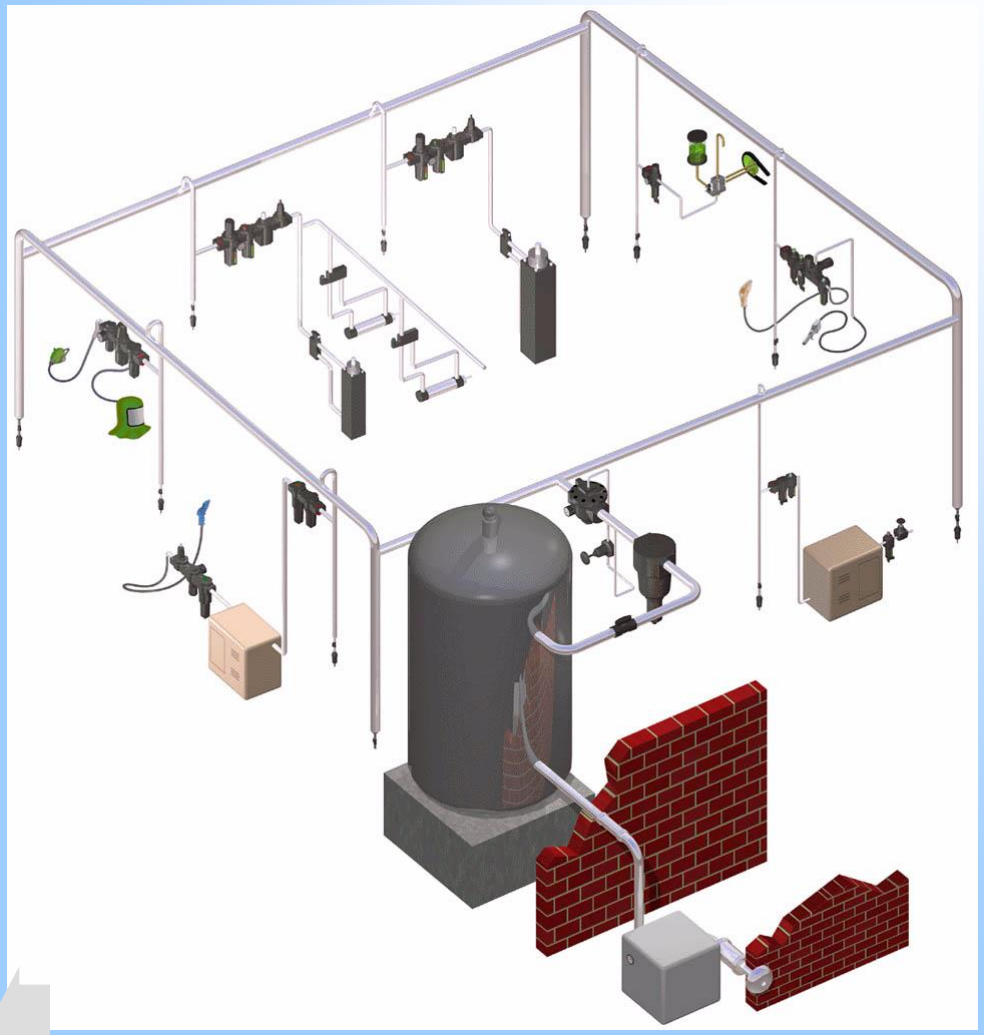


Compressor siting

- High temperatures are produced when air is compressed, efficient cooling is important
- Compressor house well ventilated located on an outside north facing wall
- Inlet filter to inhale only clean dry air, keep away from:
  - fumes from parked vehicle with engine running
  - solvent fumes from paint plant or store
- Avoid locations where the air may have a high humidity such as above a pond, river or canal
- Avoid locations where wind eddies whip up dust, grit and litter
- An intake on the factory roof must be protected from the weather and emissions from ducting and chimneys

Distribution

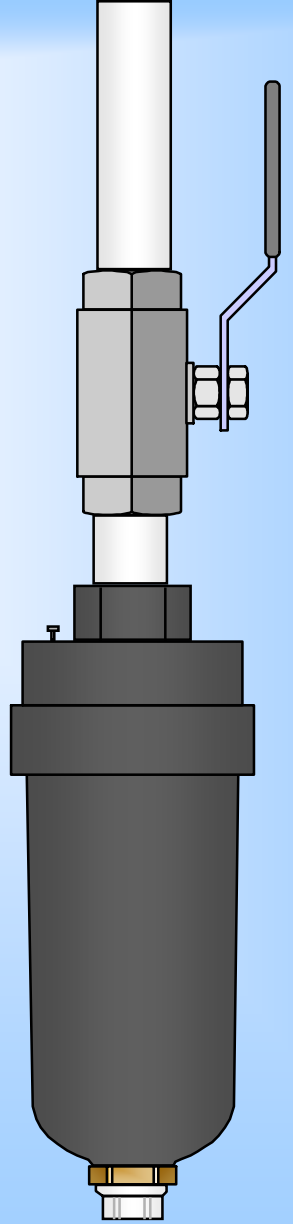
Distribution



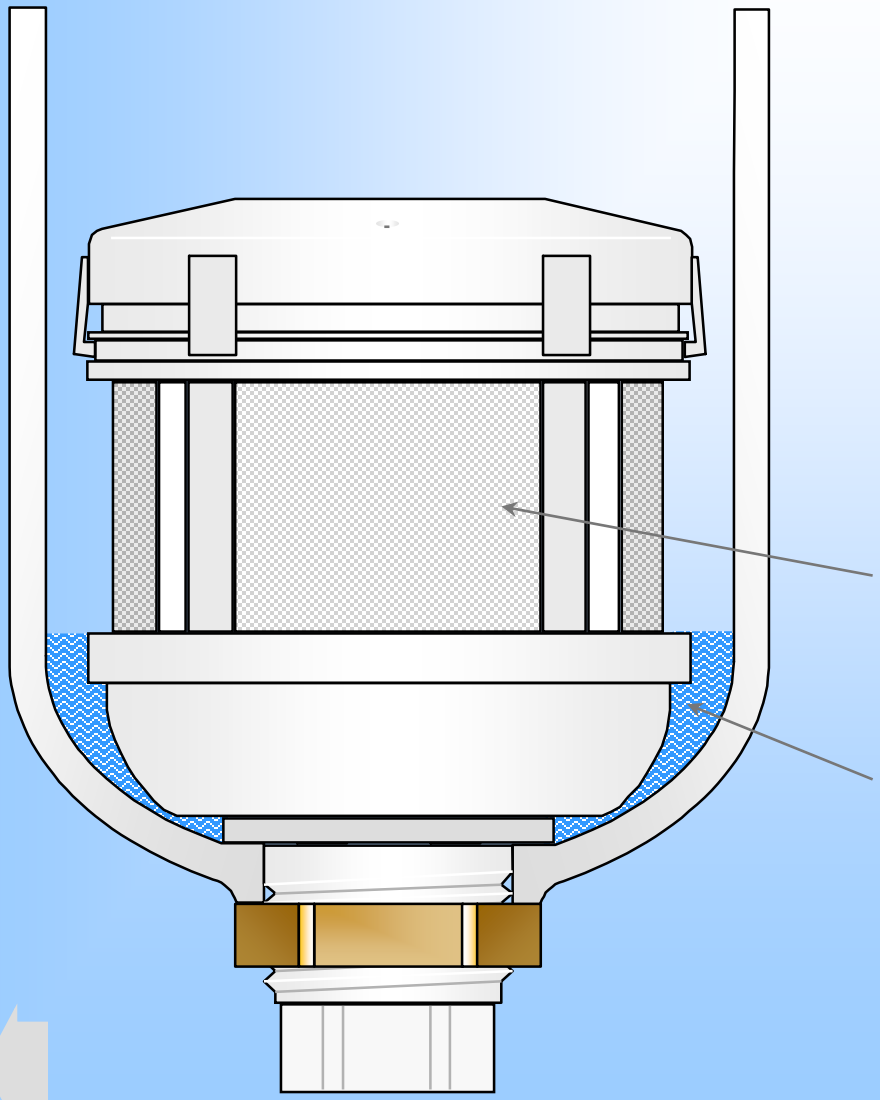
- Ring main installation
- Dead leg with a drip leg drain on each corner to collect and remove water
- Pipes slope to each corner
- Take off drops connected to the top of the main pipe to avoid water pick up
- FRL units before each application

Drip leg drain

- Automatic drain valve for terminating a dead leg
- Water automatically drained when pressure is on, also when shut down
- Fit with an isolating shut off valve for maintenance
- Incorporates a course mesh filter to retain large solid particles
- Built in bleed valve to depressurise the unit prior to maintenance

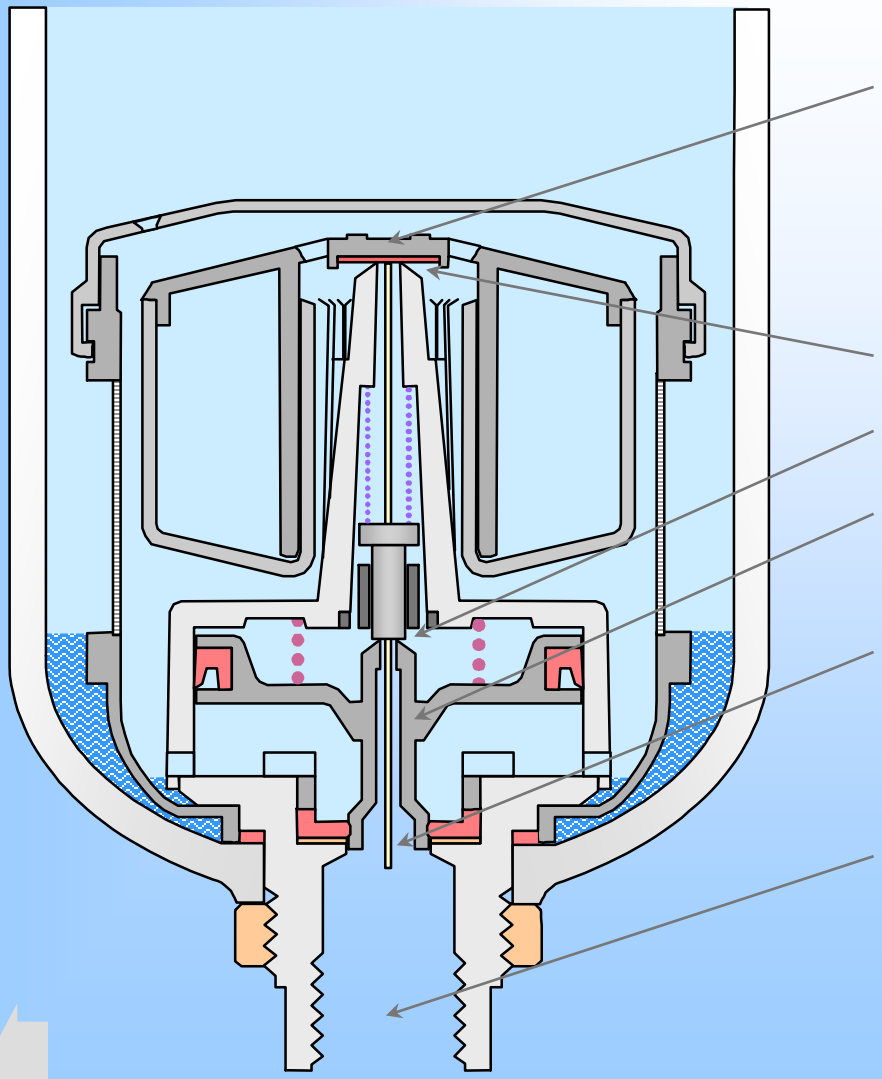


Automatic drain valve



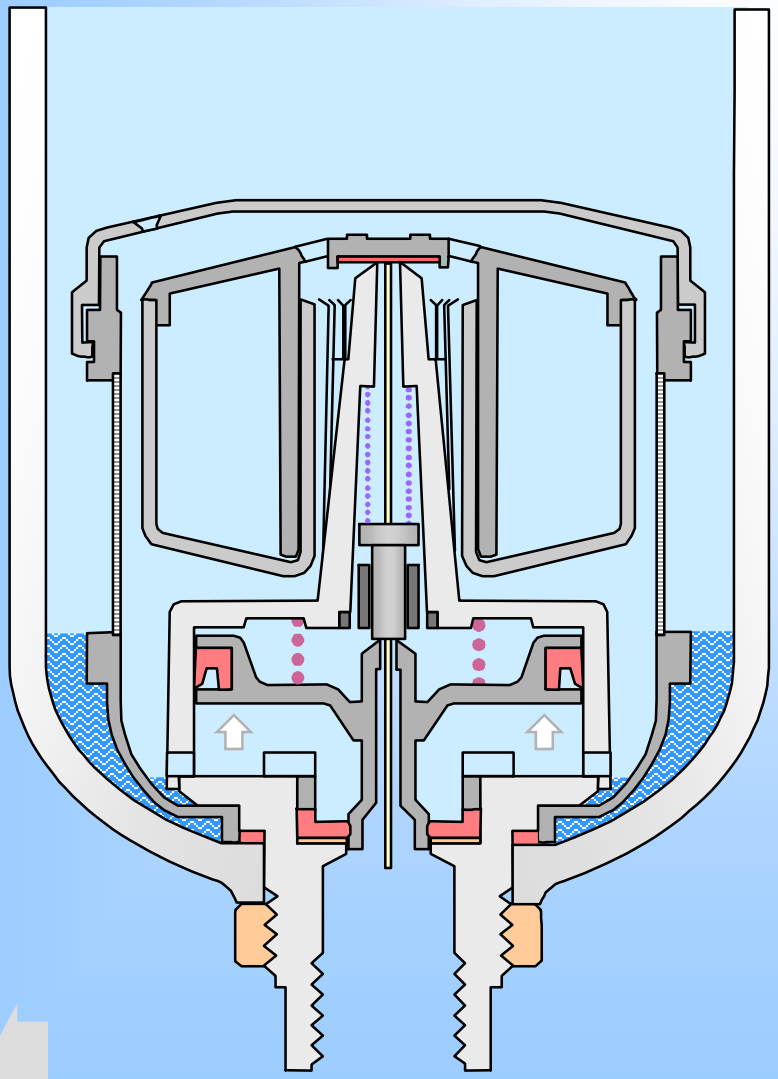
- When water level rises valve opens to eject the water then closes again
- When no pressure, valve opens to drain system
- Unit fits in the bottom of a filter or drip leg drain
- Nylon mesh 500 µm to prevent large solid particles clogging internals
- Dead zone where large particles may settle

Automatic drain valve



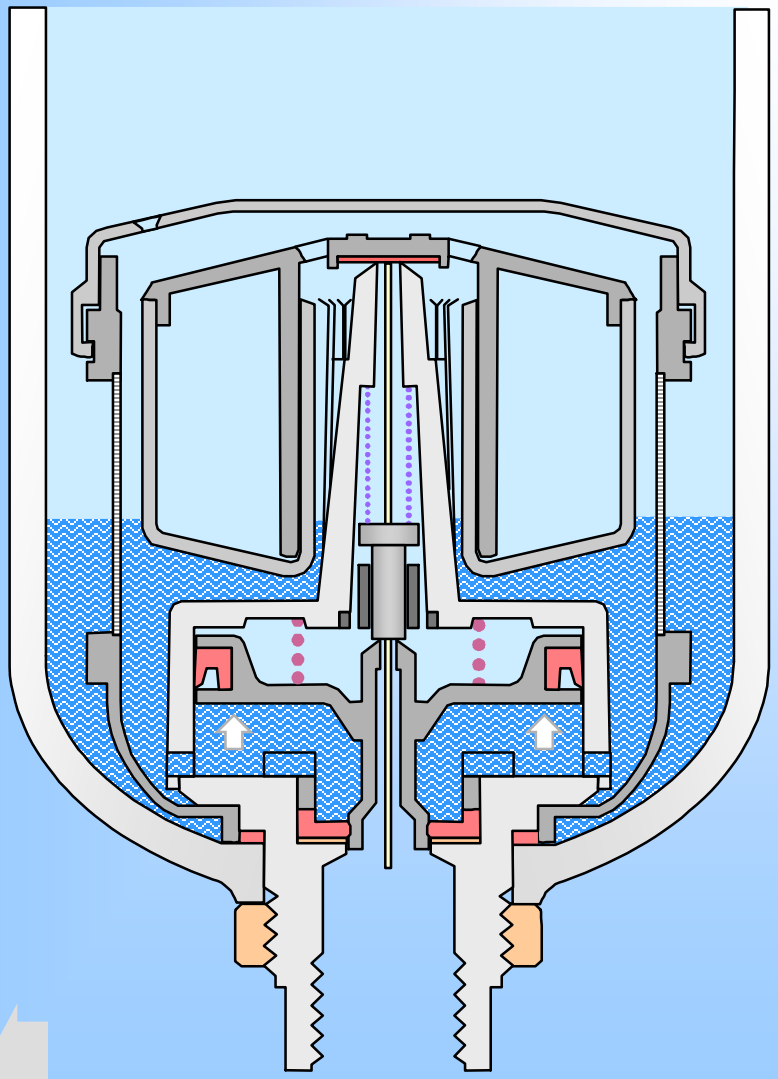
- Float breathable for pressure equalisation, internally splined to prevent rotation
- Air inlet seat
- Air exhaust seat
- Piston and drain valve spool
- Exhaust valve wire can be pushed from below to override and lift the float
- Connection for piping away contaminant

Automatic drain valve



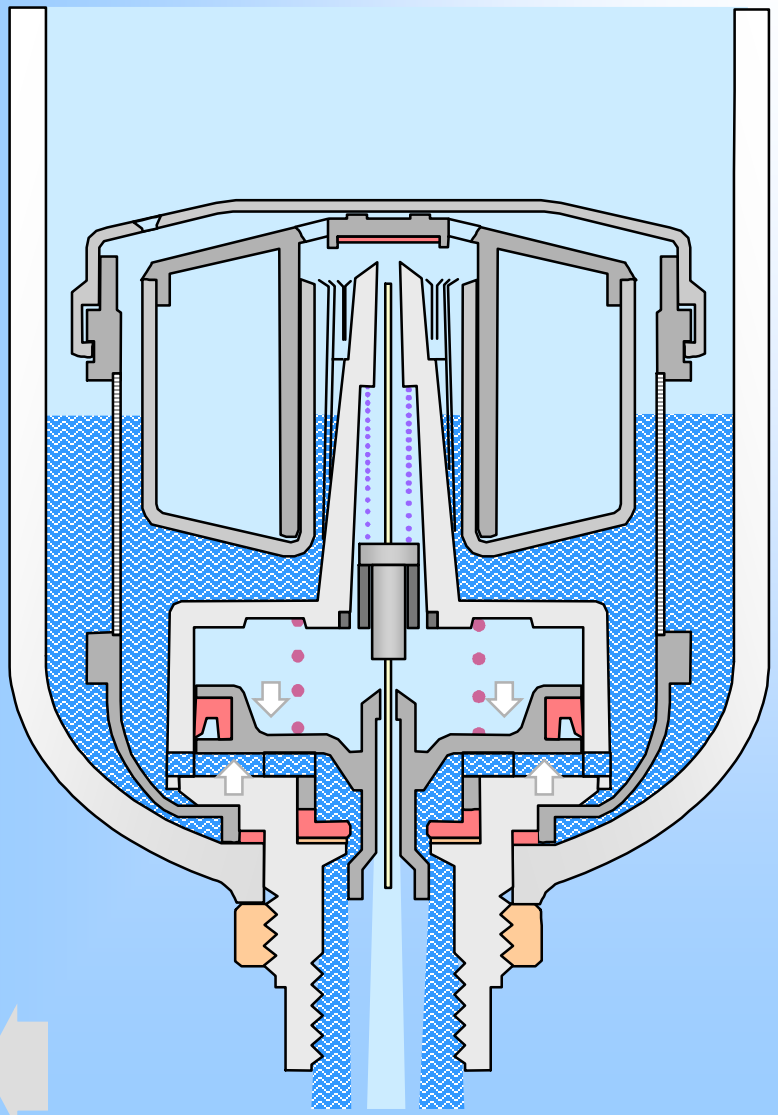
- Pressure first applied to the bowl fully lifts the piston so the drain is closed
- The wire cracks open the float inlet seat until a force balance exists across the piston in the closed position
- Changing bowl pressure, slightly lifts or lowers the piston to adjust the balancing pressure

Automatic drain valve



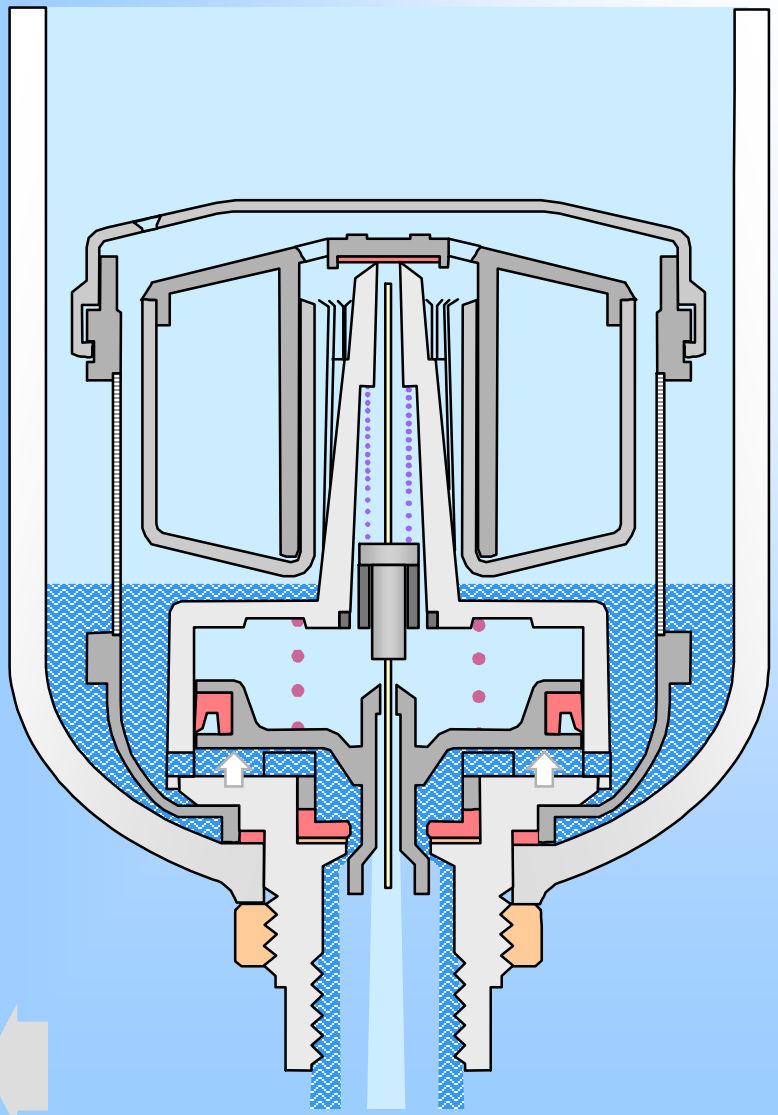
- Water level rises but not enough to lift the float
- Force holding the float down is the pressure differential acting on the float above the inlet seat area
- Water takes on the same pressure as the compressed air in the bowl

Automatic drain valve



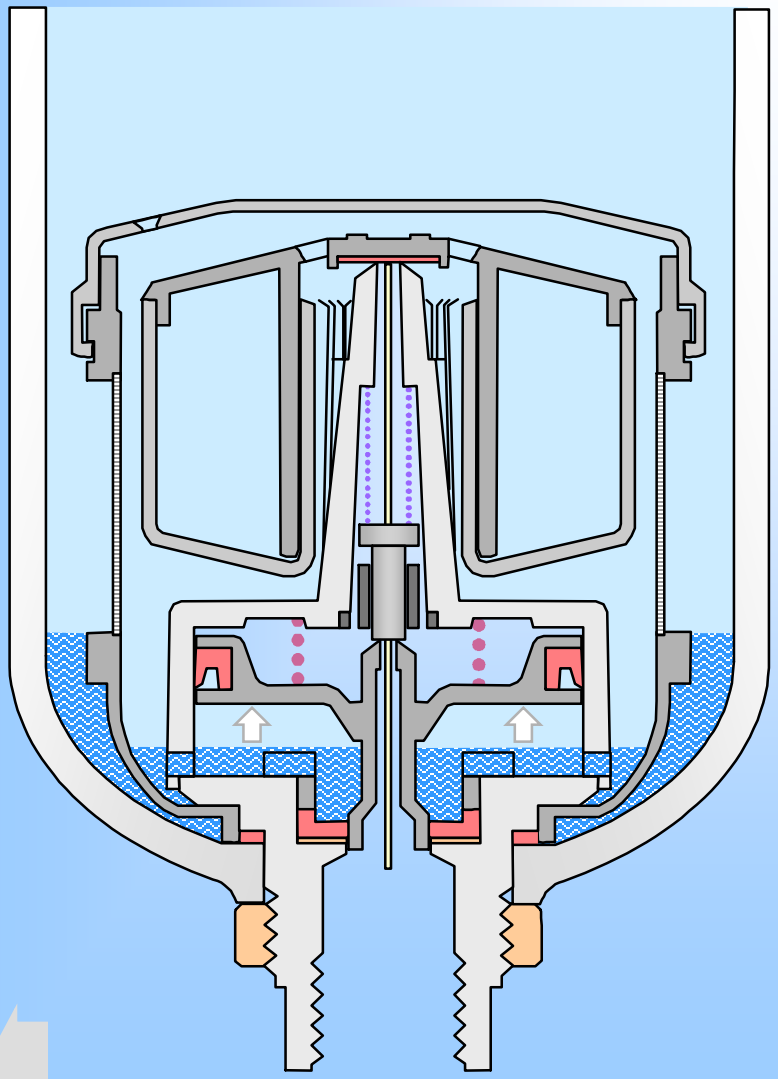
- Water high enough to lift the float
- Air pressure on top of the piston balances the pressure under it
- Spring pushes piston down to open the valve
- Water ejected under pressure
- Exhaust seat open but air enters faster than it can leave so the piston stays open

Automatic drain valve



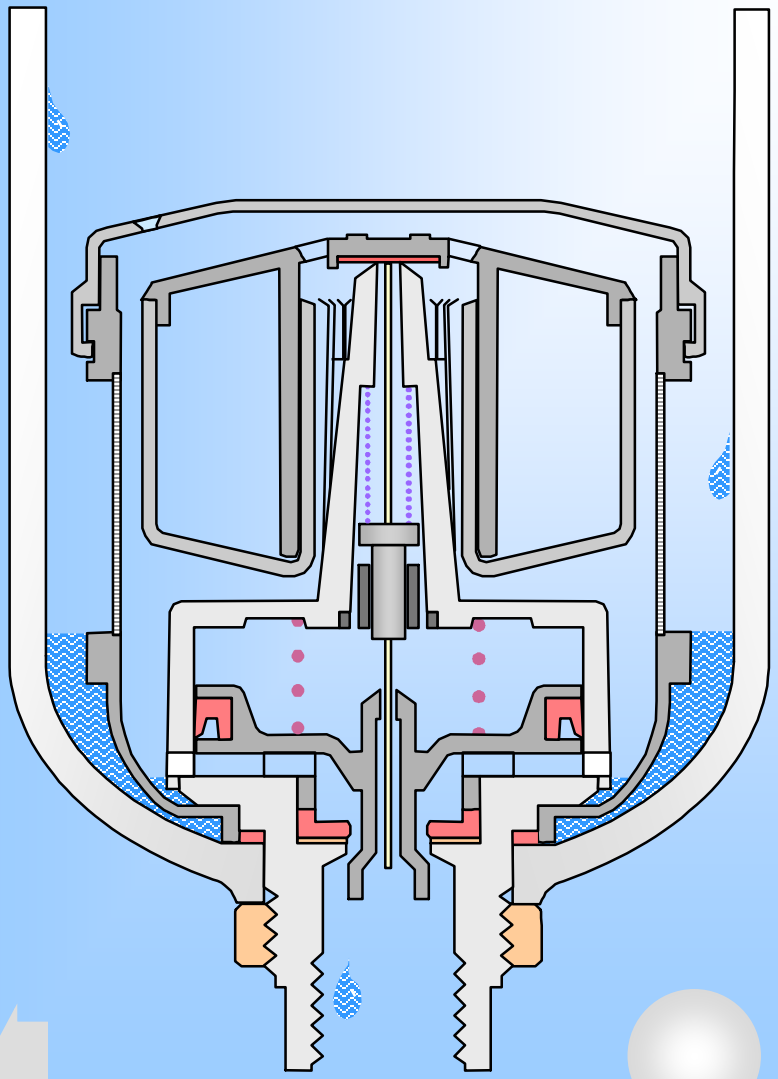
- Float drops and reseals inlet seat
- Water still being ejected as the valve starts to slowly close
- Piston pushed up slowly against air pressure on top of the piston as it escapes through the restricted exhaust seat

Automatic drain valve



- Piston in the up position fully closing the valve
- The cycle is repeated whenever there is sufficient water to lift the float

Automatic drain valve



- When system pressure is turned off and exhausted the spring will push the piston down to open the valve
- Any water gradually draining through a depressurised system will be able to pass through the open drain valve

FRL’s

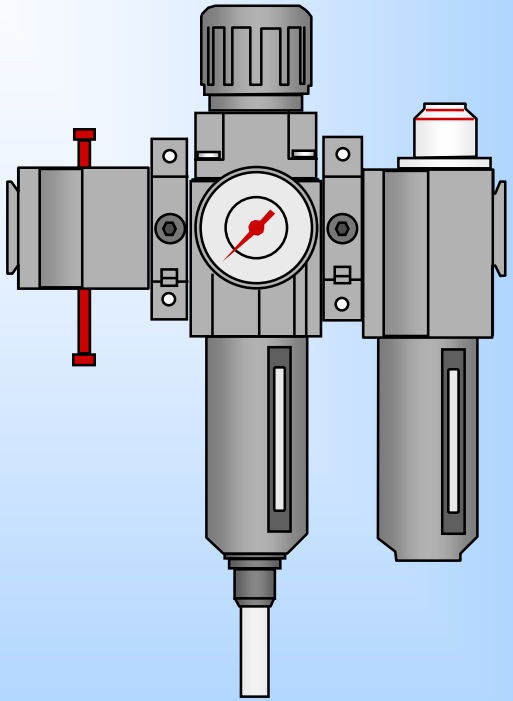
FRL’s

- FRL stands for filter, regulator and lubricator
- When an FRL unit is referred to, it means a combination of these three devices closely connected together
- They form a unit that will prepare the condition of compressed air just before delivering it to pneumatic equipment or machinery
- This ensures the air supply is clean and dry, the pressure is at the correct level and fine particles of oil are carried in the air to lubricate the wearing parts within valves, cylinders and tools
- A convenient method of combining these components is to use a modular system

Excelon

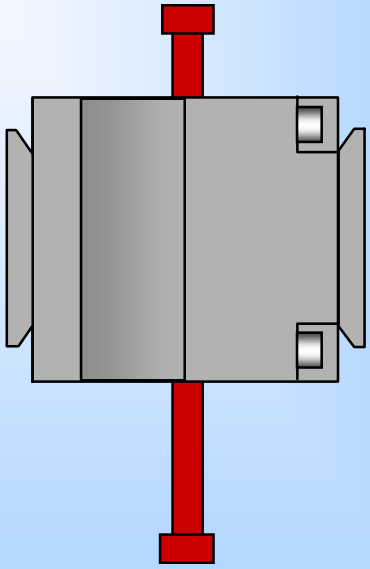
Excelon

- Excelon modular unit shown comprising:
- Shut off valve to isolate upstream air and exhaust downstream air
- Combined filter and pressure regulator with gauge
- Micro-Fog lubricator
- Connected together with Quikclamps

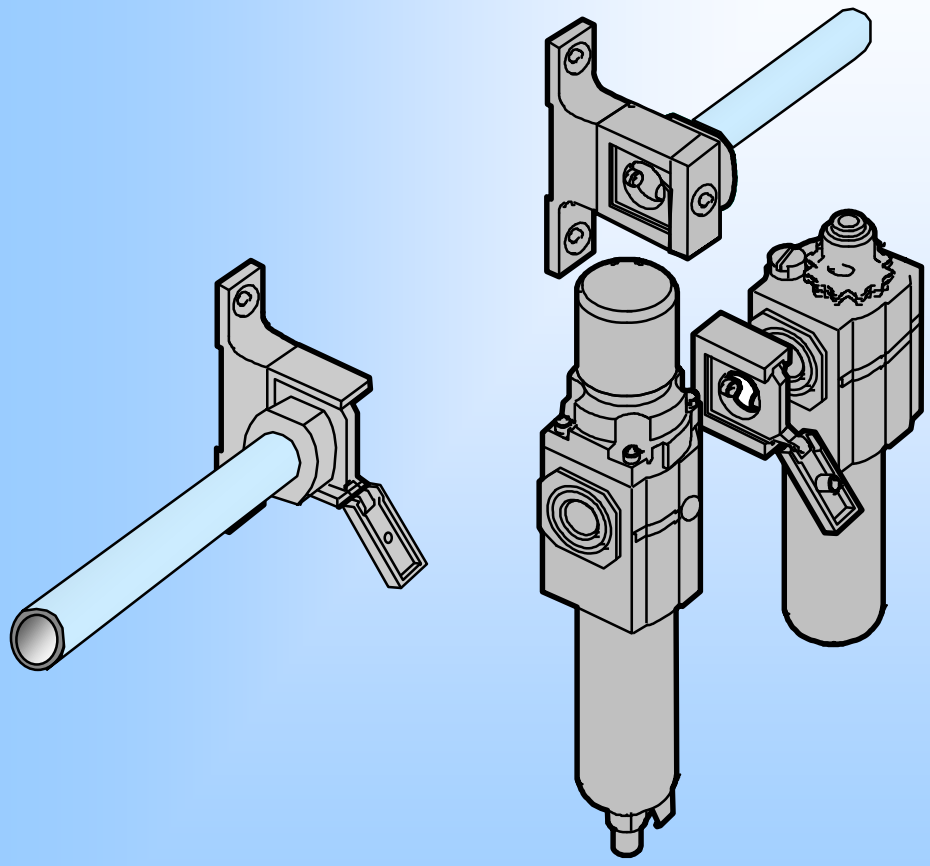


Excelon shut off valve

- Slide valve On / Off action 3/2 (2/2 option)
- Quikclamp attachment for modular units
- Stand alone with ported connections on inlet and outlet
- Use upstream and downstream
- Lockout feature for anti tamper during shut off
- Threaded exhaust port

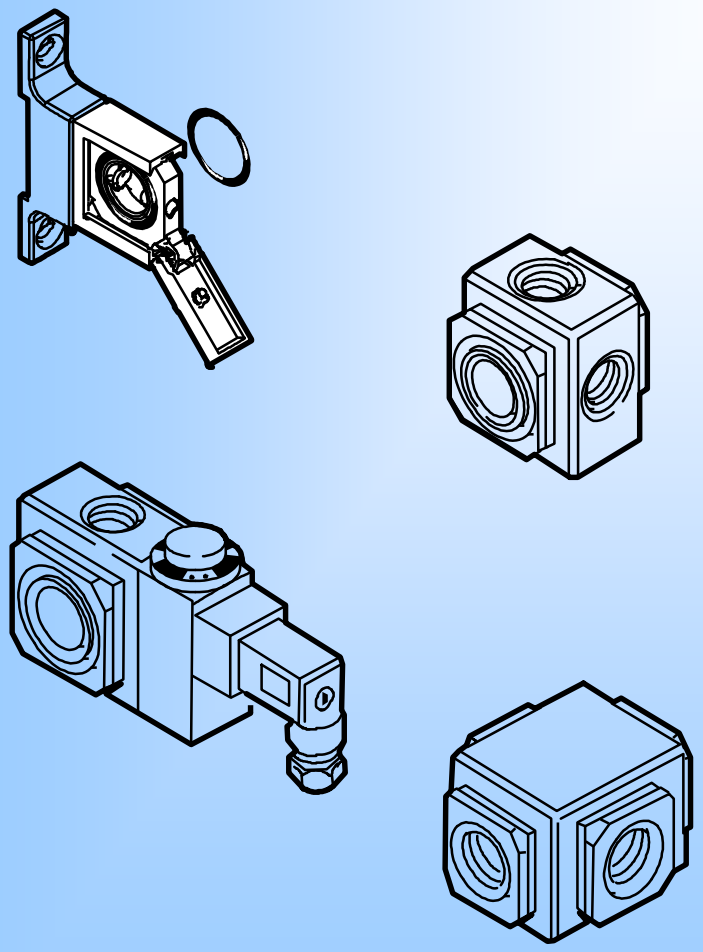


Modular units



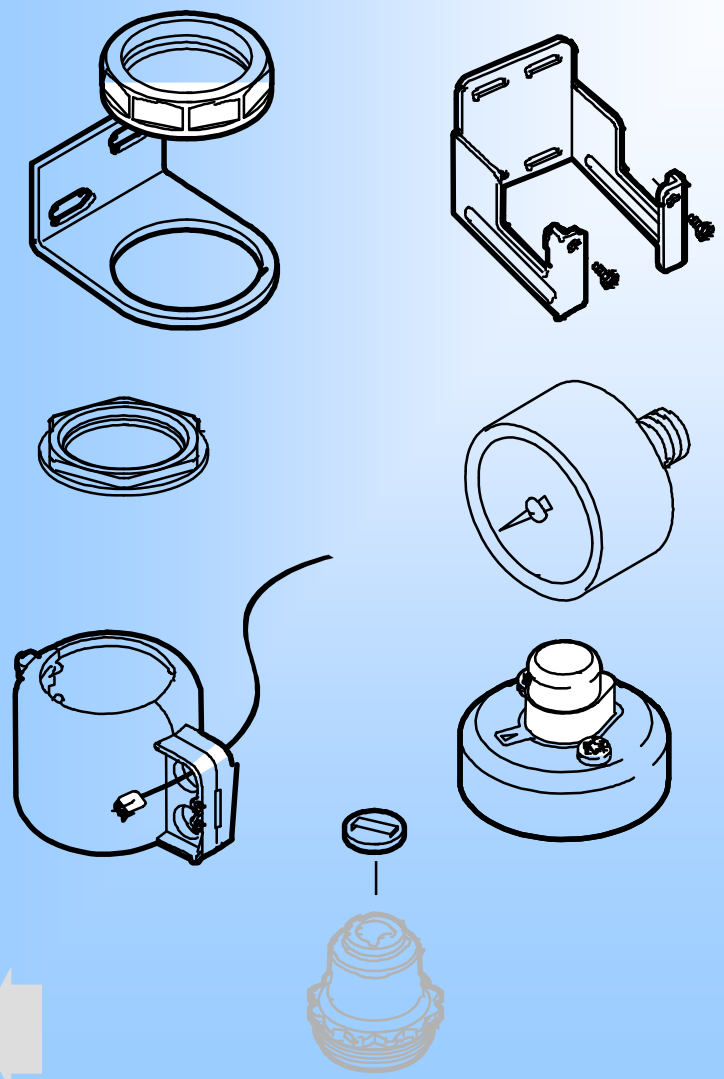
- Wall brackets assembled with Quikclamps and pipe adaptors rigidly fix the pipework
- Units can be joined and slid into the pipework using quikclamps
- Units can be quickly and easily removed for servicing or replacement without disturbing the pipe joints

Accessories



- This system is extremely flexible as any variety of units can be joined using quikclamps
- Accessories include:
- Porting block
- Adjustable pressure switch with porting block
- Manifold block
- Shut-off valve

Accessories

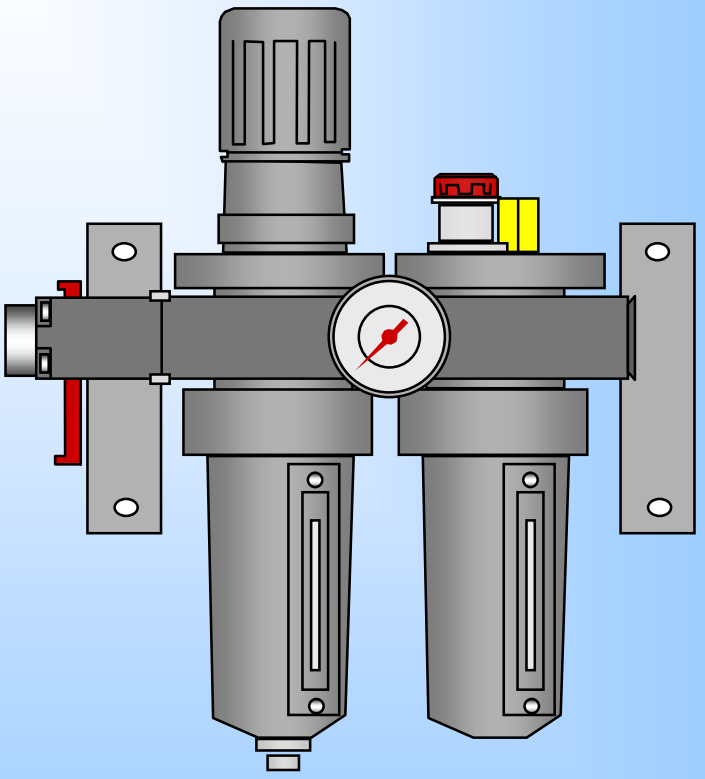


- Neck mounting bracket
- Wall mounting bracket
- Panel Nut
- Pressure gauge
- Tamper resistant cover for regulators and relief valves
- Replacement service life indicator for filters
- Tamper resistant snap on cap for lubricators

Olympian Plus

Olympian Plus

- Olympian Plus FRL unit shown with gauge, shut off valve and wall mounting brackets
- Updated system based on the popular modular yoke with plug in units
- Extensive range of plug in units

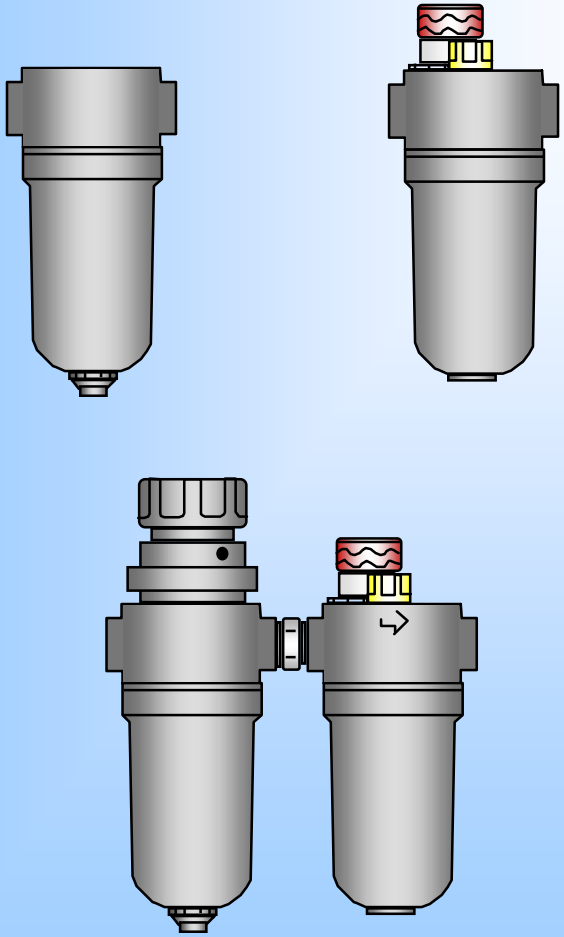


Olympian Plus

1. Quick connect yokes
2. Plug in unit
3. Bayonet bowls
4. Prismatic sight glass
5. Captive ‘O’ Rings
6. Tamper resistant cover
7. Pressure switch
8. Soft start/dump
9. Shut off valve 3/2

Ported Units

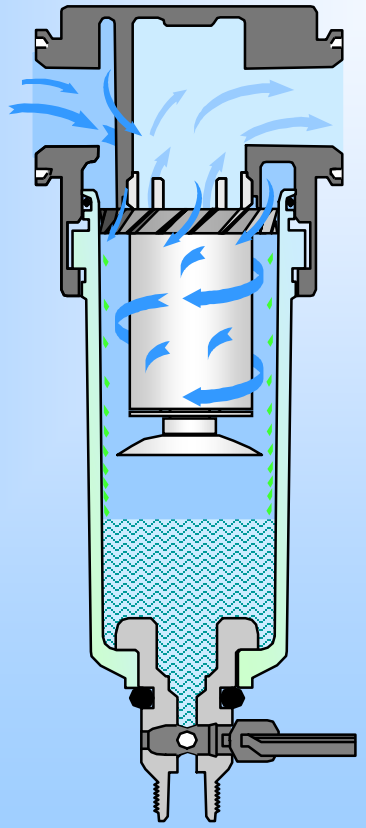
Ported units



- For individual connection and combining with screw fittings
- Wide range of types and sizes
- Illustrated are a G1/4 11 series filter and micro fog lubricator and FRL joined with a screw connector
- Note: all Excelon components also stand alone as ported units

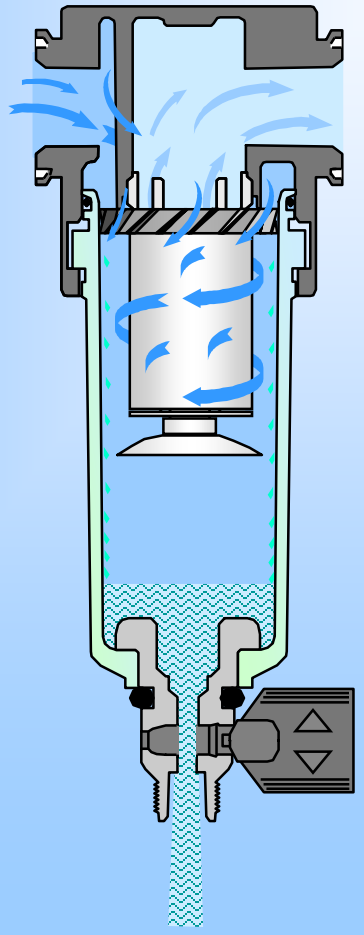
Filters

Filter (general principle)



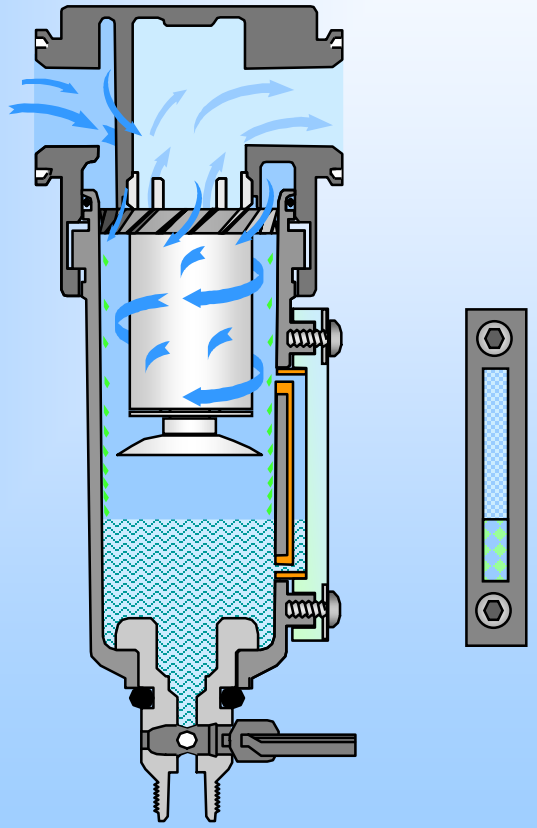
- Separate and collect contaminants
- Angled louvers spin the air as it enters the bowl
- Water droplets and large solid particles spun outwards against bowl and run to the bottom
- Baffle prevents turbulent air splashing water on to the filter element
- Element traps finer solid particles

Filter (with manual drain)



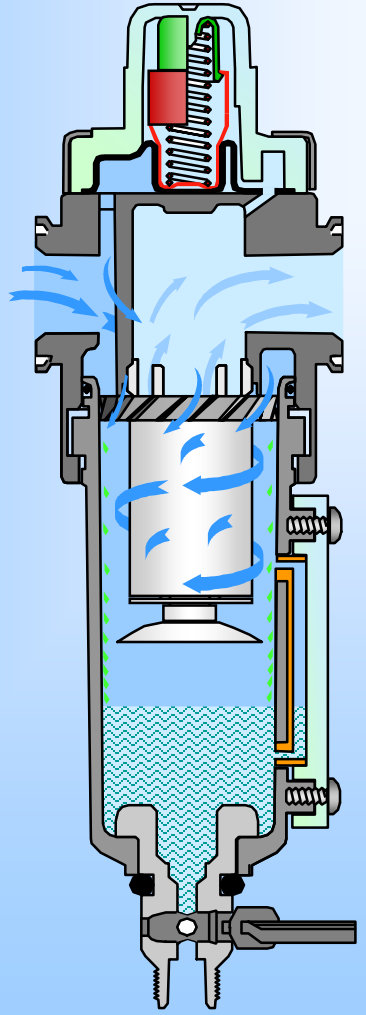
- Daily visual inspection is required to ensure the water contaminant level is prevented from rising to a level where it can be drawn through the filter element
- A quarter turn valve allows the contaminant to be ejected under pressure
- Threaded end allows a tube connection for draining to a suitable container

Filter (with metal bowl)



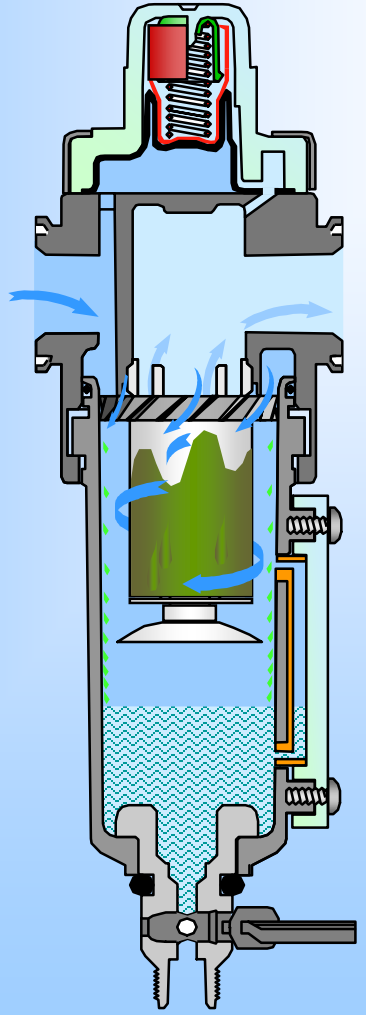
- For use when:
  - 50^{O}C or above
  - 10bar or more
  - Solvent fumes nearby
- The normal choice for G$^{1}/_{2}$ and larger units
- Metal bowl fitted with a sight glass
- Refraction grid clearly indicates contaminant level

Filter (with service indicator)



- As a filter element becomes clogged the flow decreases
- The developing pressure differential acting on the diaphragm lifts the red sleeve
- First indication appears at 0.3 bar and fully covers the green by 1 bar
- The filter element must then be replaced

Filter (with service indicator)



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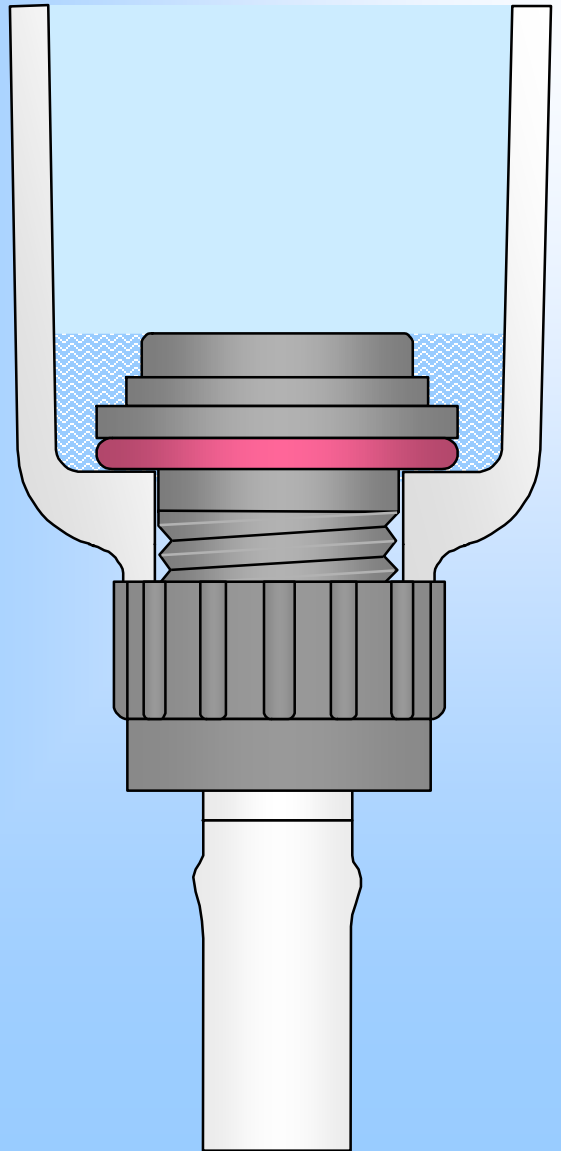
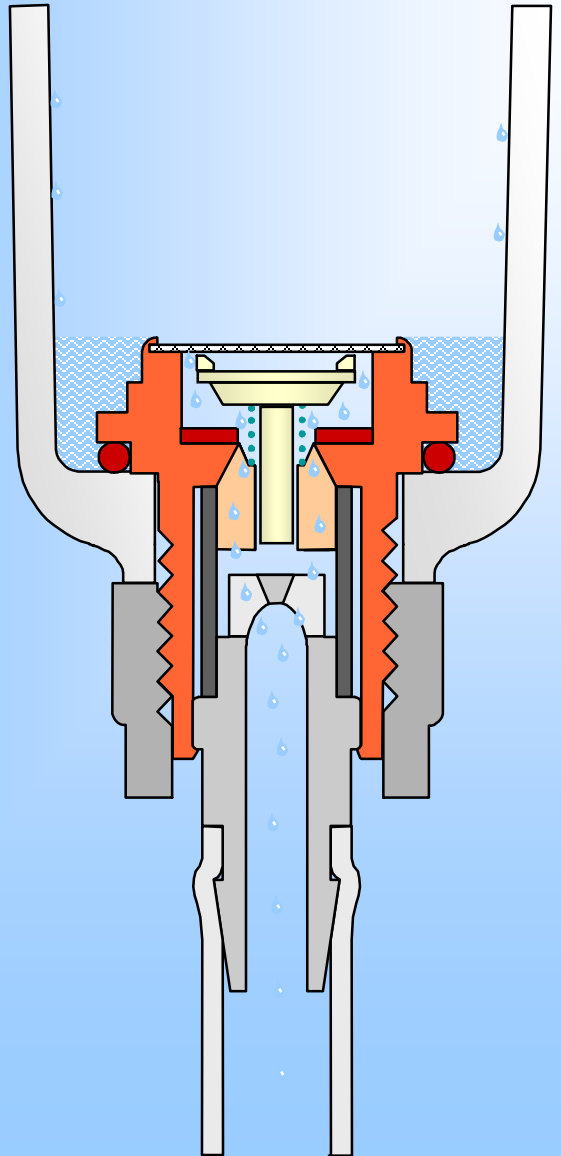
Semi-automatic drain



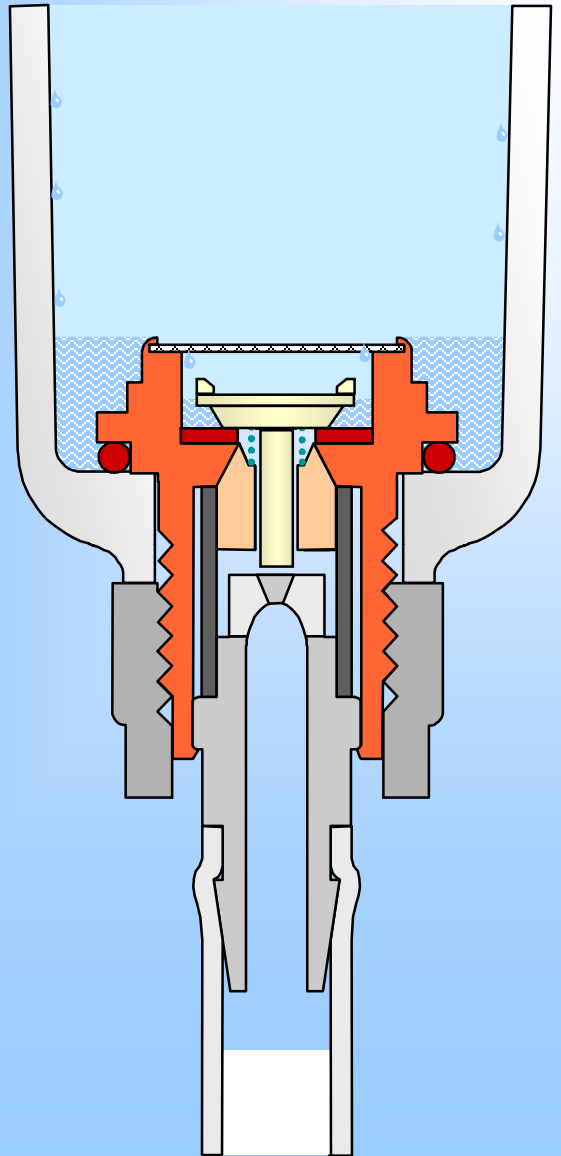
- When the pressure is turned off at the end of the day or at any other time the drain valve will open automatically
- In most applications the normal daily cycle will keep the bowl cleared
- If the bowl needs draining while under pressure this can be achieved manually by pushing up on the pipe connector

Semi-automatic drain



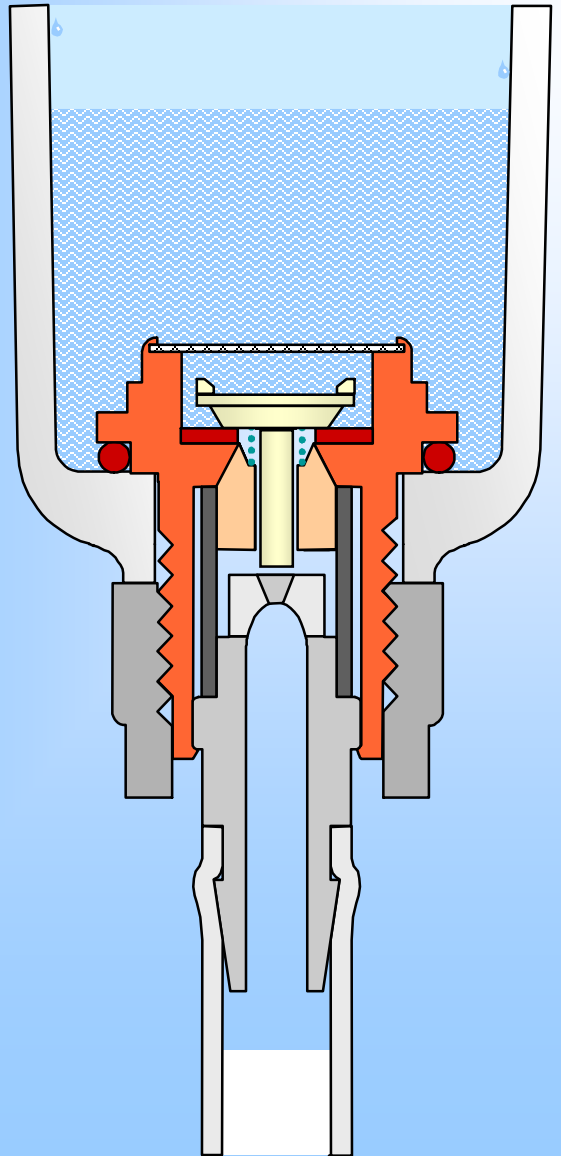
- When air pressure is OFF the valve springs to the open position and draining occurs
- Water contained in the bowl will be cleared
- Over time additional water may drain from the supply pipework. When it enters the bowl it will clear through the valve

Semi-automatic drain



- When air pressure is ON the valve is pushed closed
- Water will start to build up in the bowl
- If the level becomes too high before the pressure is turned off it can be drained under pressure manually
- Push up on the pipe connector and hold until draining is complete

Semi-automatic drain



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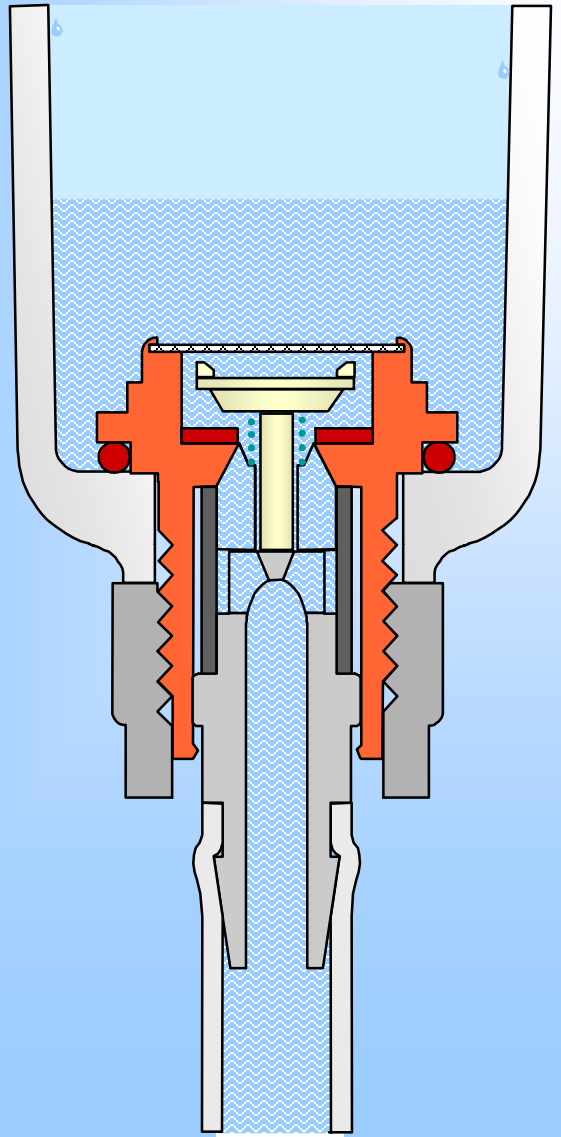

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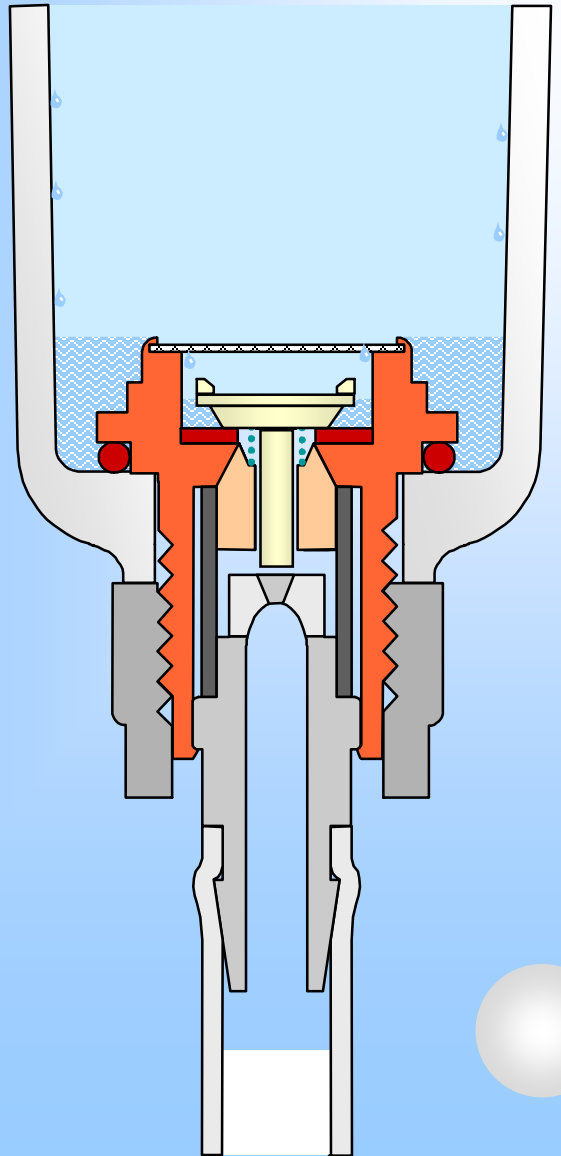

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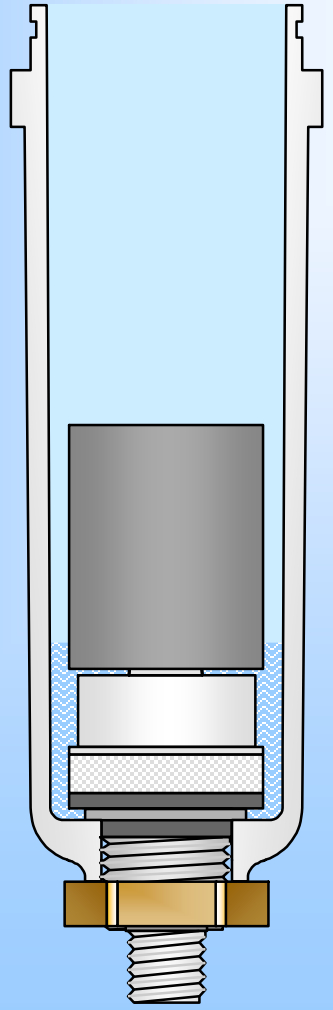
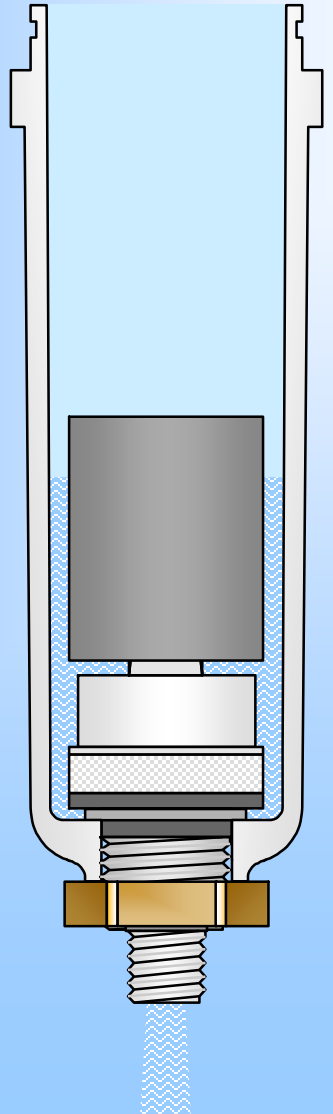
Fully automatic drain valve



- In normal working under pressure, the float will lift when the water level rises
- This causes the valve to open and the water is ejected
- The float falls and the valve closes
- When the pressure is turned off at the end of the day or at any other time the drain valve will open automatically

Fully automatic drain valve



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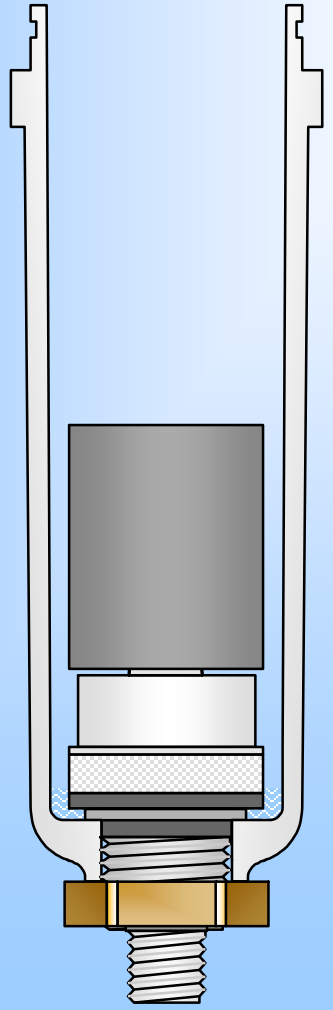

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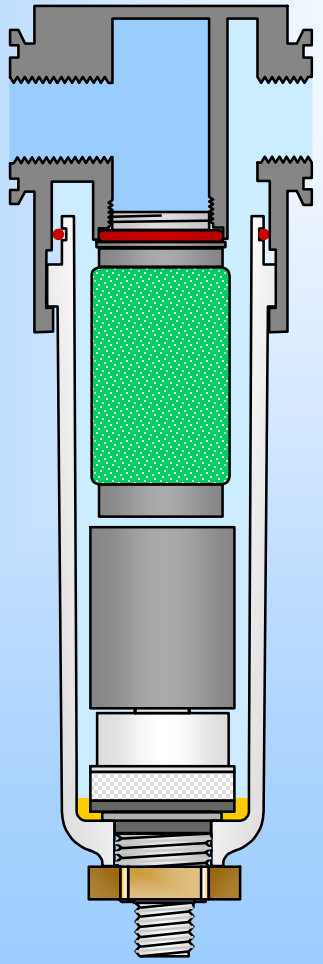
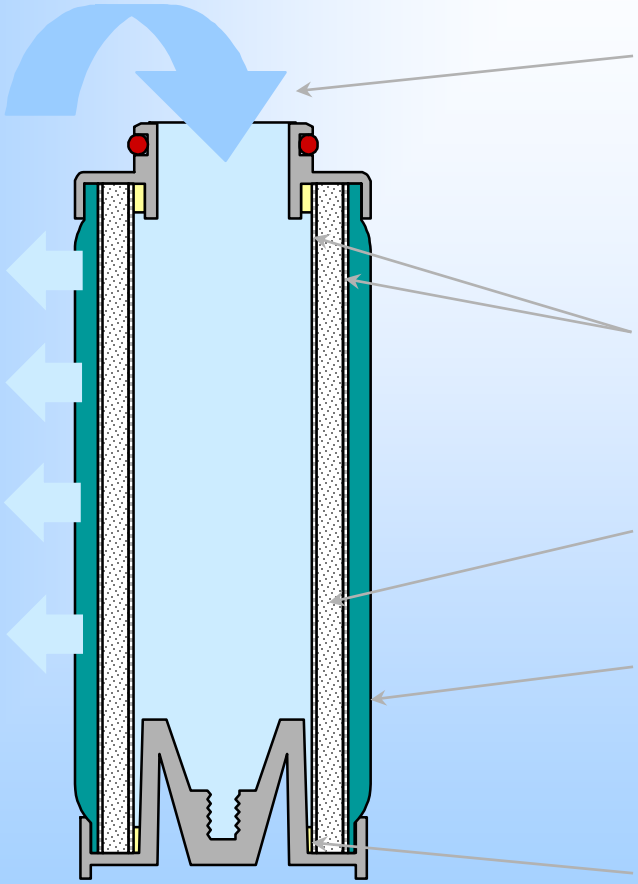
Coalescing Filters

Coalescing filters



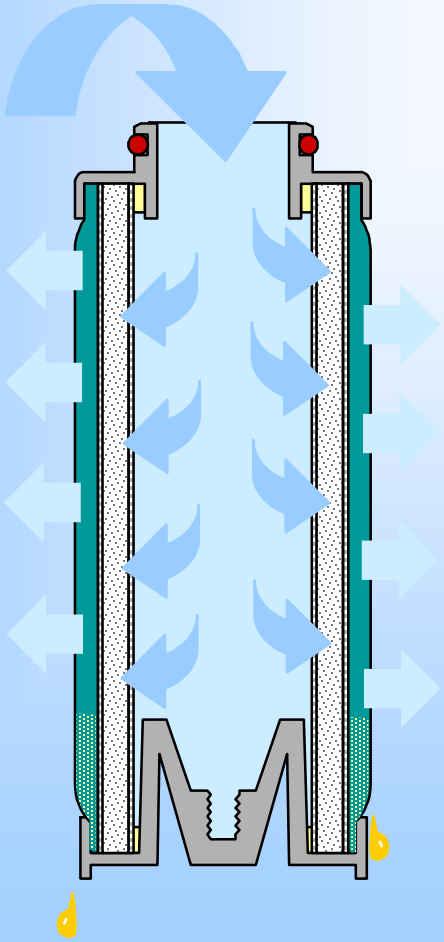
- For applications where the air is to be exceptionally clean and free of oil
- For use in food and drug processing, air bearings and paint spraying etc.
- Sub-micrometre particle removal down to 0.01 µm
- Air should be pre-filtered down to 5 µm to prevent short element life due to solid particle build up

Coalescing filter element



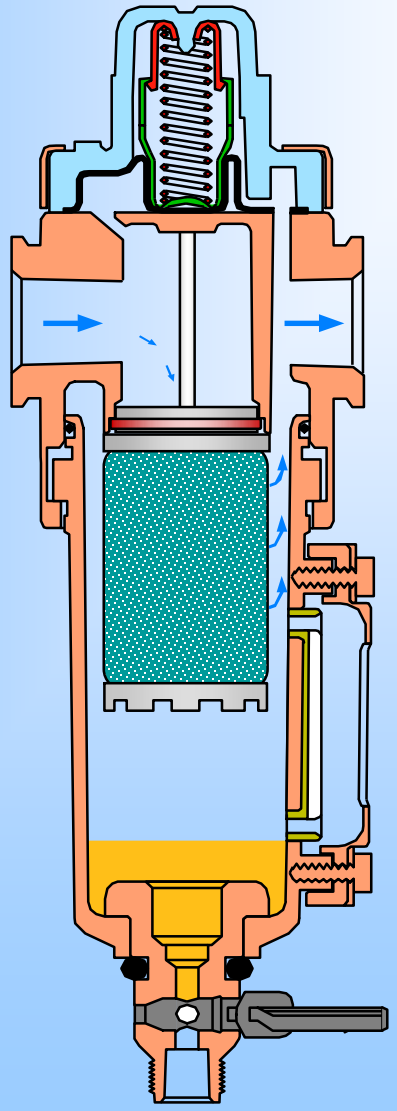
- Air enters the inside of the element and passes through the filter to the outer surface
- Perforated stainless steel supporting formers for up to 10 bar differential
- Filter media: borosilicate glass micro fibre
- Foam sock diffuses air flow to low velocity to prevent oil re-entrainment
- Ends set in resin to seal

Coalescing filter element



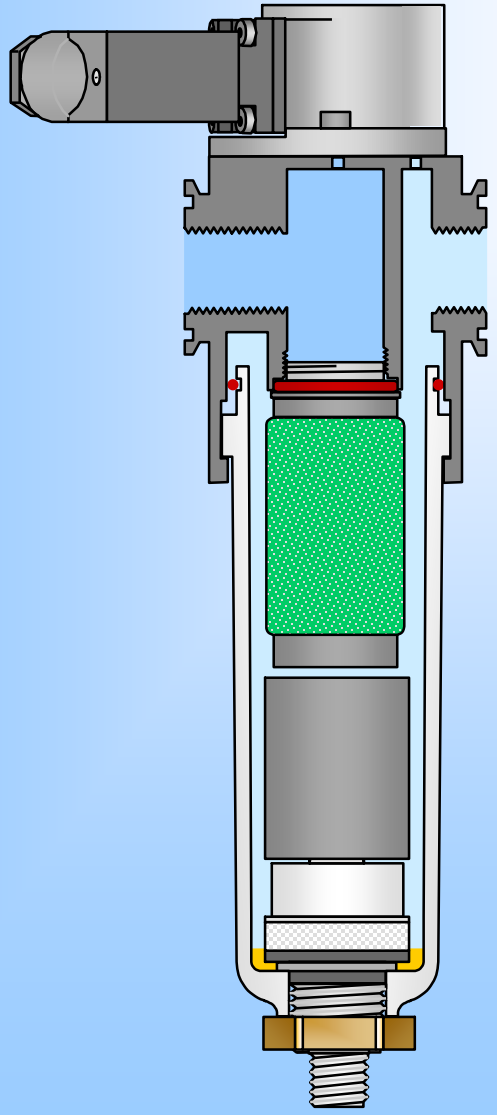
- Oil aerosol particles coalesces (join together) when they contact the element media
- The pathways through the media are so fine and complex that the particles cannot pass through without contact
- Oil soaks and drains to the bottom of the sock where it drips in to the bowl

Coalescing filters



- Flow ratings are lower than equivalent sized standard units e.g. 28 dm3/s compared to 83 dm3/s for G1/2 at 6.3 bar
- Filter area large for rated flow to keep air velocity low and prevent oil re-entrainment
- Standard service life indicator monitors the pressure drop to warn when element requires replacing

Electrical service life indicator



- Ideal for remote indication when filter element requires replacing
- Can be used to give remote visual and audible warning
- For sensitive applications can be used to automatically turn off a machine or process

Air filtration quality

- ISO 8573-1 Compressed air for general use
- Part 1 Contaminants and quality classes
- Allowable levels of contamination are given a quality class number
- Specified according to the levels of these contaminants:
  - solid particles
  - water
  - oil
- An air quality class is stated as three air quality numbers e.g. 1.7.1
  - solids 0.1 µm max and 0.1 mg/m ^{3} max
  - water not specified
  - oil 0.01 mg/m ^{3} max
- This is the filtration class given by the ultra high efficiency units
- To obtain pressure dew points that are low, also use an air drier

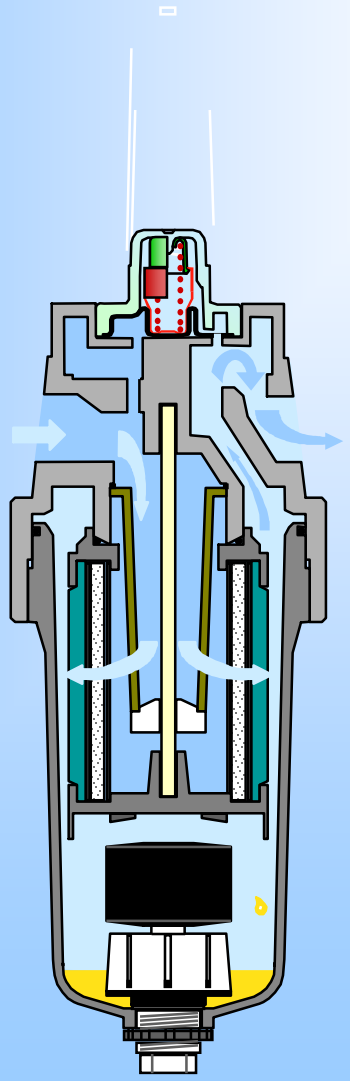
Compressed air quality

ISO 8573-1

Class	Solids		Water	Oil
	particle size max µm	concentration maximum mg/m ^{3}	Max Pressure Dew point ^{O}C	concentration mg/m ^{3}
1	0.1	0.1	– 70	0.01
2	1	1	– 40	0.1
3	5	5	– 20	1
4	15	8	+ 3	5
5	40	10	+ 7	25
6	-	-	+ 10	-
7	-	-	Not Specified	-

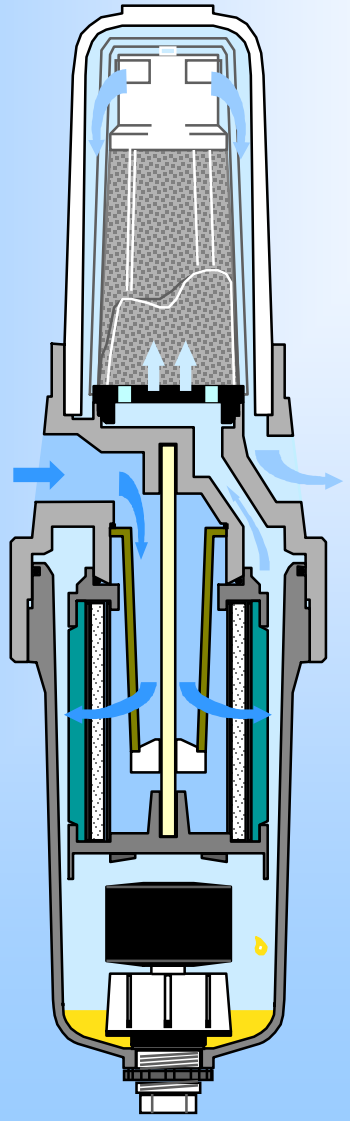
Pressure dew point is the temperature to which compressed air must be cooled before water vapour in the air starts to condense into water particles

High efficiency oil removal



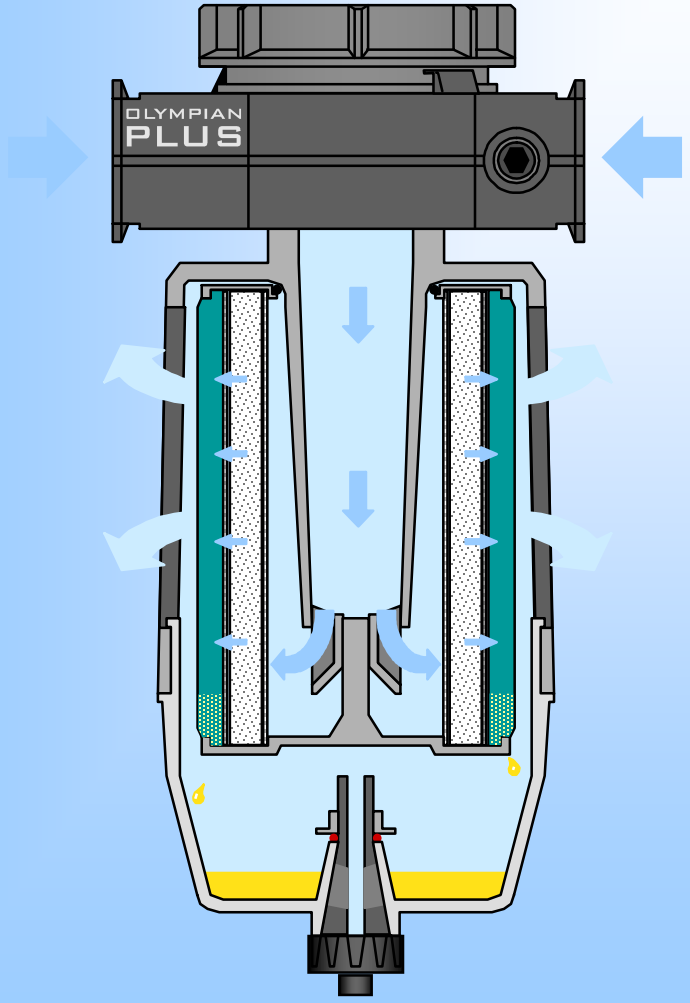
- High efficiency coalescing element
- Remaining oil content 0.01 ppm max at + 21°C
- Particle removal down to 0.01 µm
- Air quality to ISO 8573-1 Class 1.7.2
  (to accommodate any oil vapour carry-over that may condense out at lower temperatures)

Ultra high efficiency



- Active carbon pack for oil vapour and odour removal
- Warning pink dye activated if oil carries over due to coalescing element failure
- Remaining oil content 0.003 ppm max at + 21°C
- Particle removal down to 0.01 µm
- Air quality to ISO 8573-1 Class 1.7.1

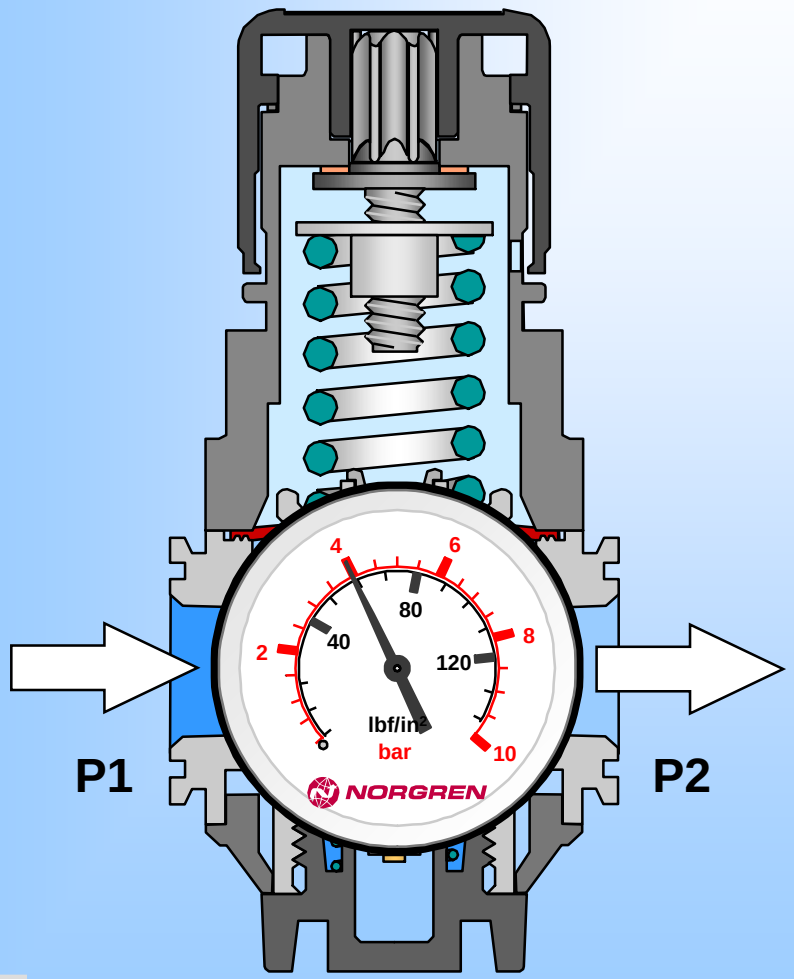
Coalescing silencers



- For the termination of all pneumatic system exhausts
- Removes lubricating oil particles carried over in the exhaust
- Large filter area keeps exhaust velocity low for very low noise
- Piped exhausts can be connected to either end
- Can be gang mounted also with porting blocks

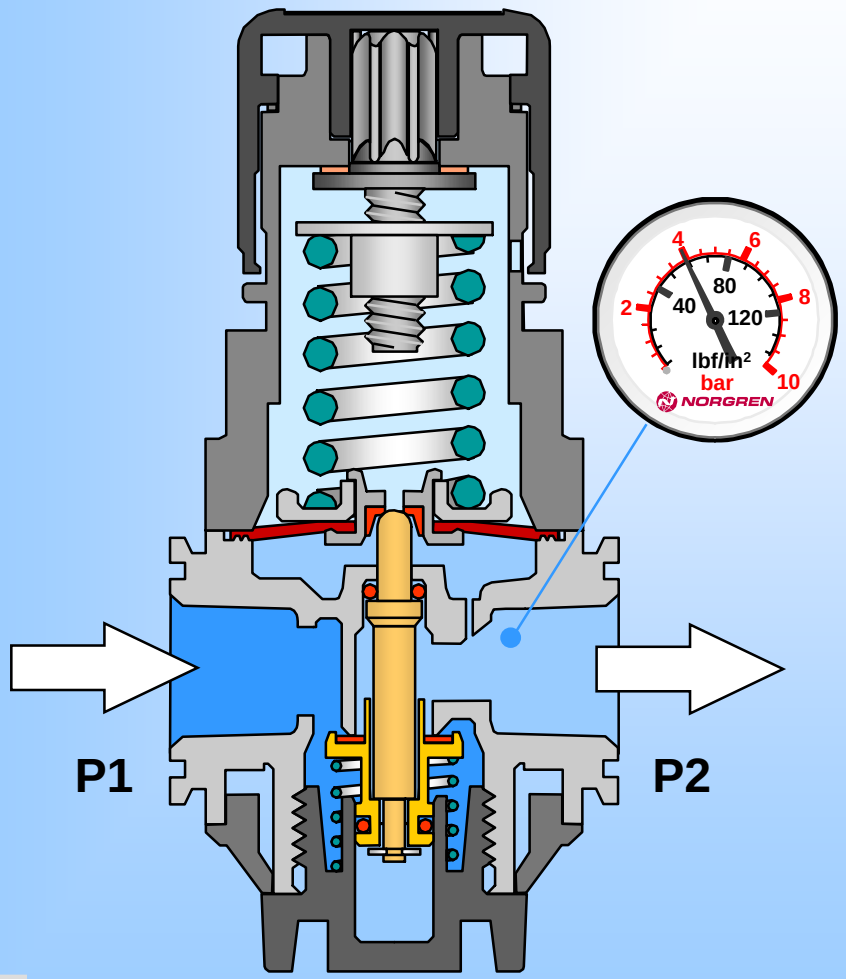
Pressure Regulators

Pressure regulator



- Reduces supply pressure P1 to a suitable working pressure P2
- When there is no flow demand the poppet valve closes to hold the pressure at P2
- Flow demand will open the poppet valve wide enough to satisfy the flow rate at pressure P2
- P2 can be set on a gauge fitted to the regulator

Pressure regulator



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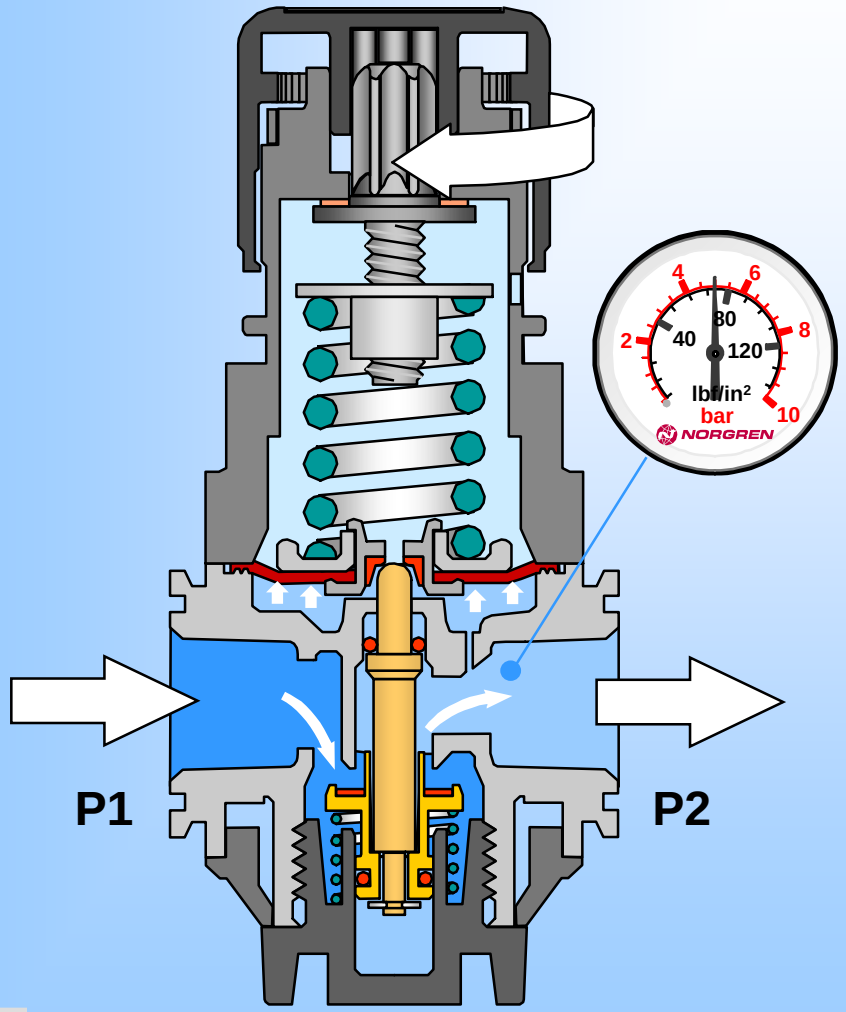
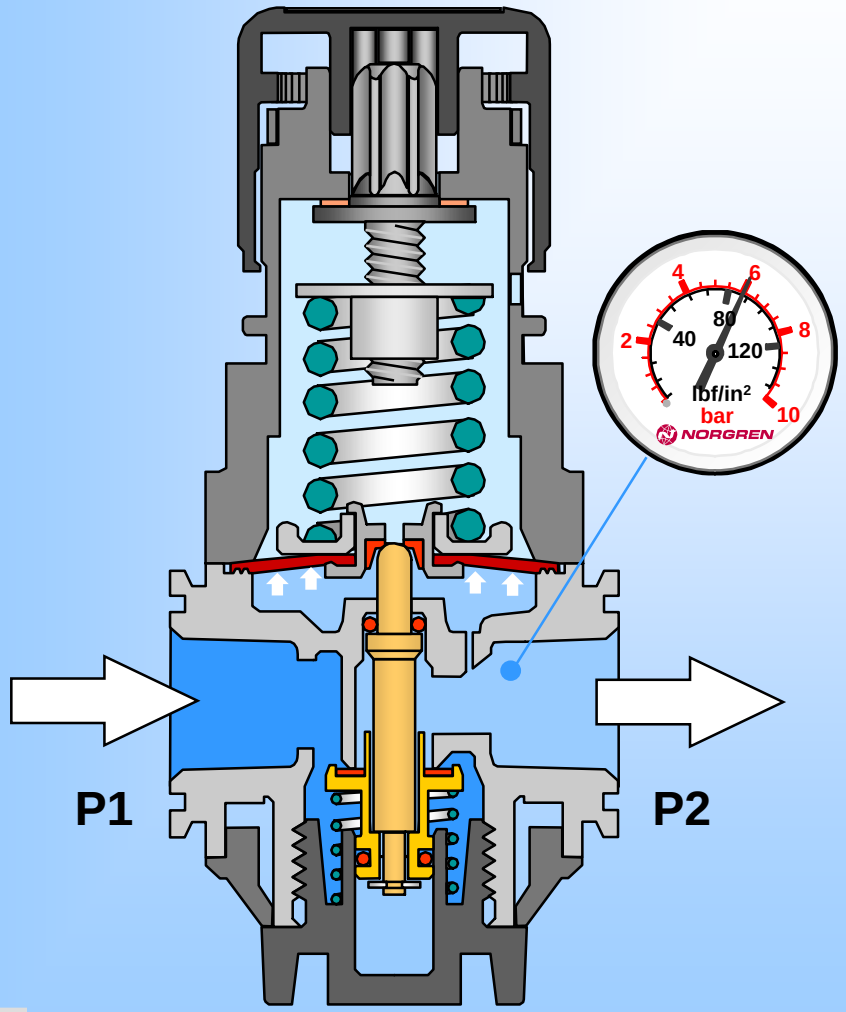
Pressure regulator



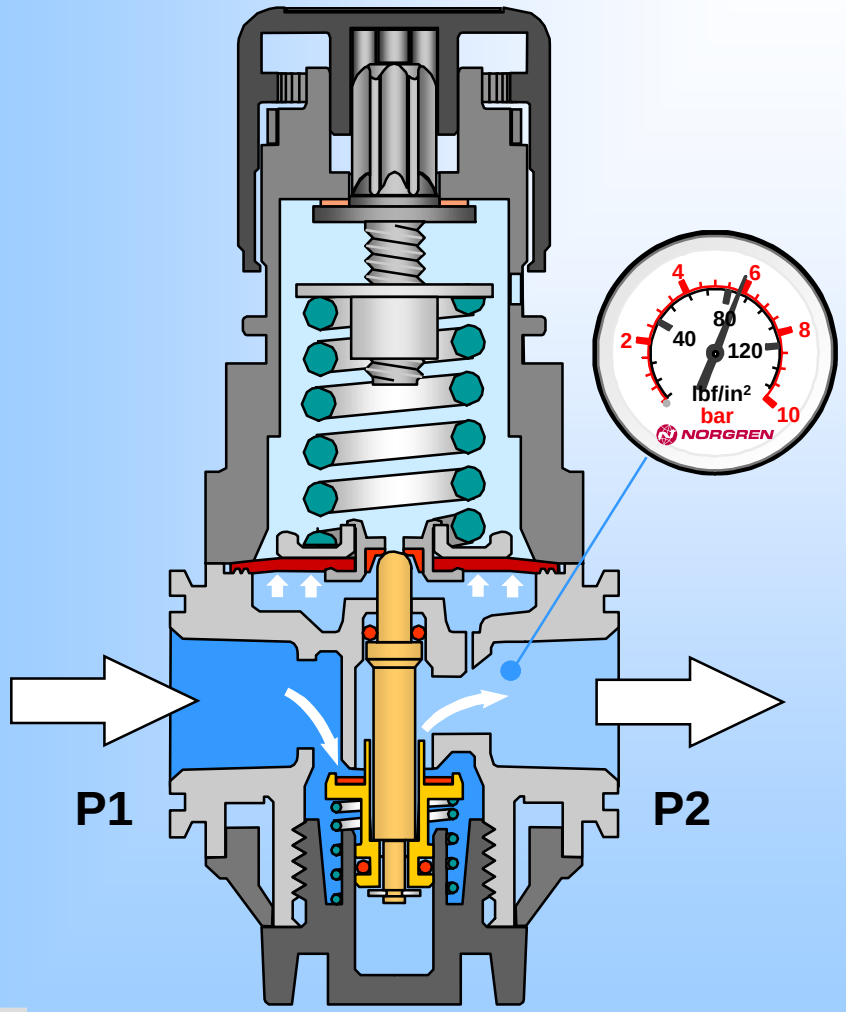
- To increase pressure P2, pull the adjusting knob up to disengage the locking teeth
- Turn clockwise until new P2 pressure reached
- The higher spring force pushes the valve open
- The rising pressure P2 acts under the diaphragm to balance the spring and allow the valve to close
- Dead end application

Pressure regulator



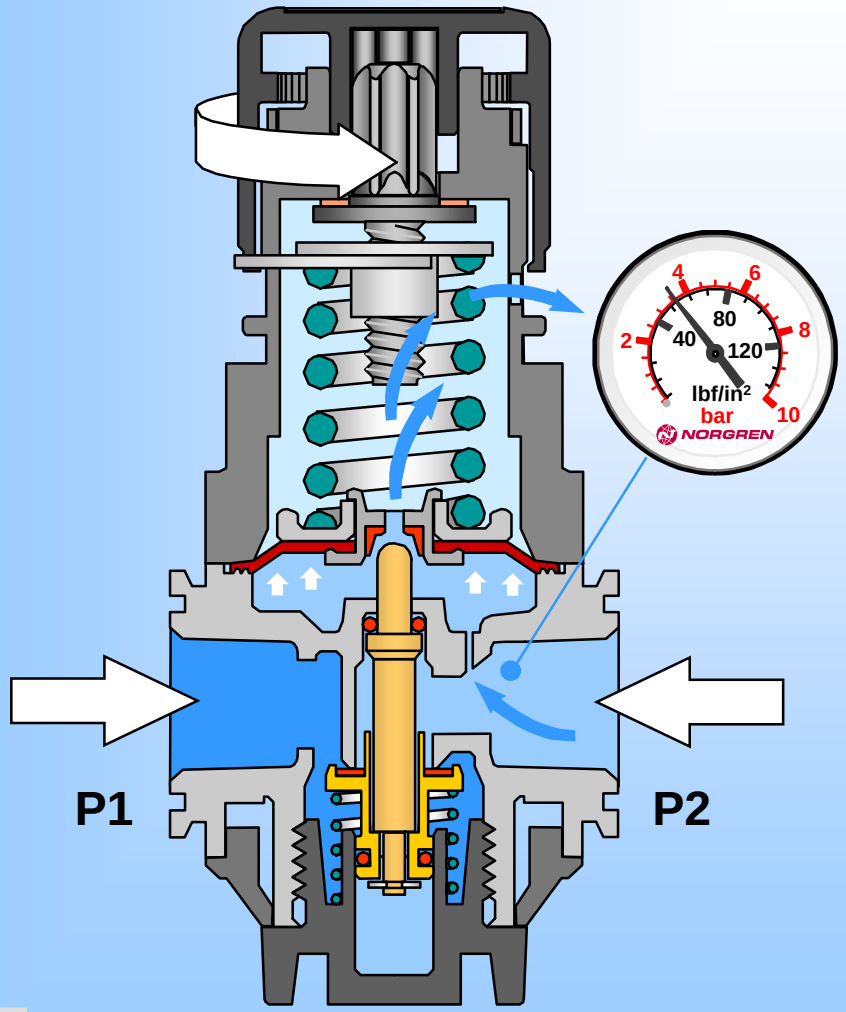
- When the desired pressure is reached the force on the diaphragm will fully balance the force on the spring and the valve will close
- Dead end applications are those that are closed ended. The flow demand is intermittent so the system will fill and settle at the set pressure e.g (a single stroke of an actuator)

Pressure regulator



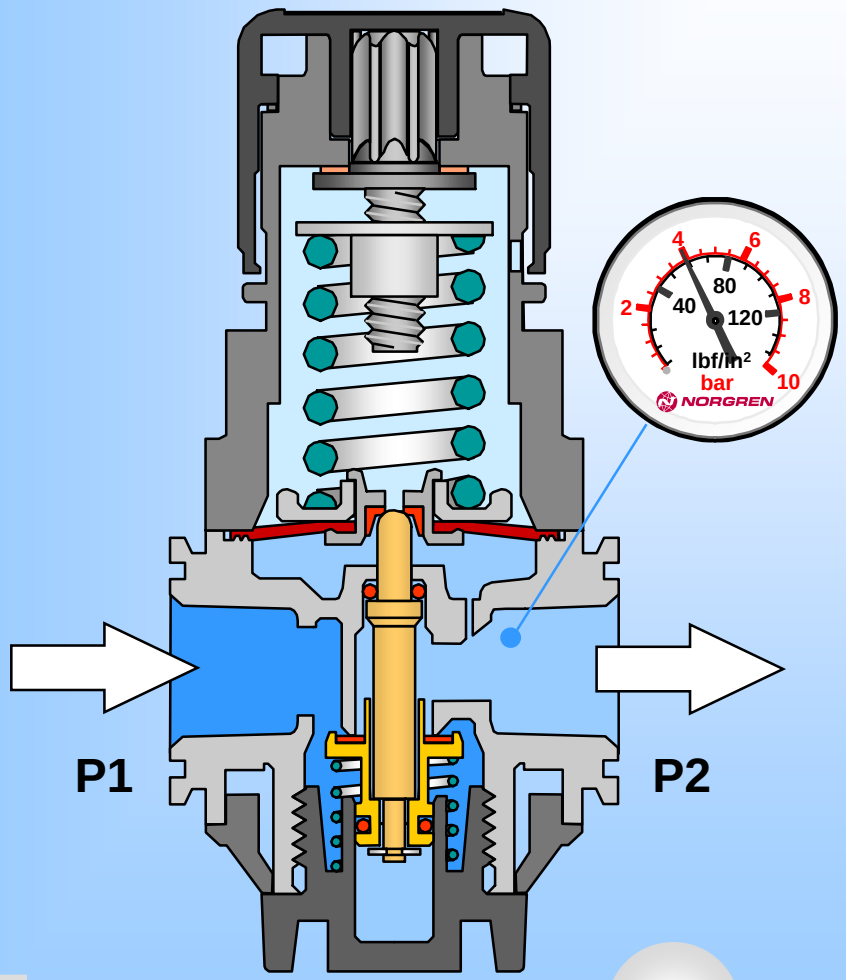
- While flow is taking place the valve will be held open wide enough to keep as close to the set pressure as possible for the flow demand
- As the flow rate increases so the pressure under the diaphragm decreases to open the valve wider to maintain the flow close to the set pressure

Pressure regulator



- This is a relieving regulator to allow pressure to be reduced to a lower setting
- Turn anticlockwise to reduce the spring force
- The higher force under the diaphragm lifts it clear of the valve spindle
- P2 can now exhaust until the diaphragm seals
- Turn clockwise to adjust up to the new pressure

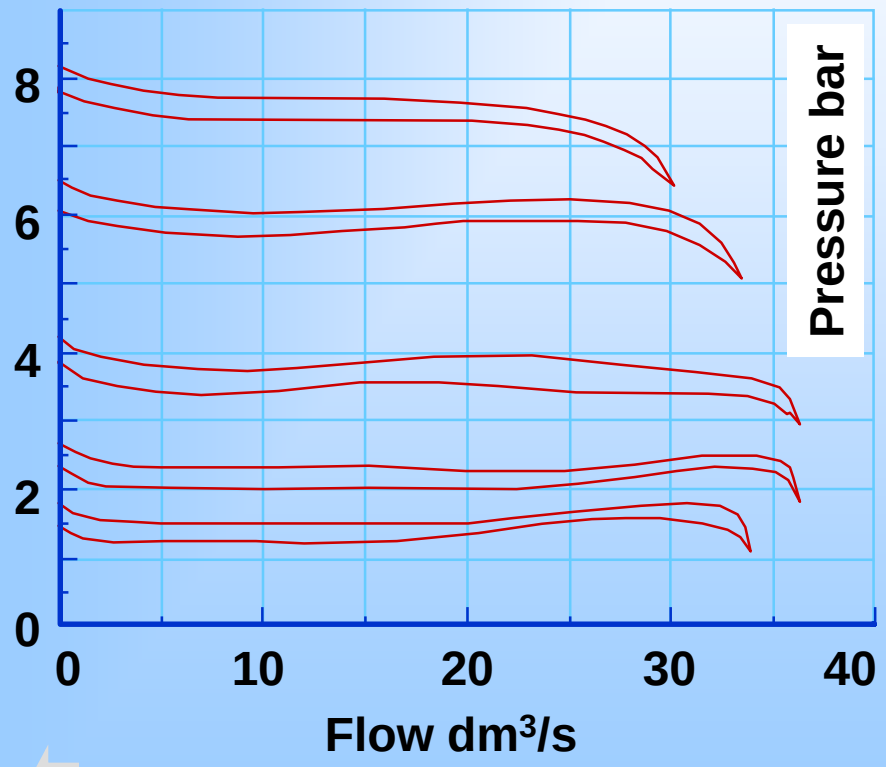
Pressure regulator



- **Once the desired setting has been established push down the locking adjusting knob to prevent inadvertent changes**

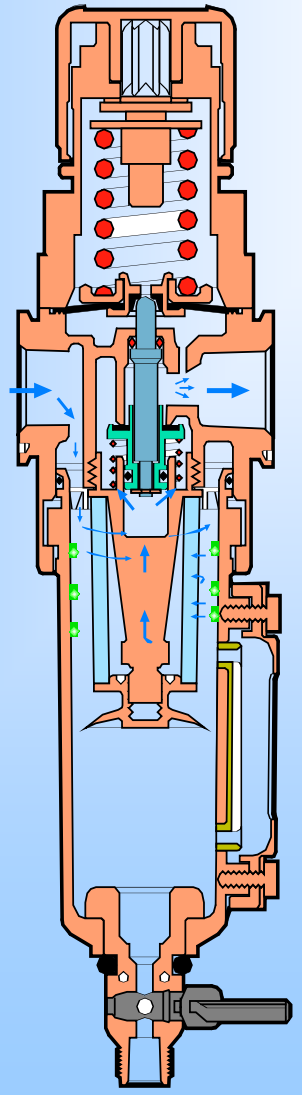
Pressure characteristics

R72G Relieving G$^{1}/_{4}$
Spring range 0-10 bar
Primary pressure 10 bar



- The curves show the characteristics and hysteresis of pressure from a set value for increasing then decreasing flow
- The transition from no flow to just a little flow produces an initial drop
- For the useable range the curve levels out and even rises slightly then falls steeply as the useable range is exceeded

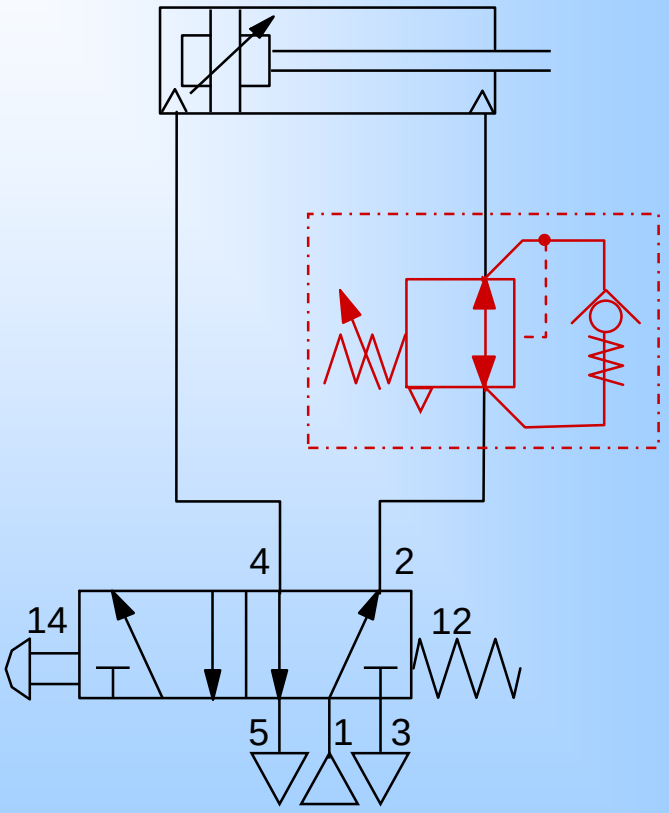
Filter Regulator



- Filter and regulator designed as a single unit
- Air is first filtered then directed to the primary side of the regulator
- Pressure is then reduced to a working value
- Only one unit to install
- Cost saving when compared to two separate units

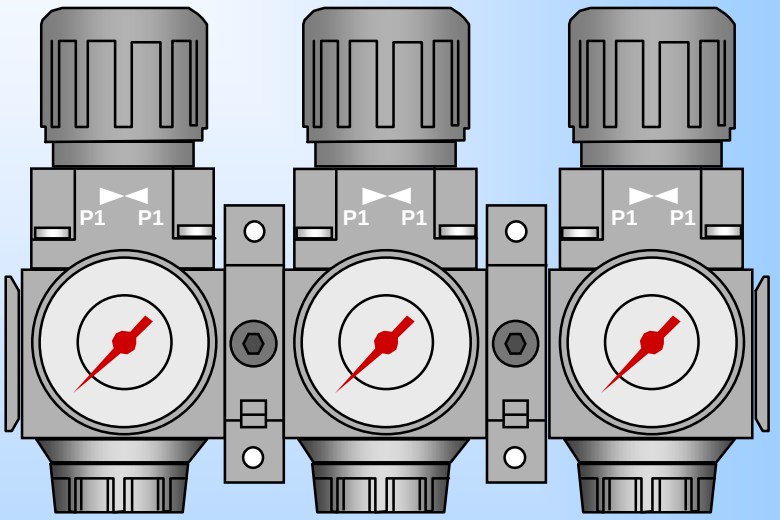
Reverse flow regulator

- For applications where the supply to a regulator is cycled
- The reverse flow pressure regulator features an inbuilt check valve to allow reverse flow
- Types R72R, R74R
- Illustration shows a reverse flow regulator between cylinder and valve, this allows pressure reduction to the front end of a cylinder



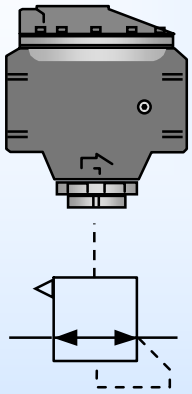
Manifold regulator

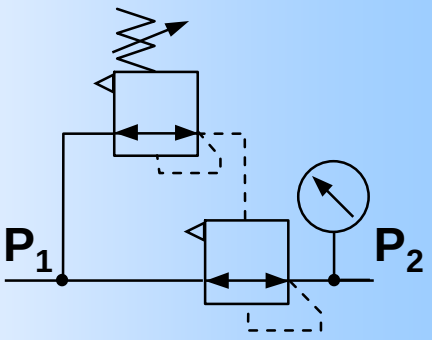
- Compact multi-pressure outputs from manifolded pressure regulators
- In line common manifolded supply
- P_1 supply connection can be:
  - from both directions (recommended for large banks)
  - a through supply from either direction
  - single ended supply from either direction

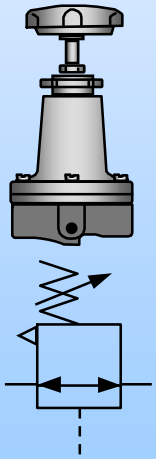


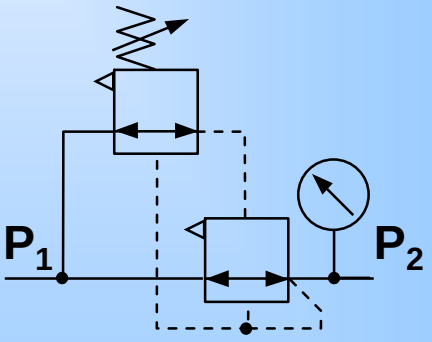
Pilot regulators

- Large pressure regulators generate high forces, unsuitable for direct manual operation
- Often mounted in remote locations difficult to reach
- A piloting regulator is easy to operate and sends a signal to adjust the remote pilot regulator
- Independent or single loop feedback dependant on piloting regulator type, internal or external

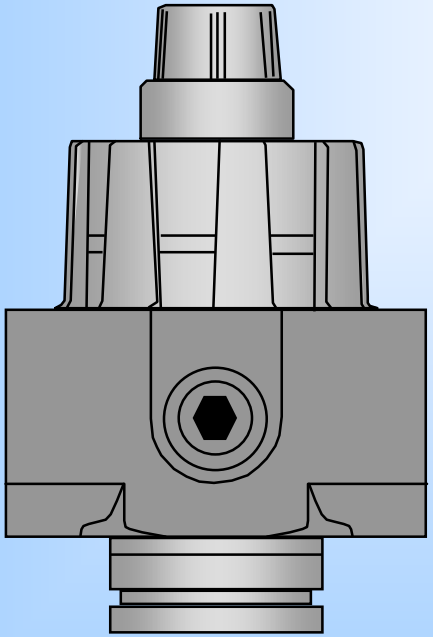








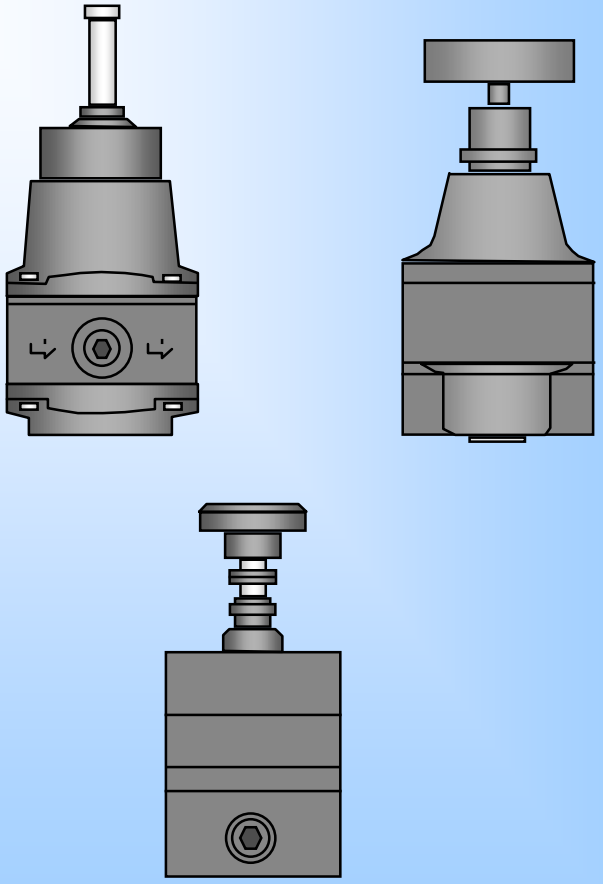
Micro Trol pressure regulators



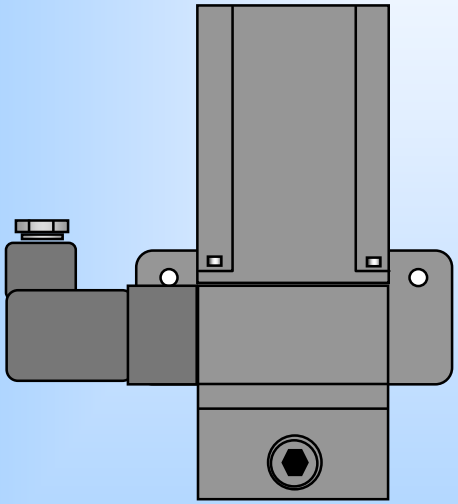
- Manual and pilot operated versions
- High forward and exhaust flow
- No force feedback to operating control for easy fingertip adjustment
- Suitable for applications where downstream pressure needs rapid up and down adjustment
- Sizes G$^{1}/_{4}$,G$^{3}/_{8}$, G$^{1}/_{2}$, G$^{3}/_{4}$, G1, G1$^{1}/_{4}$

Precision regulators

- Types R38, 11-818 and R27
- For precisely set and accurately held pressure
- Suitable for process control, air gauging and instrumentation
- Selection of pressure ranges e.g. 0.02 -0.5 bar, 0.06-4 bar, 0.16-7bar etc.
- Manual, mechanical and pilot operation



Pneu-Stat



- Electronically controlled pressure regulator
- Control signals 4-20mA, 0-5V and 0-10V
- Precision regulating valve
- Span adjustable from 0-8bar to 0-4bar
- Protection to IP65
- Flow max at 4bar 600l/min forward. 300l/min relief. < 5 l/min consumption
- Nominal 24V 100mA max supply

Lubricators

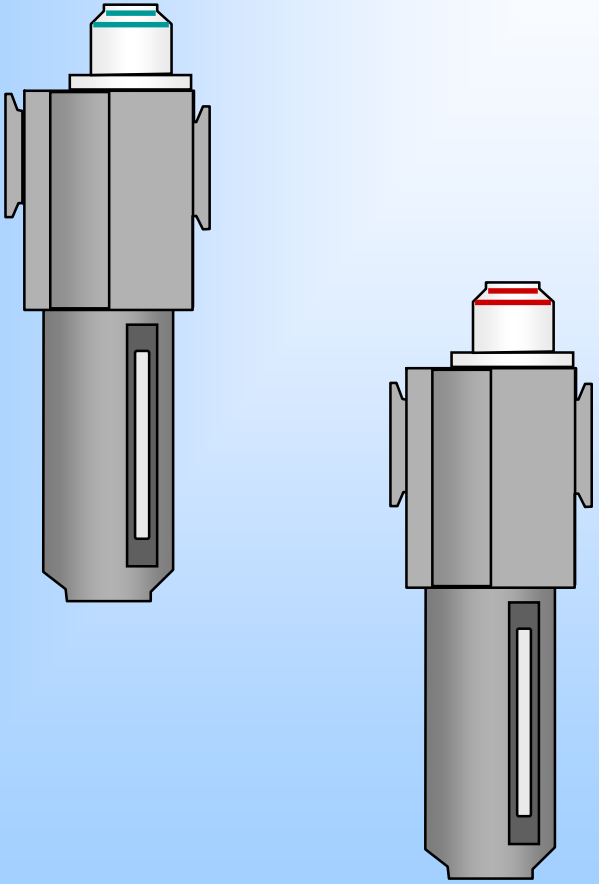
Lubrication

- For efficient running of pneumatic equipment and long life of seals and wearing surfaces, correct lubrication is essential
- Where non-lube equipment is used it has been pre-lubricated on assembly and will last for the normal life expectancy of that equipment without further lubrication. It will not be detrimental however to include this equipment on lubricated air supplies and is likely to result in an extension of the normal life of the equipment
- For the best results light lubrication is applied continuously from an air line lubricator. This is particularly relevant in adverse applications where there may be high speed and high temperature running or where the condition of the compressed air has been poor

Lubrication

- Valves, actuators and accessories in a typical application can operate at different rates and frequencies and require lubrication rates to match. The airline lubricator provides a very convenient method of satisfying this demand
- In a lubricator, oil drips are atomised and the tiny oil particles form a very fine mist in the air supplying the application
- The amount of oil delivered is automatically adjusted as the air flow changes. The result is constant density lubrication. For any setting the oil particles per cubic meter of air are the same regardless of the flow rate

Lubricators

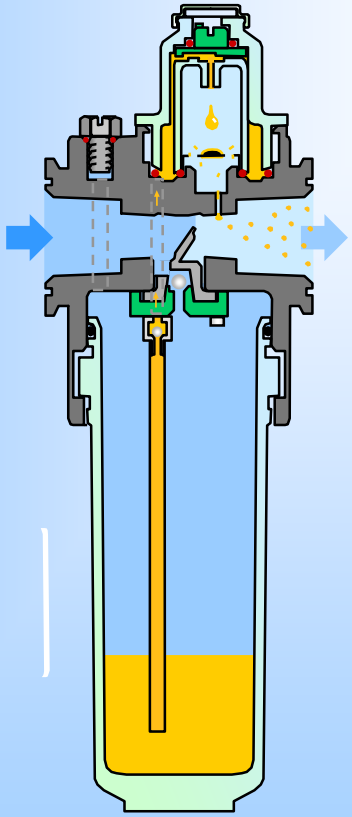


- There are two main types of lubricator
- One is the conventional high delivery Oil Fog series (coded green)
- The other is the unique and more widely used Micro Fog range (coded red)
- Both types are easily adjusted to pre-set the lubrication density

Oil fog lubricators

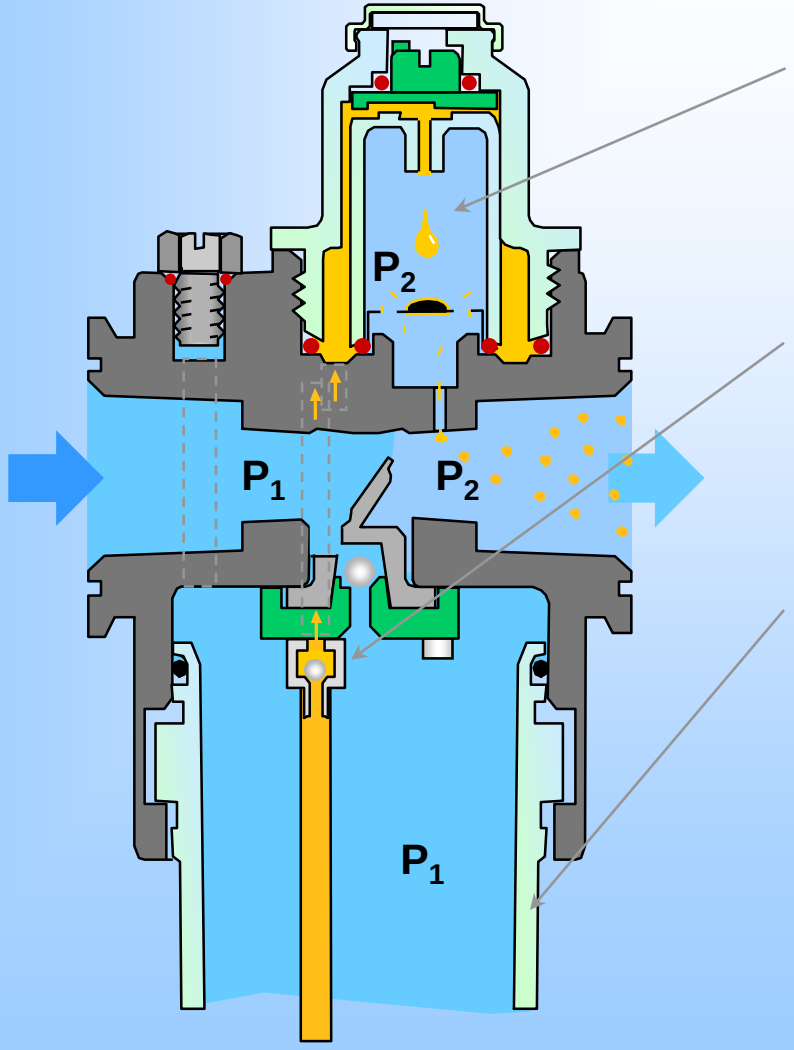
- Oil fog lubricators are often referred to as high delivery units and can be identified by the green drip rate control
- All of the oil drips seen through the sight dome enter the air stream and are atomised
- The size range of the oil particles produced are ideally suited to lubricating single items of equipment on medium to short runs of pipe
- The oil particles are carried along with the air flow, and gradually "wet out" to provide adequate lubrication for applications such as nut runners, screwdrivers and other equipment requiring heavier lubrication

Oil fog lubricator



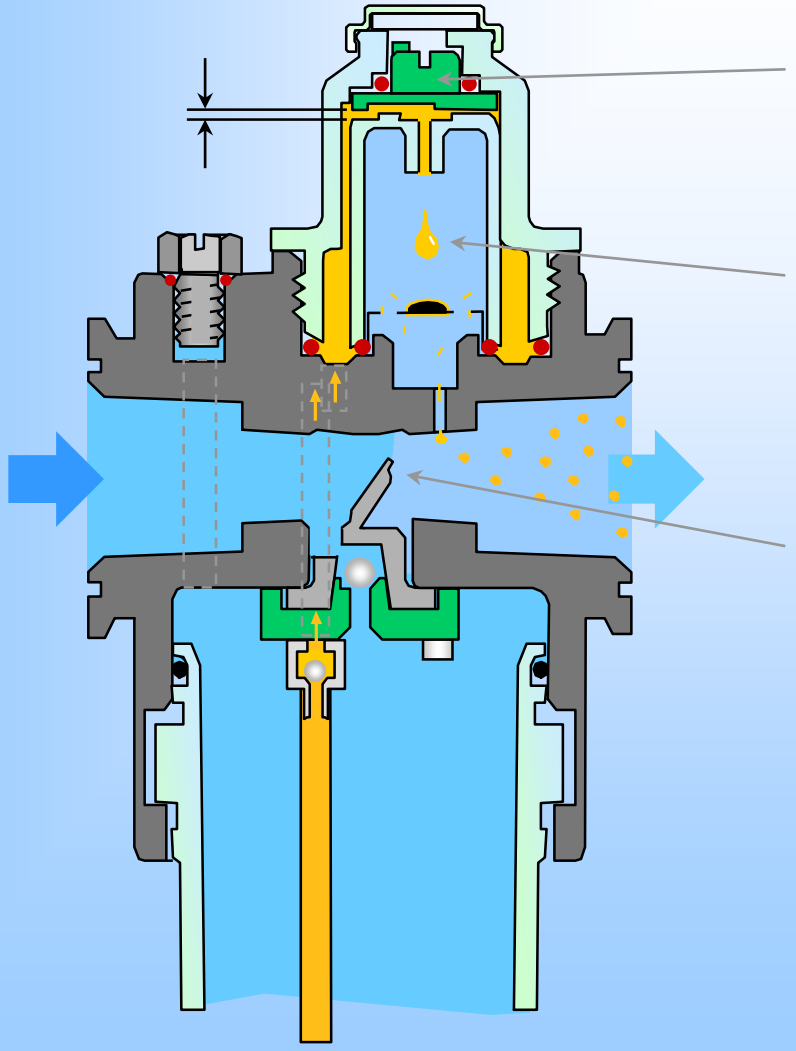
- For lubricating over short distances where wet-out is required early
- Suited for; air tools, air motors, single large cylinders etc.
- Oil drips are broken up in the main air stream and all particle sizes carried in the air
- Drip rate is adjustable

Oil fog lubricator



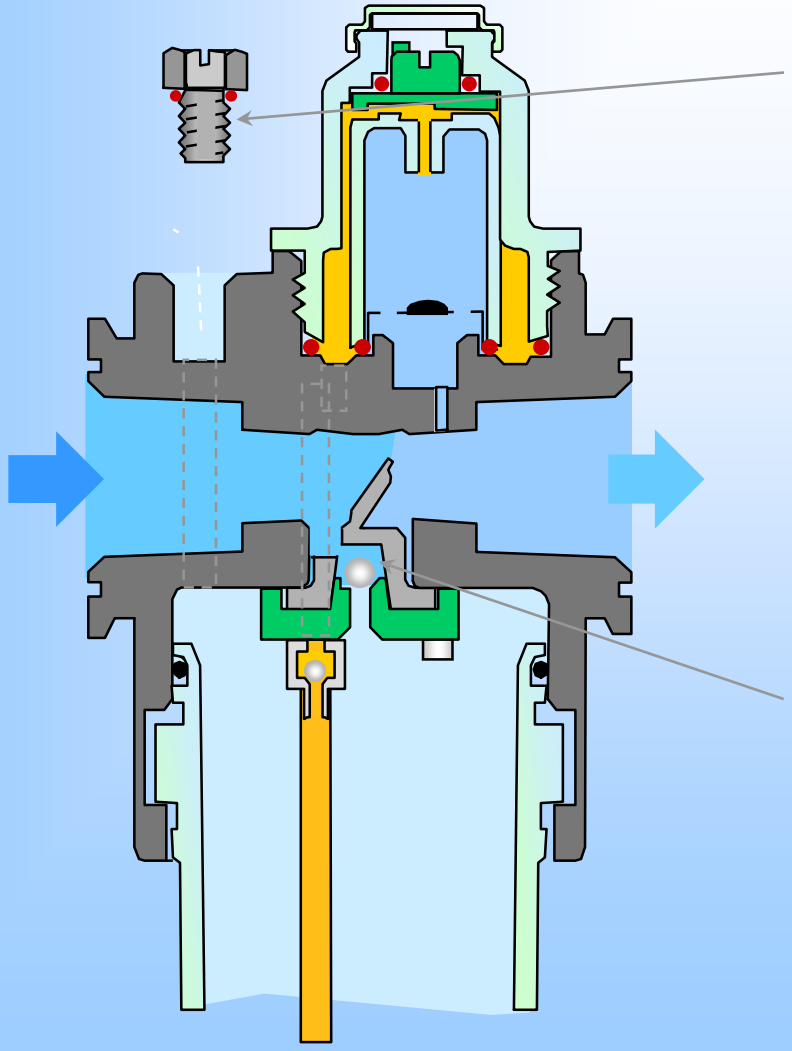
- Oil drips visible through the sight dome pushed by the pressure difference between P_1 and P_2
- Syphon tube with check valve to prevent oil drain back when there is no flow taking place
- Transparent polycarbonate bowl to inspect oil level
- Alternative metal bowl with sight glass

Oil fog lubricator



- Turn the green control to adjust the oil flow restriction
- Observe the drip rate and set to 2 drips/min at 10 dm^3/s. Change from this according to results
- Flexible flow sensor, progressively bends flat as the flow increases. This controls the local pressure drop to draw oil drips in proportion to air flow

Fill under pressure (oil fog)

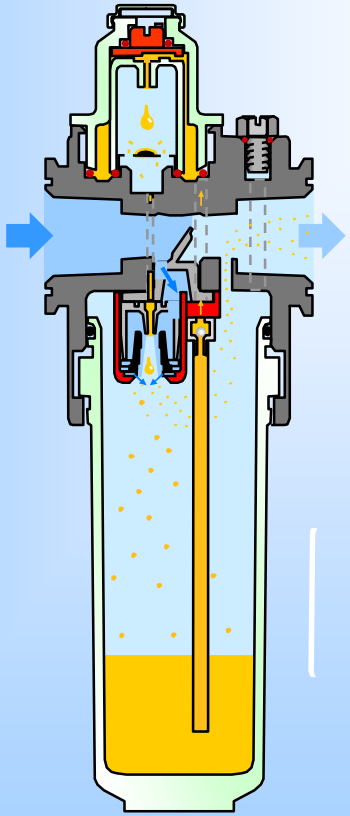


- Filler plug with flats to bleed the bowl pressure
- Crack open and wait for pressure to drop then remove the plug
- Remove bowl with simple bayonet action, fill and replace securely
- Replace plug and tighten
- Check valve with small by-pass notch. Flow too low to pressurise bowl when plug removed

Micro-fog lubricators

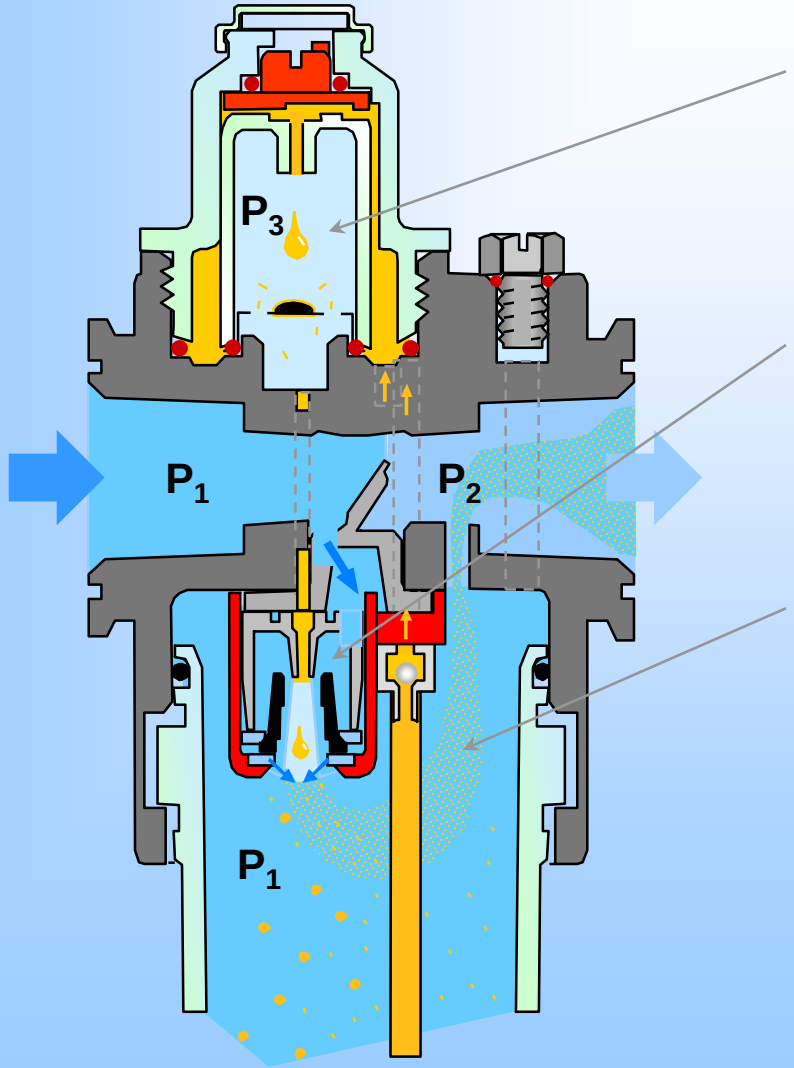
- Micro-Fog lubricators are the most widely applied type and can be identified by the red drip rate control
- The oil drips seen through the sight dome in this unit are atomised in the bowl, but only a small percentage of the particles produced actually enter the air stream
- Those that do, make up about 10% of the drip rate and are the very smallest ones, so fine they can be likened to thin smoke. The drip rate is 10 times that of the oil fog units for the same oil delivered. Setting the drip rate is 10 times quicker too as there is less time to wait between drips
- Wetting out of these oil particles occur gradually. This allows them to be carried the long distances associated with the maze of pipework, tight turns and fittings that form part of the typical industrial pneumatic system

Micro-fog lubricator



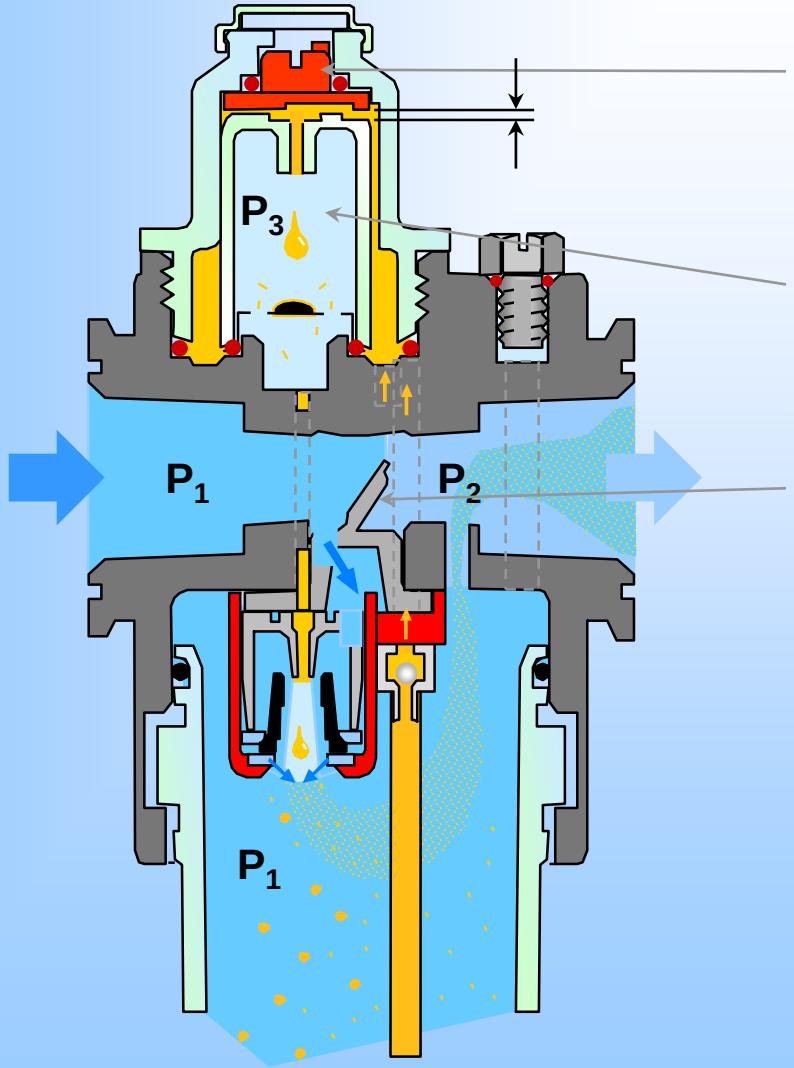
- For lubricating over long distances where particles must reach the furthest parts of intricate systems
- Suited to; control circuitry, multiple valve / actuator systems
- Oil drips are atomised in the bowl
- Only the finest 10% of oil particles leave the bowl
- Stay in suspension longer

Micro-fog lubricator



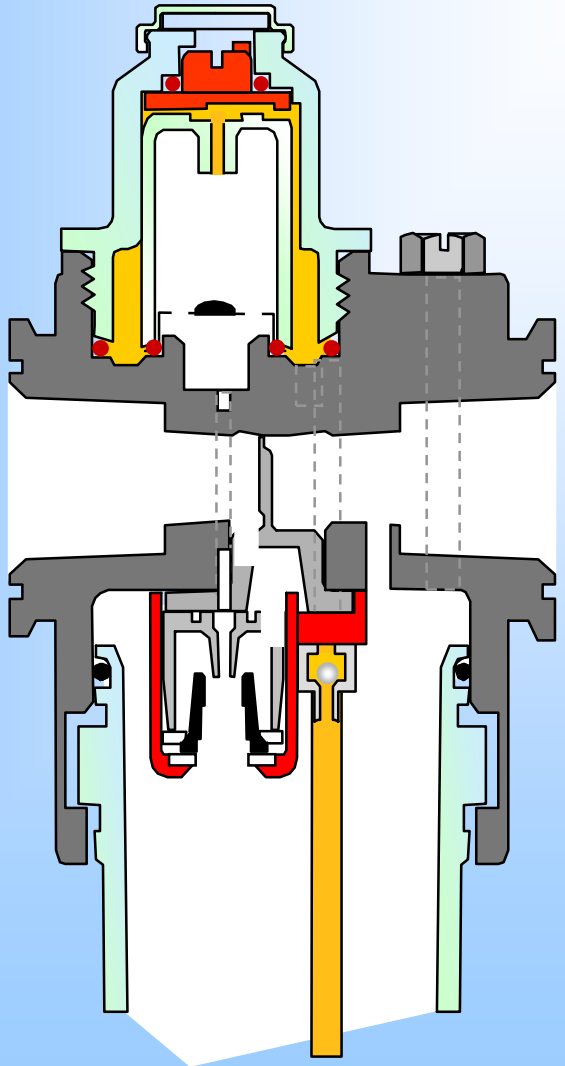
- Oil drips visible through the sight dome pushed by the pressure difference between P_1 and P_3
- All drips pass through the atomising head. Pressure drop P_3 created by venturi in atomising head
- Only smallest lightest 10% oil particles can make the tight turn to exit the bowl carried by the pressure drop $P_1 : P_2$

Micro-fog lubricator



- Turn the red control to adjust the oil flow restriction
- Observe the drip rate and set to 20 drips/min at 10 dm^3/s
- Flexible flow sensor, progressively bends flat as the flow increases. This controls the local pressure drop $P_1 : P_2$ to draw lubricated air from the bowl in proportion to flow

Micro-fog lubricator

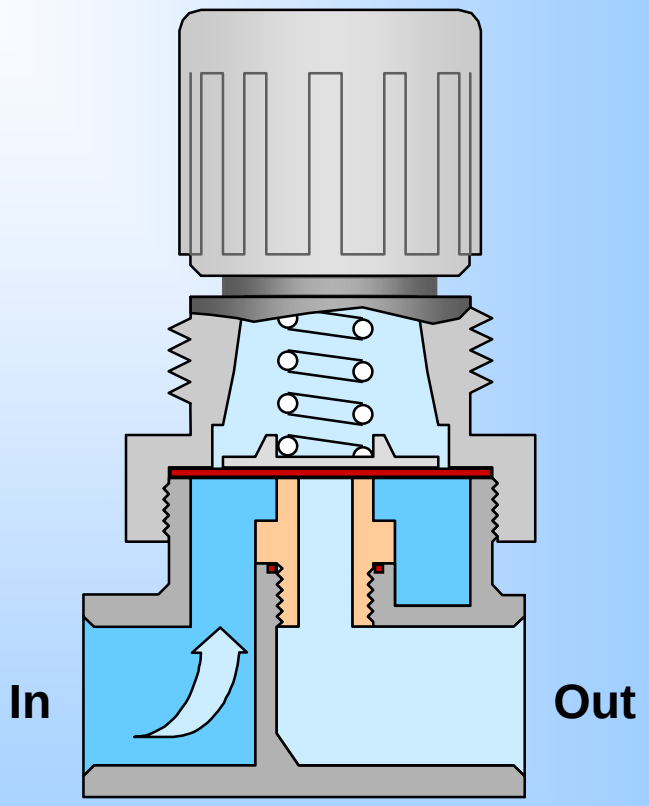


- Due to the high flow in to the bowl, a micro-fog cannot be filled under pressure
- First turn off and exhaust the air supply
- Remove the bowl and fill
- Replace bowl securely
- Turn on the air
- To fill under pressure, replace filler plug with a nipple adaptor

Relief Valves

Relief valve

- Spring force prevents normal air pressure from lifting the diaphragm
- Excessive pressure will lift the diaphragm to open the poppet valve and relieve air to the outlet
- When the pressure drops to the pre-set value again the spring closes the diaphragm poppet



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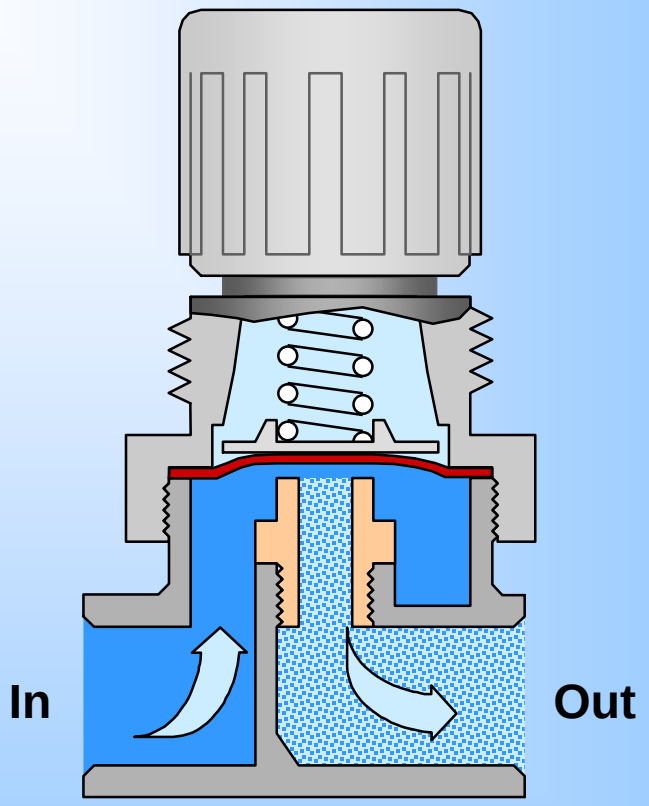
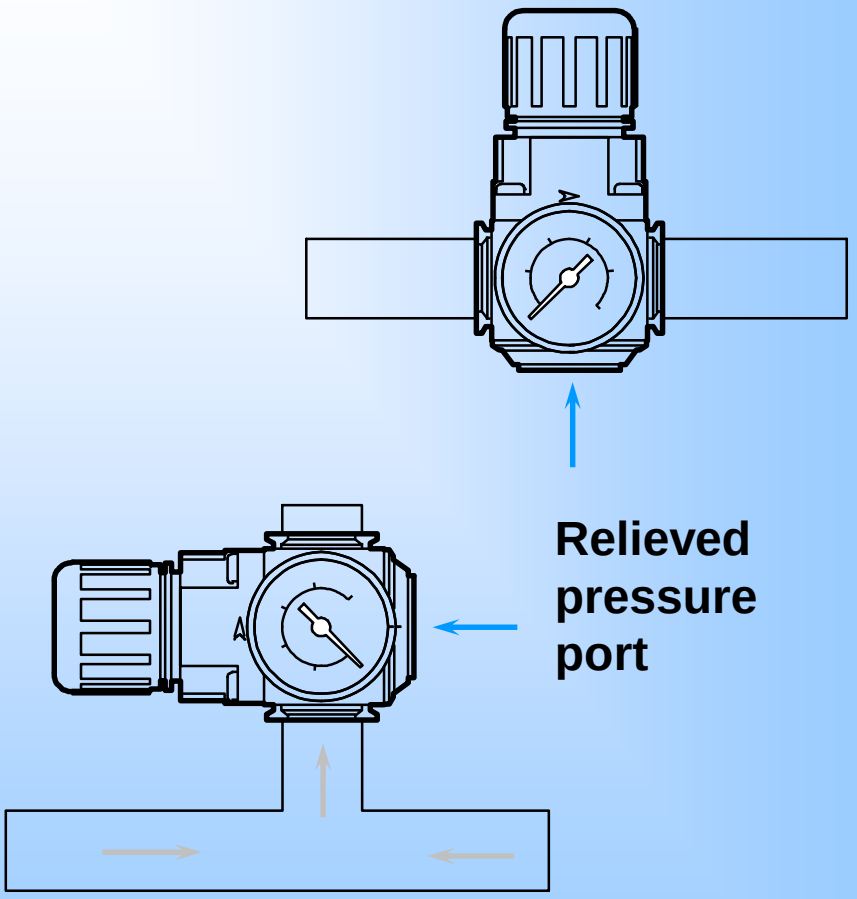


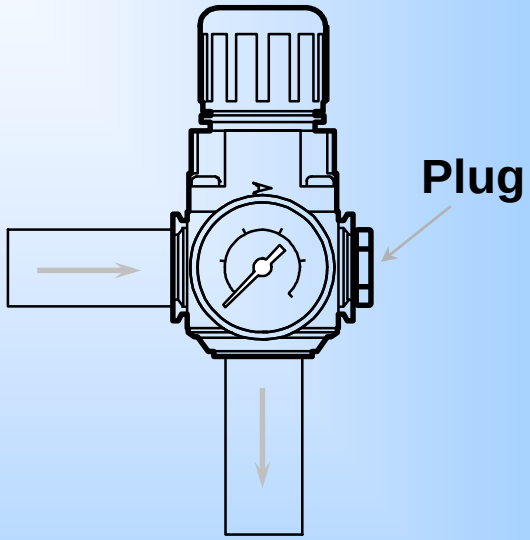
Excelon V72G

- In line pipe or modular mounted
- Can be T mounted
- Exhaust is in the bottom port G1/4

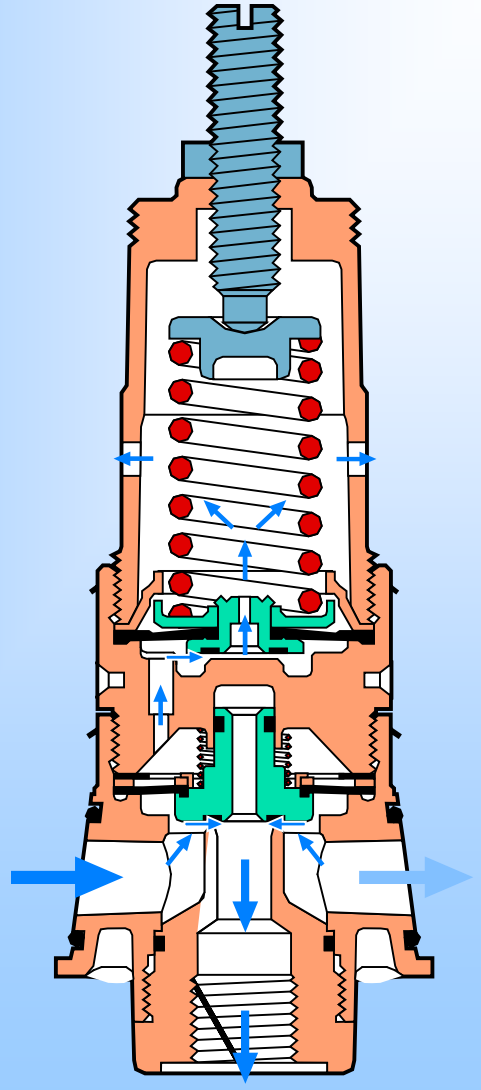


Excelon V72G

- Can be used as a minimum pressure valve. Air will not be delivered until the pressure has exceeded a pre-set minimum value
- Since the primary pressure is normally higher than the set pressure the valve will stay open
- When the primary drops below the pre-set the valve shuts off the supply

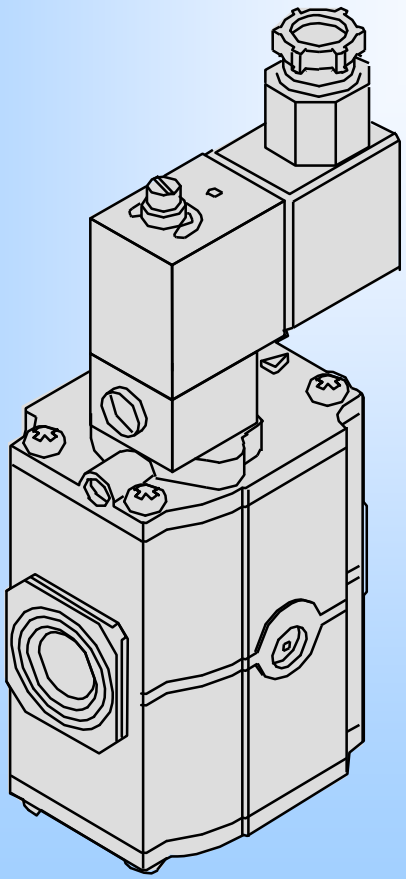


Sensitive relief valve



- Internal pilot relief valve provides high sensitivity
- Large relief flow for a small change above the set pressure
- Top pilot diaphragm pressurised from small bleed across bottom diaphragm
- Large poppet for rapid bottom port relief
- In line through flow installation

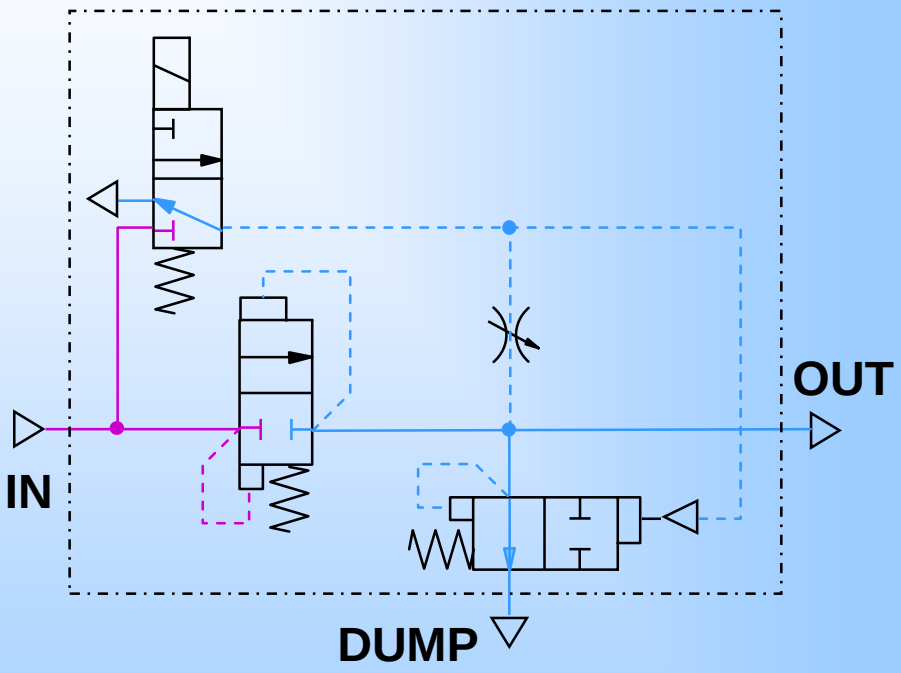
Soft start / Dump valve



- Applies air to a system under controlled flow to allow moving parts to position themselves gently
- At 50% pressure the full flow path is opened
- When turned off air is quickly dumped from the system and the inlet isolated
- Solenoid or air operated versions

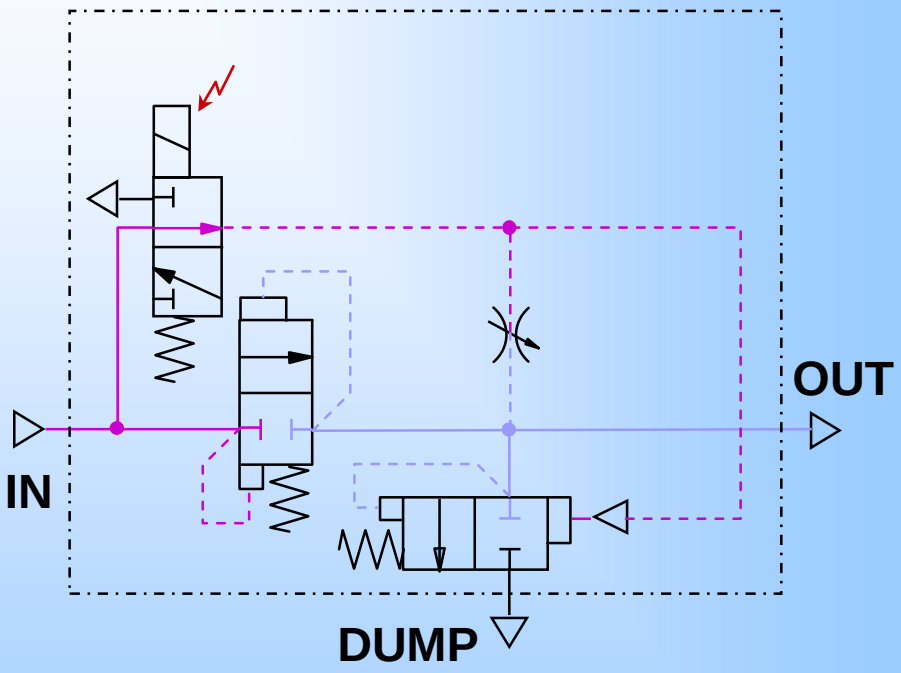
Equivalent circuit

- In the OFF position the solenoid and differential valves block the inlet and the outlet air is exhausted through the dump valve
- When the solenoid is energised the dump valve will close and air is supplied to the outlet at controlled flow
- At 50% system pressure the differential valve opens for full flow



Equivalent circuit

- In the OFF position the solenoid and differential valves block the inlet and the outlet air is exhausted through the dump valve
- When the solenoid is energised the dump valve will close and air is supplied to the outlet at controlled flow
- At 50% system pressure the differential valve opens for full flow



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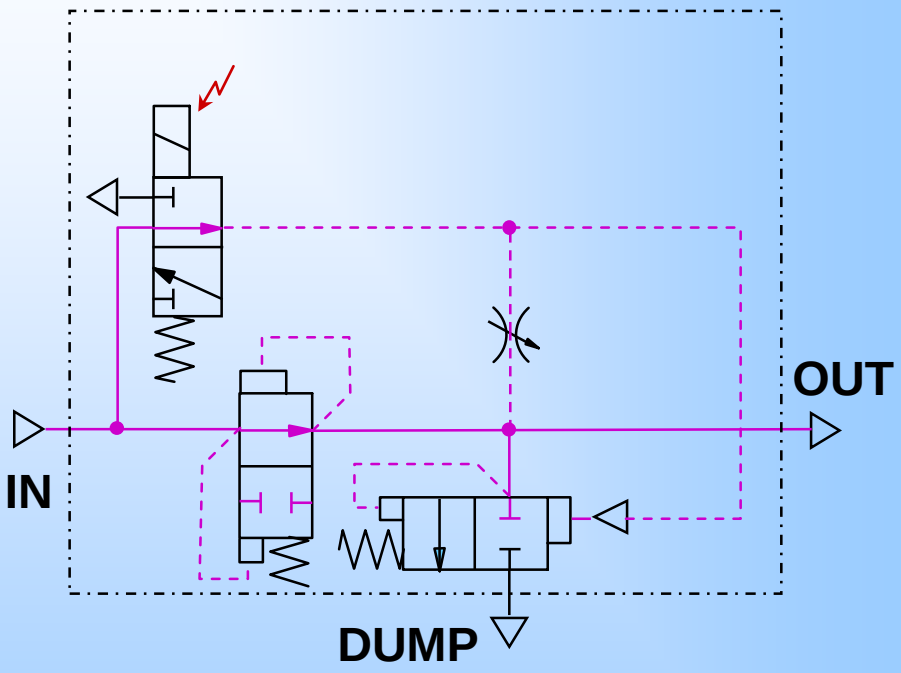
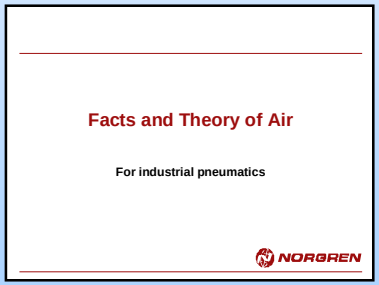


End

Facts and Theory

- Pressure
- Flow units
- Free air
- Water in compressed air
- Drying compressed air

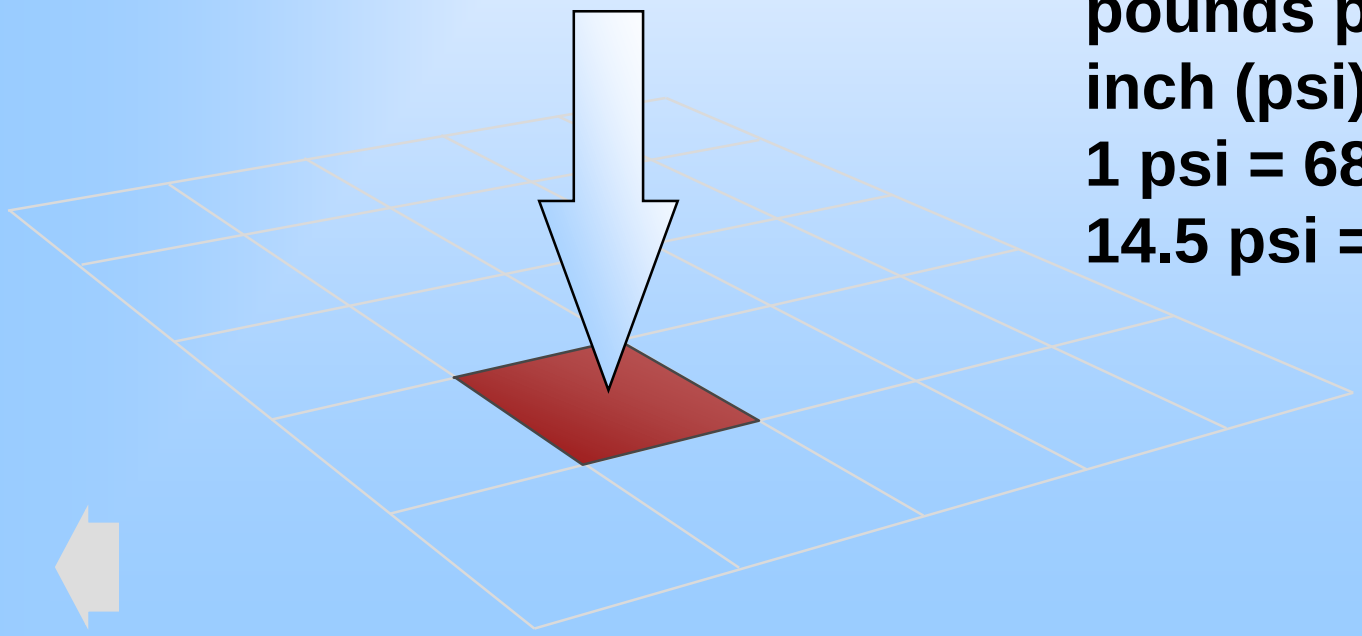


- For reference some extracts from the Facts and Theory presentation have been included on the following slides
- To access the full Facts and Theory presentation click on the presentation icon

Click the section to go to it

Pressure

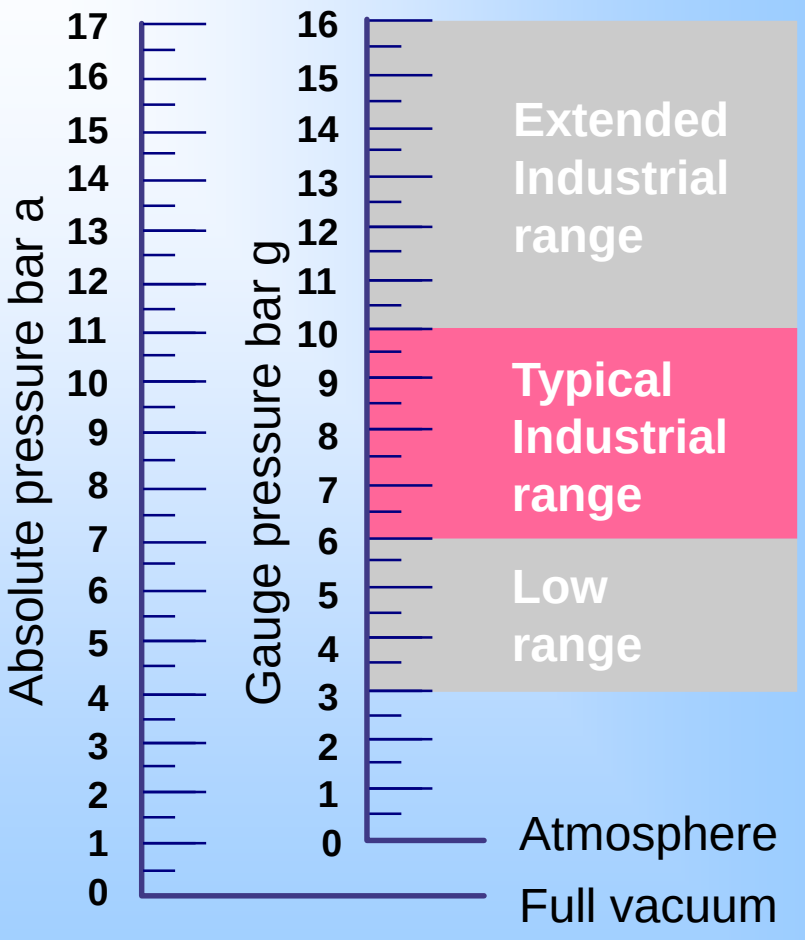
- 1 bar = 100000 N/m^2 (Newtons per square metre)
- 1 bar = 10 N/cm^2



- For measuring lower pressures the millibar (mbar) is used
- 1000 mbar = 1 bar
- For measurements in pounds per square inch (psi)
  1 psi = 68.95mbar
  14.5 psi = 1bar

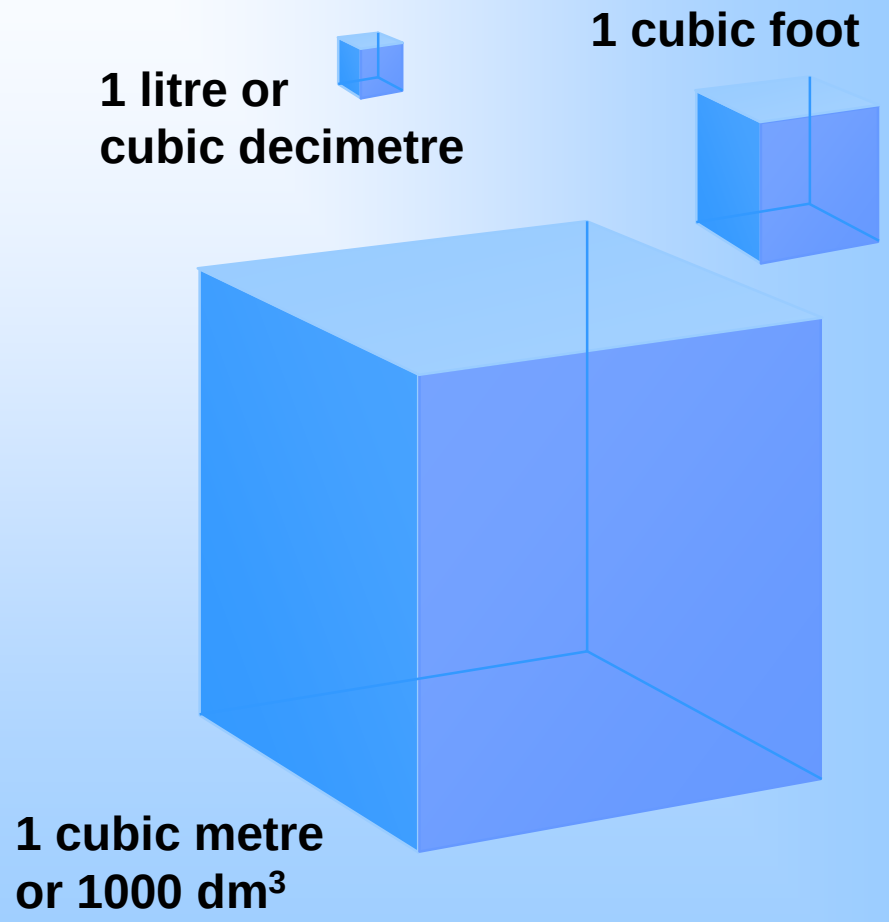
Industrial compressed air

- **Pressures are in “bar g” gauge pressure (the value above atmosphere)**
- **Zero gauge pressure is atmospheric pressure**
- **Absolute pressures are used for calculations Pa = Pg + atmosphere**
- **For quick calculations assume 1 atmosphere is 1000 mbar**
- **For standard calculations 1 atmosphere is 1013 mbar**



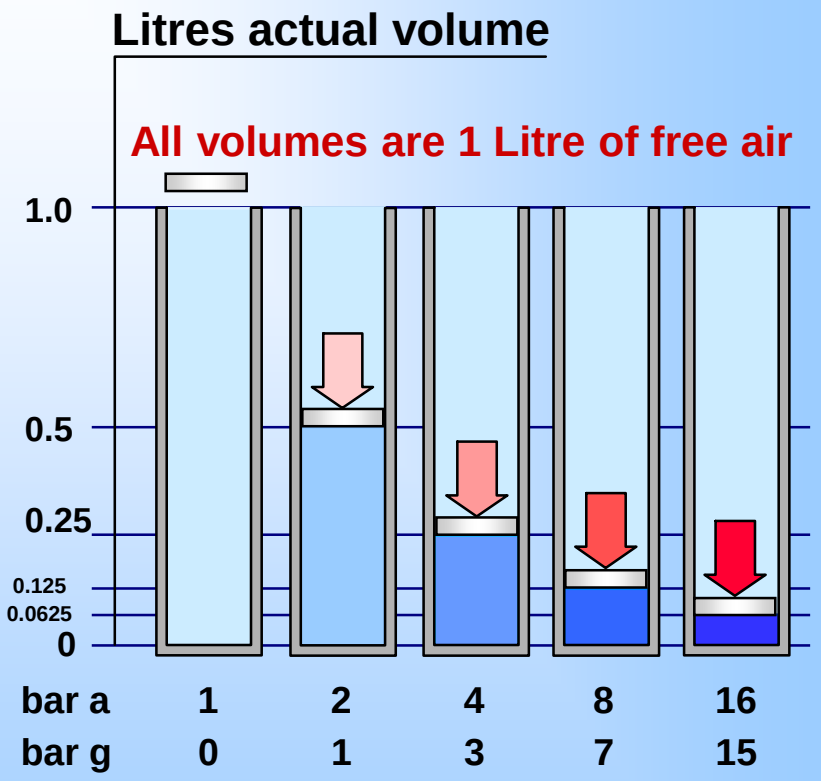
Flow units

- Flow is measured as a volume of free air per unit of time
- Popular units are :
  - Litres or cubic decimetres per second *l/s or dm^3/s*
  - Cubic metres per minute *m^3/m*
  - Standard cubic feet per minute (same as cubic feet of free air) *scfm*
- 1 m^3/m = 35.31 scfm
- 1 dm^3/s = 2.1 scfm
- 1 scfm = 0.472 l/s
- 1 scfm = 0.0283 m^3/min

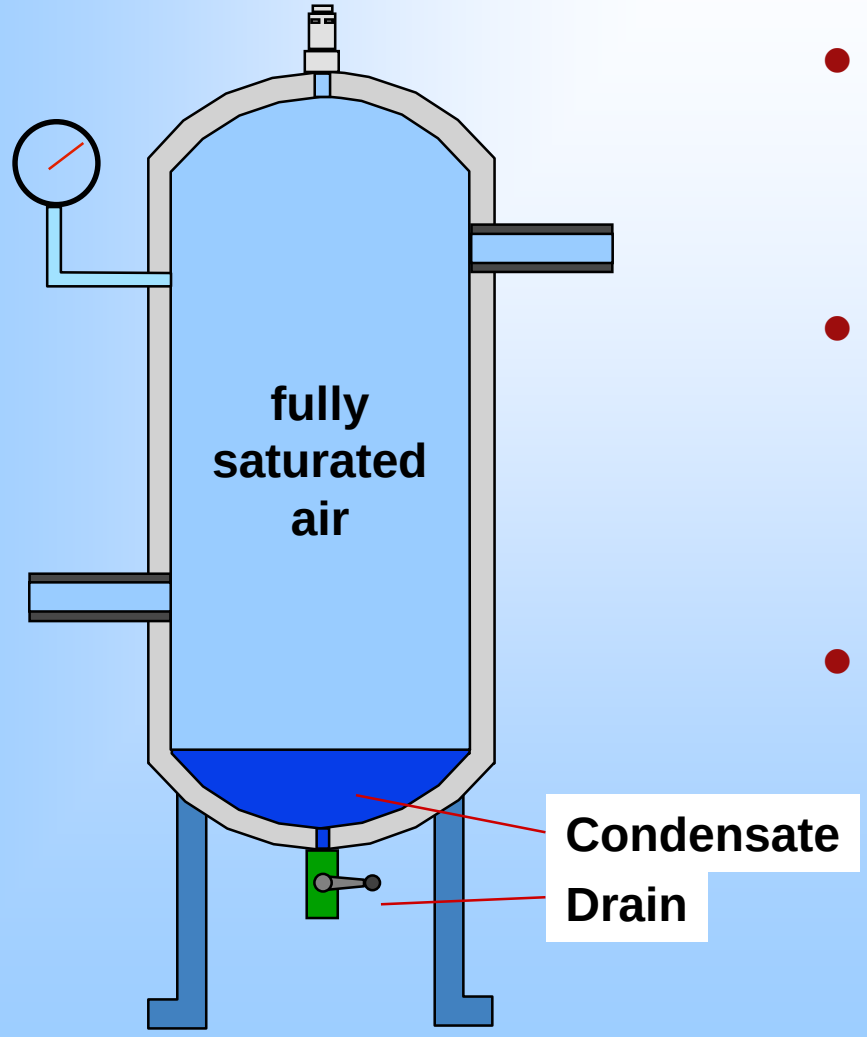


Free air

- Flow figures are quoted as litres of free air per unit of time
- “N” litres of free air at any pressure will take up a space of “N” litres when released to atmosphere (for this example assumed as 1000mbar)
- The actual volume taken up by 1litre of free air is shown at various absolute and gauge pressures



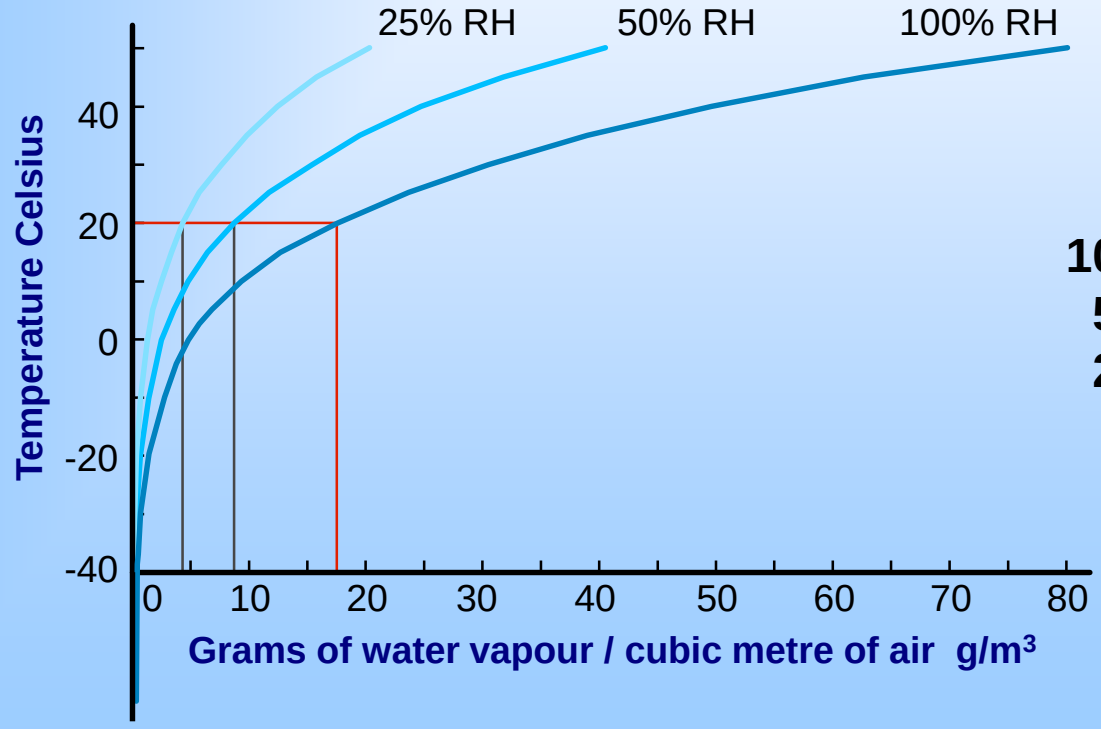
Water in compressed air



- When large quantities of air are compressed, noticeable amounts of water are formed
- The natural moisture vapour contained in the atmosphere is squeezed out like wringing out a damp sponge
- The air will still be fully saturated (100% RH) within the receiver

Water in compressed air

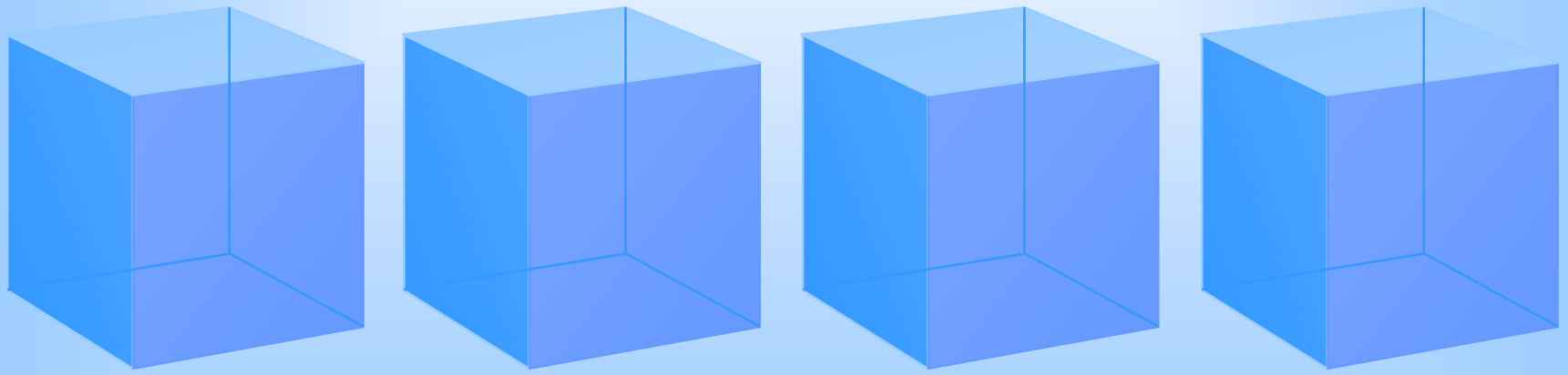
- **The amount of water vapour contained in a sample of the atmosphere is measured as relative humidity %RH. This percentage is the proportion of the maximum amount that can be held at the prevailing temperature.**



At 20º Celsius
100% RH = 17.4 g/m³
50% RH = 8.7 g/m³
25% RH = 4.35 g/m³

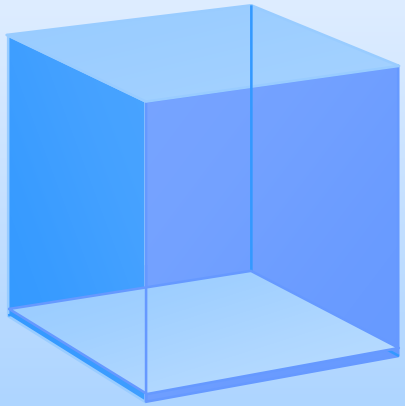
Water in compressed air

- **The illustration shows four cubes each representing 1 cubic metre of atmospheric air at 20ºC. Each of these volumes are at a relative humidity of 50% (50%RH). This means that they actually contain 8.7 grams of water vapour, half of the maximum possible 17.4 grams**



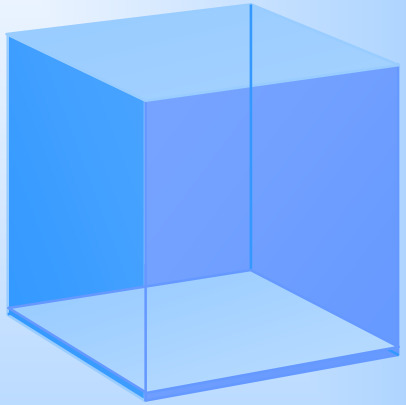
Water in compressed air

- **When the compressor squashes these four cubic metres to form one cubic metre there will be 4 times 8.7 grams, but only two of them can be held as a vapour in the new 1 cubic metre space. The other two have to condense out as water droplets**



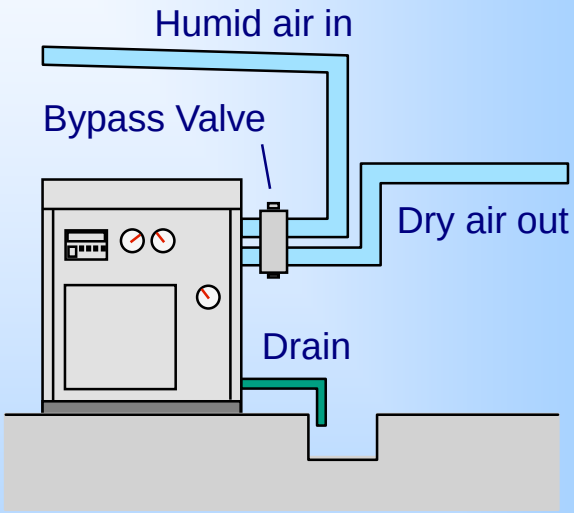
Water in compressed air

- 4 cubic metres at 50%RH and 1000 mbar atmospheric pressure contained in the space of 1 cubic metre produce a pressure of 3 bar gauge
- 17.4 grams of water remain as a vapour producing 100% RH (relative humidity) and 17.4 grams condense to liquid water
- This is a continuous process, so once the gauge pressure is over 1 bar, every time a cubic metre of air is compressed, and added to the contained 1 cubic metre, a further 8.7 grams of water are condensed



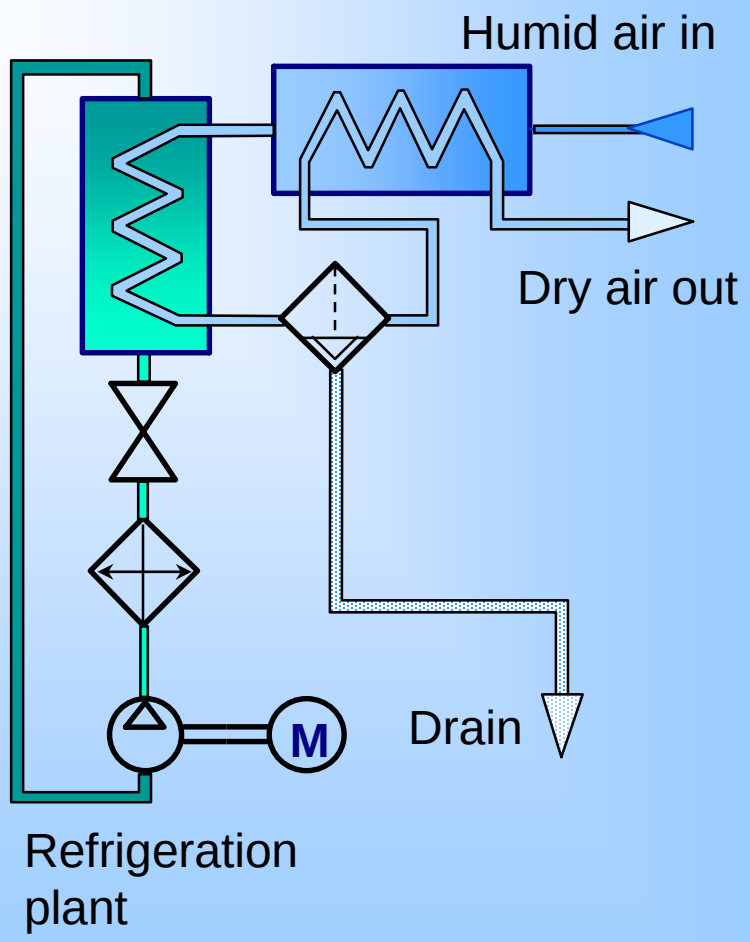
Low temperature drier

- For applications requiring air supplies with more than water droplets removed
- A low temperature dryer can process compressed air to a dew point of just above freezing
- A low cost and convenient device to use



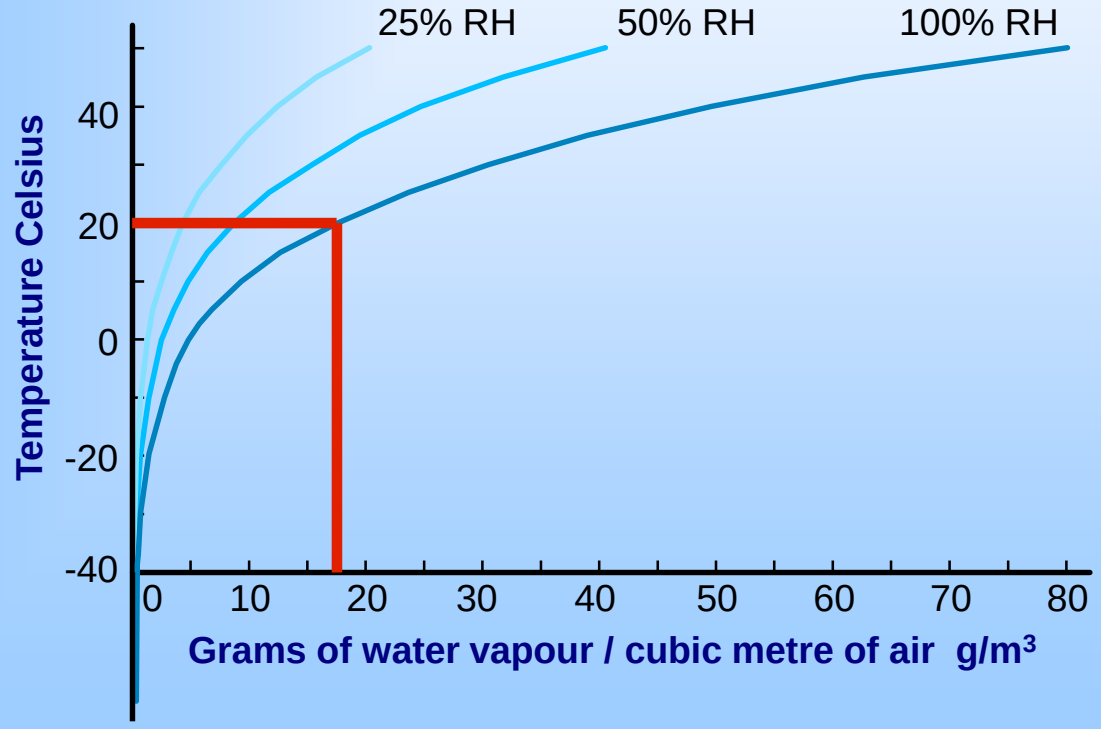
Low temperature drier

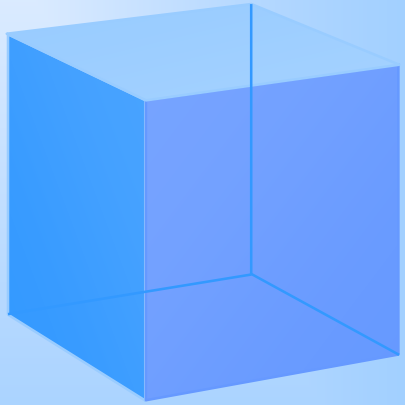
- **Humid air enters the first heat exchanger where it is cooled by the dry air going out**
- **The air enters the second heat exchanger where it is refrigerated**
- **The condensate is collected and drained away**
- **As the dry refrigerated air leaves it is warmed by the incoming humid air**



Low temperature drying

- **If 1 cubic metre of fully saturated compressed air (100 % RH) is cooled to just above freezing point, approximately 75% of the vapour content will be condensed out. When it is warmed back to 20^{O}C it will be dried to nearly 25% RH**





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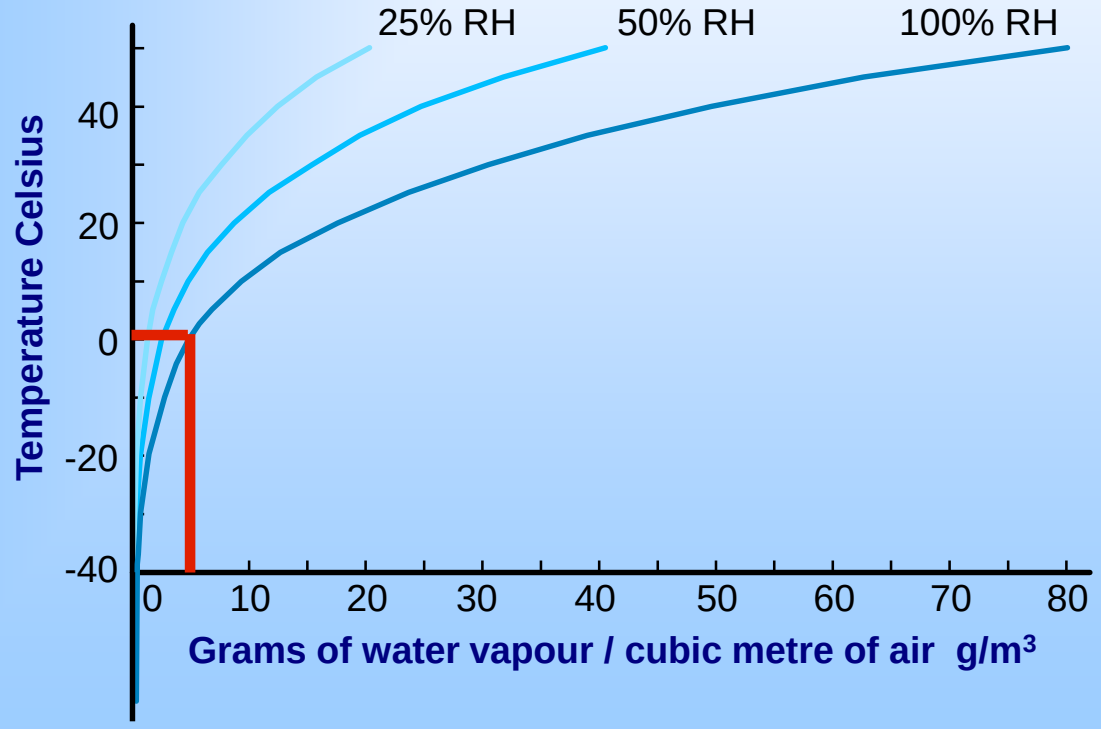

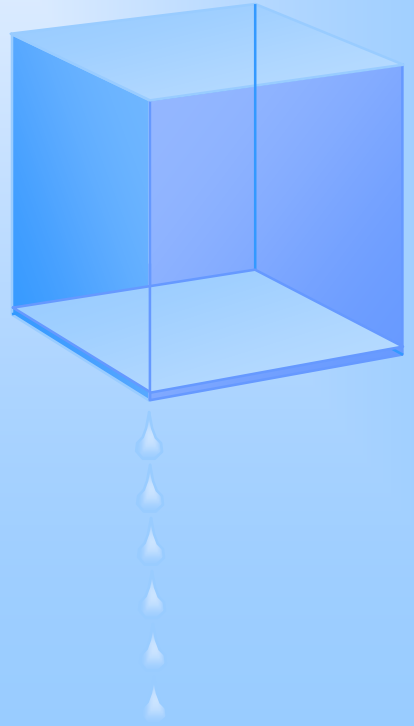

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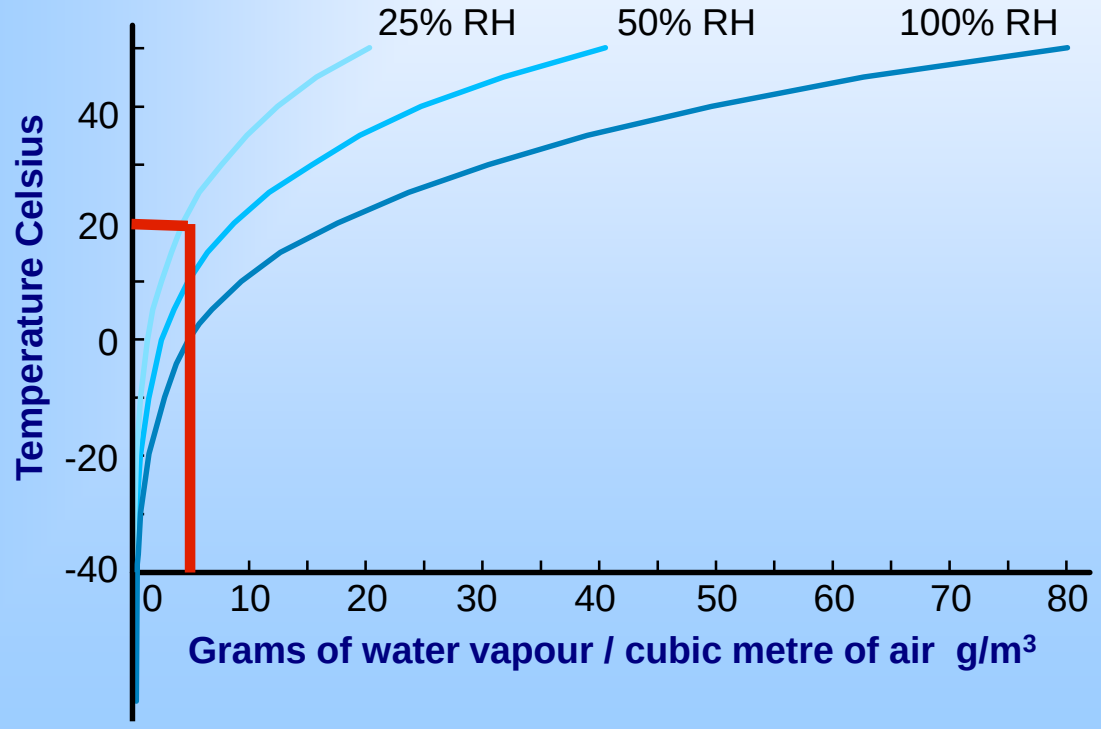

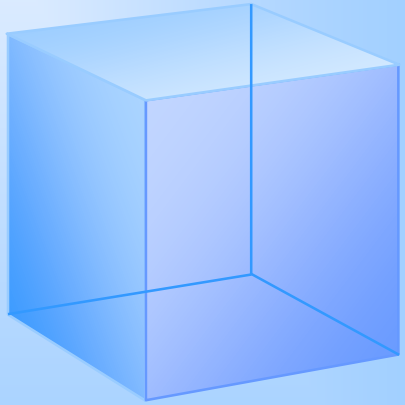

End

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Help ?