A

Compressed Air Systems

Air Treatment and Control Components

Compressed air is an essential power source for most industries today. It is a safe operation, relatively inexpensive to operate and very reliable. However, compressed air is susceptible to various types of contamination which not only reduces its value as a power source, but can seriously affect the performance of other pneumatic equipment and, therefore, productivity.

Air valves, air cylinders, logic control systems and air tools can malfunction due to air-borne contamination. Air intended for air-gauging, air conveyors, spray painting, instrumentation, automation and food processing can be rendered unusable. Poor product quality and system shutdown due to compressed air contamination can occur frequently. There are many other problem areas associated with compressed air contamination, as numerous companies in differing industries can attest to.

With today's technology, an efficient, cost-effective compressed air system can be designed to provide years of reliable service if the proper air treatment and control equipment is installed. Operating and maintenance costs can be significantly lowered by removal of most contaminants (dirt, rust, pipe scale, oil aerosols, liquid water and water vapor, microscopic particles and oil vapor). With a well-designed air system and the use of quality air treatment and control products, you can realize extended service life of components, increased flow capacity with minimum pressure loss and improved production efficiencies in your manufacturing processes.

Air Treatment and Control

To take the fullest advantage of the benefits that can be derived from using compressed air, it must be correctly and adequately prepared. Clean, dry, regulated air is the corner-stone of an efficient air system. Where necessary, lubricated air may be required to provide dependable operation and satisfactory service life of certain air tools and components.

Dryers

All atmospheric air contains some water vapor. When the air is compressed, the water content for a given volume of air increases. Because of the effects of compression, most of this water vapor turns into damaging liquid water in your air system. Additionally, as air flows through the compressed air line system, the water vapor condenses in the pipeline. This moisture in the pipeline results in rust, scale, clogged orifices, malfunctioning of pneumatic controls, and increased wear of moving parts as it washes away the lubricant.

Compressed air dryers reduce the water vapor concentration and can prevent further liquid water formation in air lines. Liquid water and water vapor removal increases the efficiency of air operated equipment, prevents corrosion and clogging, extends the service life of pneumatic components, prevents air line freeze-ups and reduces product rejects.

Filters

Air-borne contamination from the atmosphere, such as dust, water vapor and hydrocarbons enter the air system through the compressor intake. The contaminants, usually 4 million particles per cubic foot, can easily pass through a typical compressor intake filter since over 80% of these particles are less than 2 microns in size. The compressor also contributes to the problem with wear particles, oil vapor and fine aerosols that leak past glands and seals from the oil sump into the compression chamber.

Such contamination in the air system can effect the efficient operation of various pneumatic devices and, over time, damage them. Compressed air filters that are installed upstream of the air devices will remove most of these contaminants. In addition, by design these filters will also remove most liquid water from the air line.

The need for higher quality air is more evident today than in the past. To gain improved production efficiencies through automation, more sophisticated, technically advanced pneumatic equipment and instrumentation is being used throughout industry. Due to the critical nature of these applications, the need for extremely clean, virtually oil free air is required. Coalescing (oil removal) and oil vapor removal filters should be used for applications requiring high quality air.

Regulators

All pneumatic devices are designed to provide optimum performance and service life at a specific air pressure. While it is feasible to operate these devices at pressures in excess of the manufacturer's recommended operating conditions, it is not advisable to do so. Operating at higher pressures can cause excessive wear and damage to the device. Further, operating your compressed air system at a higher-than-required pressure wastes energy and is not cost-effective.

To obtain the best operation and service life of your pneumatic equipment use the proper pressure level recommended by the manufacturer. A regulator (pressure control valve) is normally used to reduce and maintain a downstream pressure while the amount of air required to the device may vary with the demand.

Filter / Regulators

The integral Filter /Regulator units combine all the functions and features of a filter and a regulator, as discussed above, into one compact, high performance, space-saving unit.

Lubricators

Getting the proper lubrication to the proper device at the proper time is fundamental to preventative maintenance, longer service life and increased productivity. The efficiency of air motors, control valves, cylinders and other air actuators can be greatly enhanced when the proper amount of lubrication is supplied.

Air line lubricators are specifically designed to generate and introduce an oil aerosol (mist) into the compressed air flow. The air flow then carries the oil to the pneumatic devices where the lubricant mist coats the moving and sliding surfaces thus reducing friction and wear.

To provide satisfactory lubrication to your air devices most lubricators have a proportional delivery system. This feature automatically provides a nearly constant oil-to-air ratio over a wide range of air flows.

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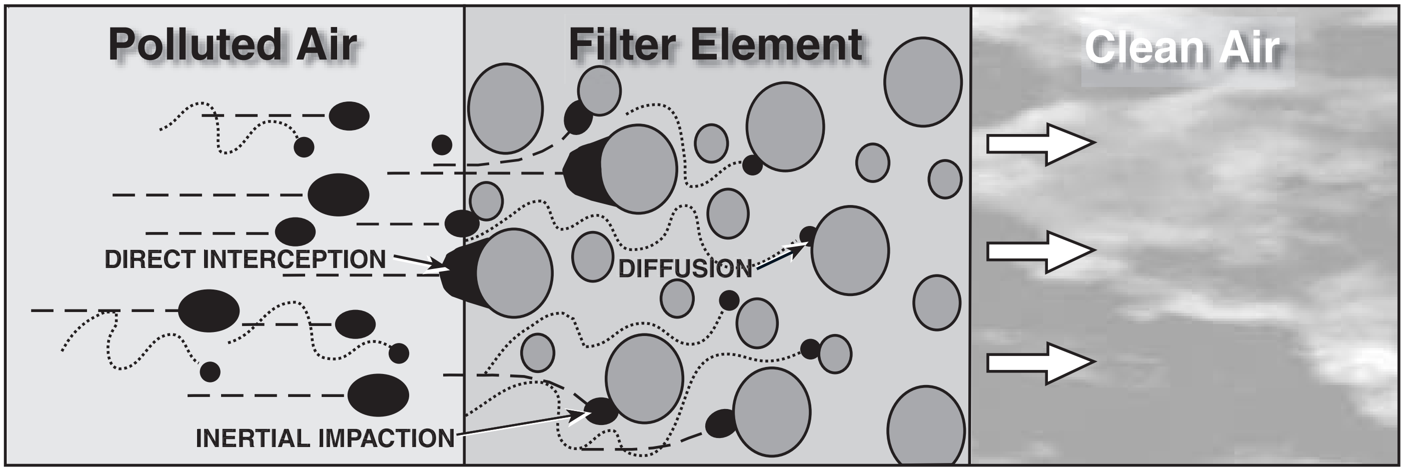
Filter Technology – Mechanisms of Filtration



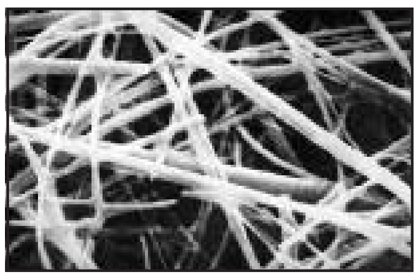
Coalescing Filters

Essentially, coalescing flters (Type B, B1 and C) rely on what is known as mechanical fltration for their effectiveness. The main mechanisms of mechanical fltration are direct interception, inertial impaction and diffusion. Electrostatic attraction can have some bearing although the efficiency of Wilkerson coalescing flters is not dependent on this mechanism.

Direct Interception occurs when a particle collides with and adheres to a fber of the flter material without deviating out of the streamline fbw. This mechanism tends to take place on the surface of the flter material and affects mainly larger particles over 1 micron in size.

Inertial Impaction occurs when a particle is unable to follow the tortuous path around the flter fbers and eventually collides with and adheres to one of the fbers. Typically affecting particles in the 0.3 micron -1 micron size range.

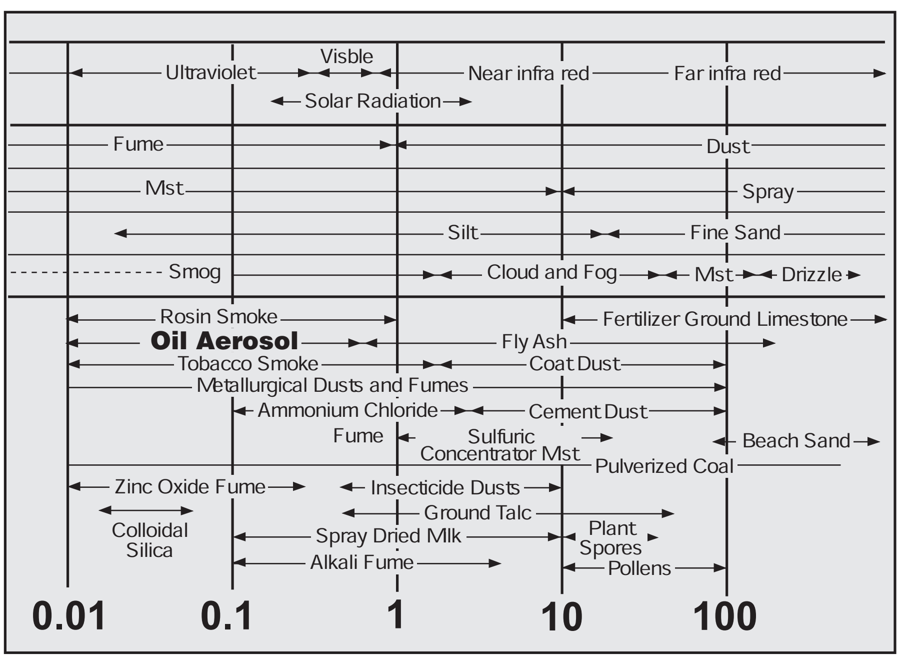
Diffusion or Brownian Mvement, as it is sometimes called, occurs with extremely small particles which tend to wander within the gas stream, increasing their chances of colliding with and adhering to a fber. This usually affects particles below 0.3 micron in size. A degree of overlap takes place with the mechanisms, the extent varying on the conditions.



Above: Clean borosilicate microfber seen at a magnifcation factor of 3900. *Right:* The same flter material in a contaminated state at the same degree of magnifcation.

When all mechanisms are combined and utilized by a deep bed of the correct type of flter material, removal of virtually all particles whether liquid or solid, is achieved.

Pollution Size Chart



To assist in understanding the parameters of fltration, refer to this pollution size comparison chart. Look at the size of a major contaminant, **oil aerosol!** It is in the region of 0.01 - 0.8 micron. Tobacco smoke is also a liquid aerosol in a similar size band 0.01 -1.2 micron. Observe the smoke test yourself, appreciate the size of the problem! The smallest particle the human eye can see is in the order of 40 microns.

Particulate Filters

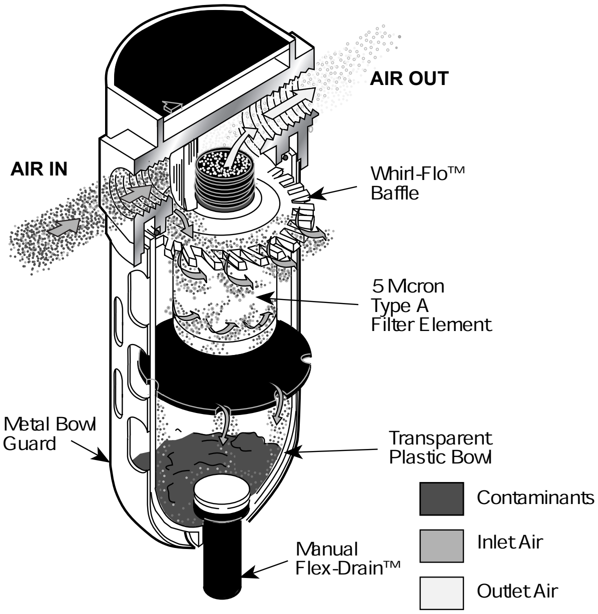
For the removal of solid particle contaminants down to 5 microns and the separation of bulk liquids.

This type of filter is generally used in industrial applications where liquid water and oil, and harmful dirt particles must be removed from the compressed air system. This type of filter should also be used as a prefilter for the Coalescing (oil removal) filter.

Operation

Wet and dirty inlet air is directed downward and outward in a circular pattern by the turbine-shaped upper baffle. This action mechanically separates a large amount of the liquid and gross particles, which then flow down the inside of the bowl, past the lower baffle, into the quiet zone to be drained away. The quiet zone baffle prevents the contaminants from re-entering the air flow stream.

The partially cleansed air then passes through the filter element. By utilizing depth filtration, the 5 micron filter media provides superior filtration, exceptional service life and minimum pressure drop.



Coalescing Filters

(Oil Removal)

Specifically designed for the removal of solid particles, water and oil aerosols down to 0.01 micron. Maximum remaining oil content of air leaving the filter down to 0.01ppm at 70°F (21°C) at a pressure of 100 PSIG (6,9 bar g) using a typical compressor lubricant. Two filter element grades are offered to better meet your air quality requirements.

Grade B and B1 filter elements are used for most air coalescing applications where the removal of liquid aerosols and submicronic particles for *general* air quality is required. Protection of components such as air valves, cylinders, as well as air conveyors, air gaging, air bearings, air control circuits and paint spraying equipment are examples of specific end-use applications. This grade of filter element should be used as a *prefilter* for the *Grade C* coalescing filter.

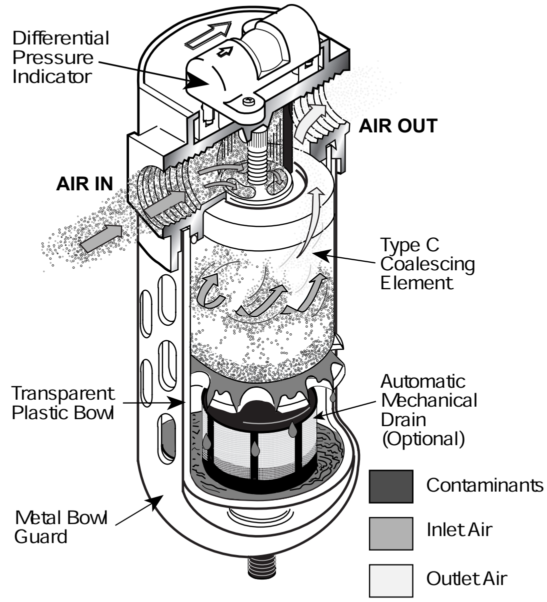
Grade C high-efficiency filter elements are used where the removal of extremely fine particulate and virtually "oil-free" or high quality air is necessary. Specific end-use applications are protection of critical air control circuits, air logic systems, flow and temperature controllers, food processing, electronics, health care and film processing. This grade of filter element should be used as a *prefilter* for the *Grade D* oil vapor removal filter.

Operation

The filter element design utilizes a borosilicate micro fiber that provides superior filtration efficiency, quick draining and minimum pressure drop. Unlike standard particle filters, air flow is inside to out. The compressed air /gas passes through the inner layer of the filter element which acts as an integral pre-filter to remove large contaminants. This gives protection to the layer of high efficiency filter material which substantially removes submicronic aerosols and solids from the air flow stream. Solid particles are permanently trapped within the filter media.

The fine liquid particles, including aerosols, after initially being trapped by the fibers of the filter media, begin to collect or coalesce forming larger droplets. These droplets, along with other large droplets present, are pushed to the outer surface. Here, the anti-reentrainment barrier collects the droplets as they break free from the micro fiber and allow them to gravitate within its cellular structure forming a "wet band" around the bottom of the element.

Clean filtered air /gas passes through the anti-reentrainment barrier above the "wet-band" where the resistance to flow is less, leaving a quiet zone of no air /gas movement in the bottom of the filter housing. The separated liquid drops from the bottom of the filter element and falls through the, without being re-entrained, to the bottom of the filter housing where it collects to be removed by a drain.



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Oil Vapor Filters

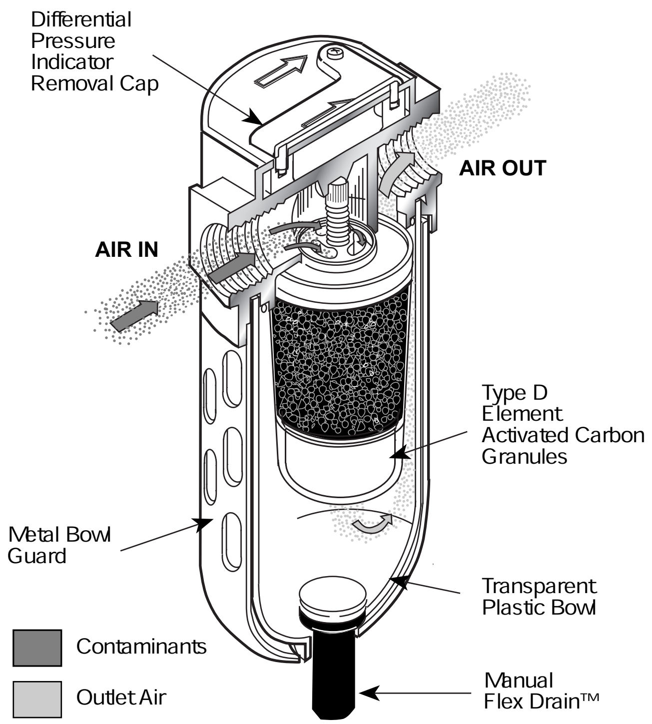
Activated carbon element for the removal of oil vapor and oil associated odors. Maximum remaining oil content of air leaving the filter is 0.003 ppm at 70°F (21°C) at a pressure of 100 PSIG (6.9 bar g). For the *Grade D* filter element, two types of designs are used depending on the size and flow capacity of the filter housing.

An oil vapor filter is used, in conjunction with a *Grade C* filter element, where the application requires very high air quality. Typical applications are food processing and packaging, pharmaceutical, fermentation, electronics and semi-conductor, and critical air control.

Operation

While the *Grade B, B1 and C* filter elements can remove extremely fine liquid and solid particles, they cannot remove gaseous contaminants such as oil vapor or odors. To do this you must employ the physical phenomena of adsorption. Activated carbon, having an affinity for oil vapor molecules and with an extremely high surface area, created by its capillary structure, is used.

Our activated carbon *Grade D* filter elements are designed to maximize the adsorption properties of the carbon. This is achieved by first passing the air through carbon granules located either in an annular space or tubular section. The granules provide a very high ratio of surface area to volume, and when arranged in a deep bed, increases the dwell time of the air flow. This type of design provides the benefit of both high efficiency and longer service life of the activated carbon.



Differential Pressure Indicator (DP2, DP8)

The Wilkerson direct mounting Differential Pressure Indicator is equipped standard on most Coalescing Filter models. It provides a maintenance free means of determining the service life of the filter element. With a new filter the indicator shows all green, and progresses to a full red indication a 7-8 PSID, indicating the element should be changed. The magnified indicator can be easily seen from the top or either side of the filter, and with only one moving part will provide reliability and long life.

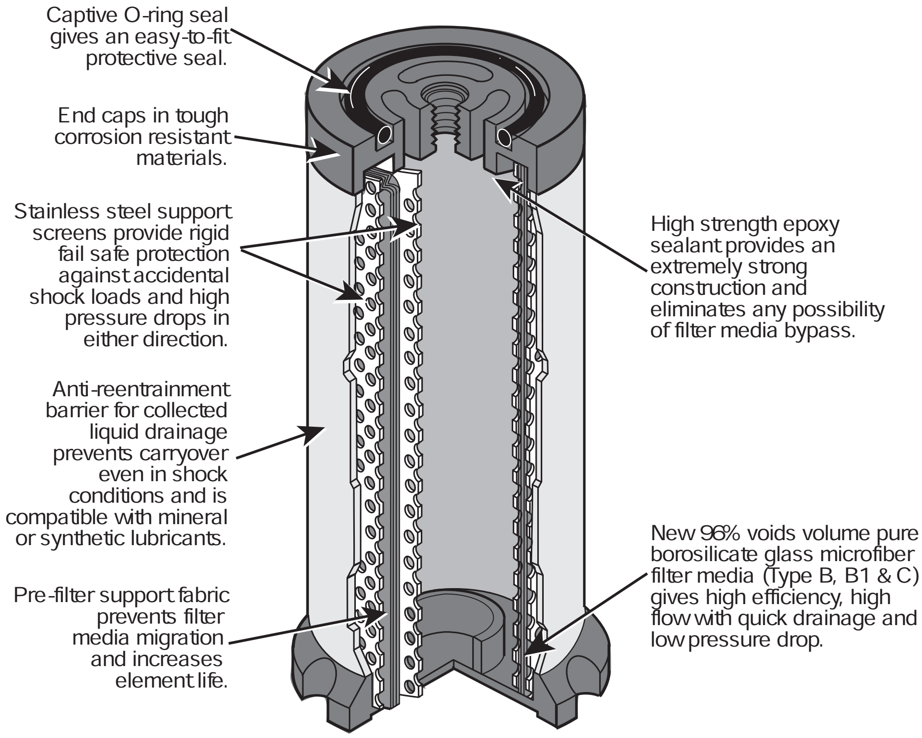
The Differential Pressure Indicator cannot be retrofitted to Wilkerson filters ordered without it. It is available as a replacement accessory kit.

Note: The maximum operating pressure for metal or plastic bowls with this Indicator is 150 PSIG. The maximum operating temperature is 150°F for metal bowls and 125°F for plastic bowls.

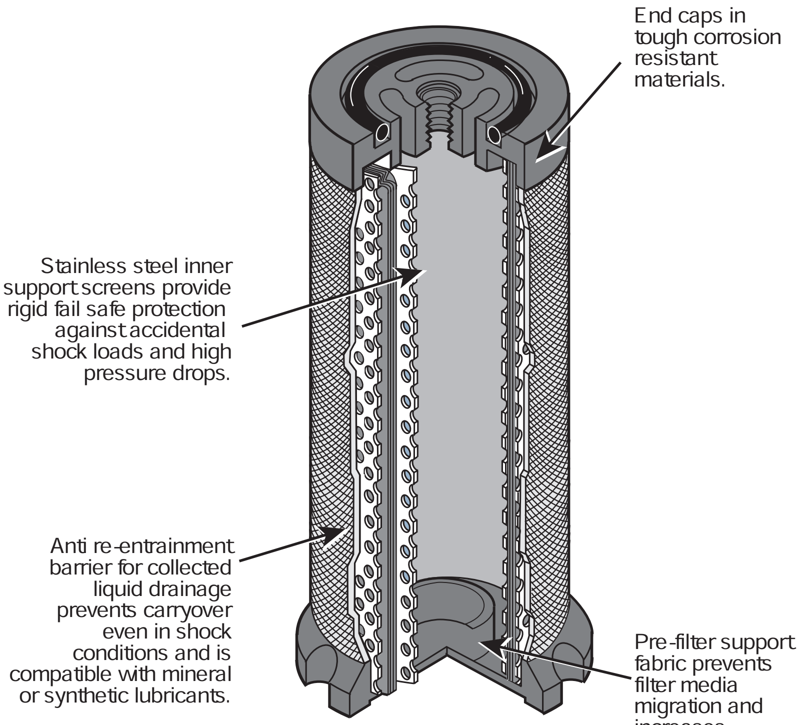
DP3 Differential Pressure Gauge

The Wilkerson direct mounting Differential Pressure Gauge (non-pressurized face) is standard on all mainline filters and it is available as an accessory in kit form. With a scale reading to 20 PSID (1370 m bar dp) the gauge gives a quick indication of the status of the filter element in the filter. The gauge provides a reliable method to help ensure that the filter element is changed at the most economical and convenient time.

Coalescing Elements Features and Benefits Type B, B1 & C



B1 and C Element



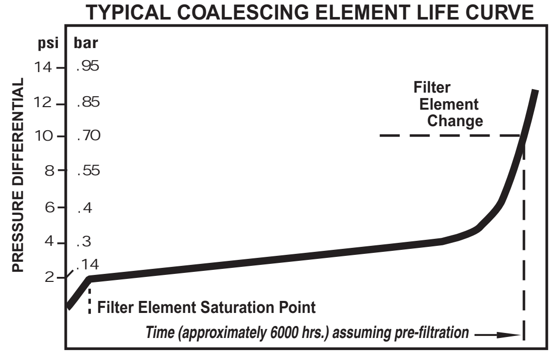
B Element

How The Elements Work

Using the principles of mechanical filtration, the filter media removes the solid particles first in the pre-filter support layers and then in the actual filter media. These particles remain permanently trapped and gradually cause an increase in pressure drop. The liquid particles similarly collected coalesce together forming larger droplets and as the flow is inside to out, are pushed to the outer surface. Here, the anti-reentrainment barrier prevents them from being introduced back into the airstream and instead drains them through its cellular structure to the bottom of the element. The resultant "wet-band" on the bottom of the element, in presenting a high pressure drop area, ensures that the filtered air passes through the upper portion of the element. This creates a "quiet zone" in the bottom of the filter through which the liquid falls to the bottom of the filter bowl and is drained away via the automatic drain.

As mentioned earlier, solid particles cause the pressure drop to slowly increase throughout the working life. Initially, during the period to reach an equilibrium saturation, as determined by the upstream liquid contamination concentration, the pressure drop rises sharply as shown below. This is a typical pressure drop verses time characteristic for a coalescing filter. The end of useful and economic service life is indicated by an accelerating increase in pressure drop. The element should be replaced every 12 months or 6000 working hours under normal working conditions.

TYPICAL COALESCING ELEMENT LIFE CURVE



Adsorption Elements Features and Benefits Type D

How The Elements Work

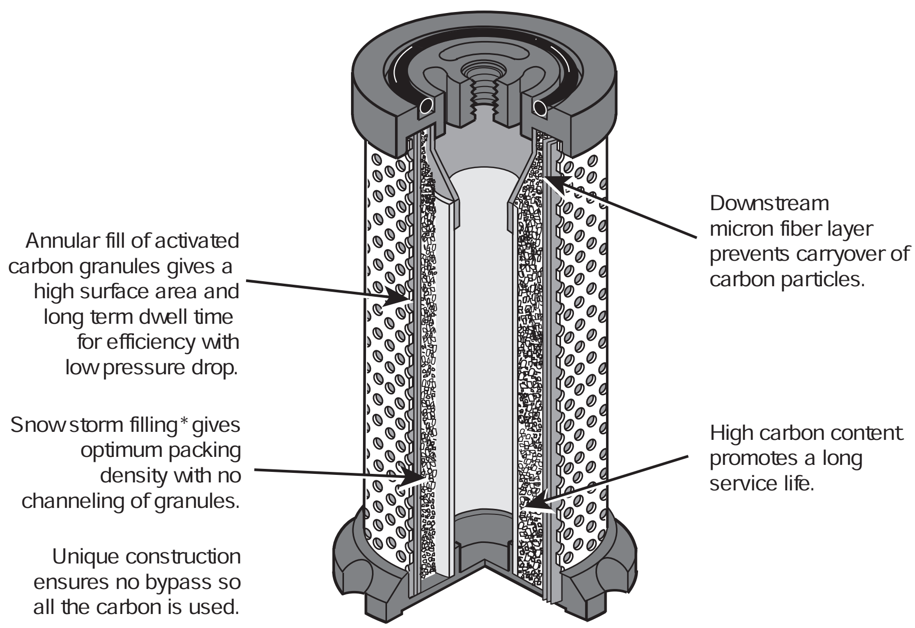
While mechanical filtration employing the Type C element is capable of removing extremely fine liquid or solid particles even as small as 0.01 micron it cannot remove gaseous contaminants such as oil vapor or odors. To do this we must employ the physical phenomena of adsorption. Activated carbon, having an affinity for oil vapor molecules and with an extremely high surface area, created by its capillary structure, is used for this.

Wilkerson activated carbon elements are designed to maximize the adsorption properties of the carbon. This is achieved by first passing the air through carbon granules, snow storm filled* into either an annular space or tubular section. The granules provide an extremely high surface area to volume and when arranged in a deep bed that increases dwell time gives the benefit of both efficiency and service life. After being passed through the carbon, the air goes through a layer of microfiber to prevent migration of fine carbon particles downstream.

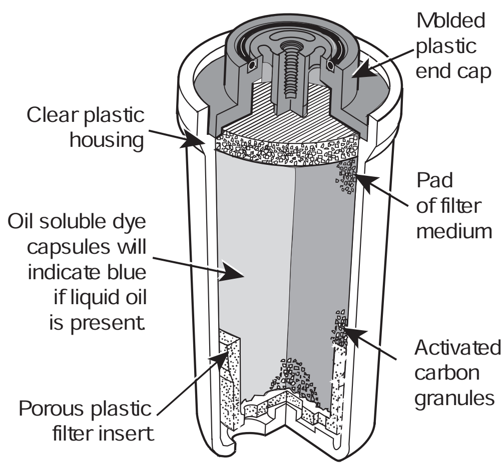
Adsorption elements have a limited life and this is affected by many factors but principally temperature. Obviously, the higher the inlet temperature, the more oil vapor there is present, for example at 104°F (40°C) there is more than ten times the oil vapor than at 70°F (21°C). For this reason, activated carbon filters are best installed at the lowest possible system temperature. The type C filter should always precede a Type D filter.

The typical life of an adsorption element is in the region of 1000-2000 hours at 70°F (21°C). Filtration temperature is based on tests carried out on a Chlorobenzene test rig, however, this is best determined in practice by a routine "odor" check.

Oil vapor has a distinct odor. The least expensive and very effective way to check for oil vapor getting through the filter is to install a small bleed valve downstream. Periodically crack this valve and smell the air. The human nose is extremely sensitive to oil vapor and at the first hint of this odor, change the element.

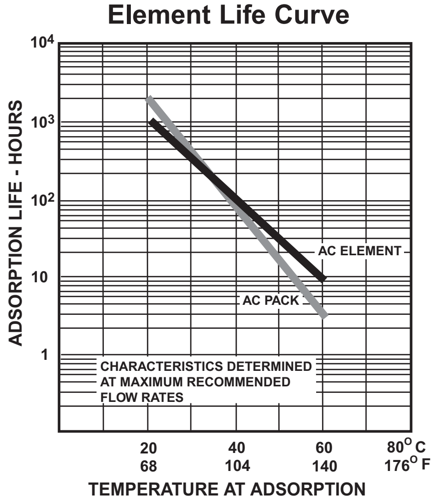


D Element (AC Element)



D Element (AC Pack)

Typical Adsorption Element Life Curve



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Type B Filter Element Specifications

Efficiency
99.97% when tested with 0.3 micron aerosol DOP test Federal Standard 209B. Compatible with mineral and synthetic oils.

Residual Oil
0.5 ppm /wt (inlet temperature /pressure 70°F /100 PSIG) when analyzed using infra red spectrophotometry based on the Pneurop 6611 procedure.

Air Quality Class *
Conforms to ISO 8573 Class 3 or better

Flow
Inside to outside

Filter Media
Resin impregnated borosilicate glass microfiber

Support Structure
Inner 304 Stainless Steel support cylinder with outer polymeric sleeve.

End Caps
Glass filled polyamide material
Initial Differential Pressure Dry — 1.5 PSID
Initial Differential Pressure Wet — 2.5 PSID
Flow range — 5 to 4800 SCFM @ 100 PSIG

Application
Installations as a coalescing prefilter for general purpose protection or as a prefilter to a high efficiency coalescer.

Appearance
White polymeric outer sleeve with black end caps.

*** "M" Series Coalescing Filters, with Type "B" 0.5 micron elements:** All Wilkerson Type "M" Oil Removal (Coalescing) Filters with Type "B" 0.5 micron elements **exceed ISO** Class 2 for maximum particle size and concentration of solid contaminants, and **exceed** Class 3 on maximum oil content (ppm /wt).[5]

Type C Filter Element Specifications

Efficiency
99.99998% when testing with 0.3 micron aerosol on dioctyl phylate (DOP) test according to Federal Standard 209B. Compatible with mineral and synthetic oils.

Residual Oil
0.01 ppm / wt (inlet temperature /pressure 70°F /100 PSIG) when analyzed using infra red spectrophotometry based on the Pneurop 6611 procedure.

Air Quality Class *
Conforms to ISO 8573, better than Class 1

Flow
Inside to outside

Filter Media
Pure borosilicate glass microfiber with a mean strand diameter of 0.5 micron and a voids volume of 96%. Contains no glues or resins.

Support Structure
Inner and outer 304 Stainless Steel support cylinders.

End Caps
Glass filled polyamide material
Initial Differential Pressure Dry — 1.25 PSID
Initial Differential Pressure Wet — 2.25 PSID
Flow range — 5 to 4800 SCFM

Application
Install where highest quality air is required; typically instrumentation, process air, pneumatic gauging, paint spraying, etc.

*** "M" Series Coalescing Filters, with Type "C" 0.01 micron elements:** All Wilkerson Type "M" Oil Removal (Coalescing) Filters with Type "C" 0.01 micron elements **exceed ISO** Class 1 for maximum particle size and concentration of solid contaminants, and **exceed** Class 1 on maximum oil content (ppm /wt).[5]

Type D Filter Element Specifications

Efficiency
Less than 0.003 ppm /wt maximum remaining oil content (inlet temperature /pressure of 70°F / 100 PSIG) when analyzed using infra red spectrophotometry based on the Pneurop 6611 procedure; removal of hydrocarbon vapors and odors.

Air Quality Class *
Conforms to ISO 8573, better than Class 1

Flow
Inside to outside

Filter Media
Snow storm filled activated carbon for optimum packing density and life.

Support Structure
Model M03 - M28: Clear plastic housing with molded plastic end cap. Integral outlet filter.
Model M30 - M45: Inner and outer 304 Stainless Steel support sleeve cylinders

End Caps
Glass filled polyamide material
Initial Differential Pressure Dry — M30 - M31: 3 PSID; M32 - M45: 1 PSID
Flow range — 5 to 4800 SCFM

Application
Installation after high efficiency coalescer for process air purification, odor removal, removal of trace vapors and for critical applications.

*** "M" Series Absorption Filters, with Type "D" activated carbon elements:** All Wilkerson Type "M" Absorption Filters with Type "D" activated carbon elements **exceed ISO** Class 1 on maximum oil content (ppm /wt).[5]

A

When Making Your Selection

1) Generally, install filters downstream of aftercoolers /separators and air receivers at the lowest temperature point and as close to the point of application as possible. This reduces the chance of additional water and oil vapor condensing after the filter.

2) Filters should not be installed downstream of quick opening valves and should be protected from possible reverse flow or other shock conditions.

3) It may be necessary to install a combination of mainline filtration near the compressor installation before entry to the main air distribution system as well as installing terminal filtration at the critical application points.
Remember, especially in existing installations, the contamination already in the pipe system downstream of the filters will take a long time to disappear and probably never will completely.

4) Purge all lines leading from the filters to the final application to be protected.

5) Install filters in a vertical position ensuring that there is sufficient room below the filters to facilitate element change.

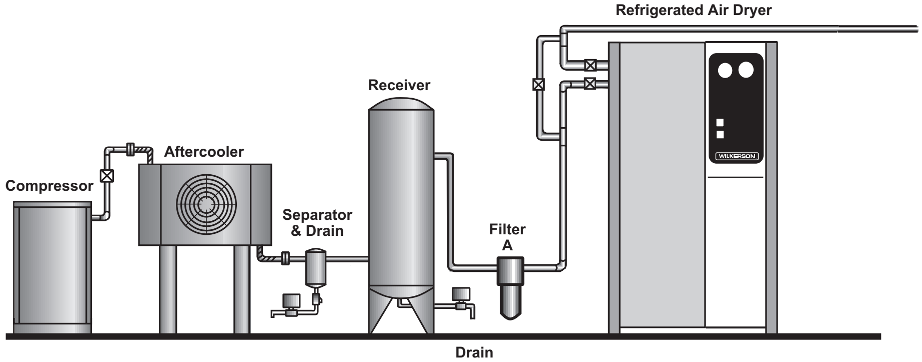
6) Provide a facility to drain away collected liquids from the filter drains via properly sized tubing, taking care there are no restrictions in the drain line.

7) Install Wilkerson differential pressure gauge or pop-up indicator to monitor the pressure drop across the filters. This will provide an easy way of visually monitoring the filter element condition, indicating when to replace the element.
If you have a problem on filter selection or installation, please contact your local Wilkerson stocking distributor. Wilkerson and their representatives will be pleased to help you in selecting the proper installation for your application requirements.

8) For piping convenience and to minimize air system disruptions, we recommend piping the system with by-pass circuits and isolation valves.

General Purpose Protection

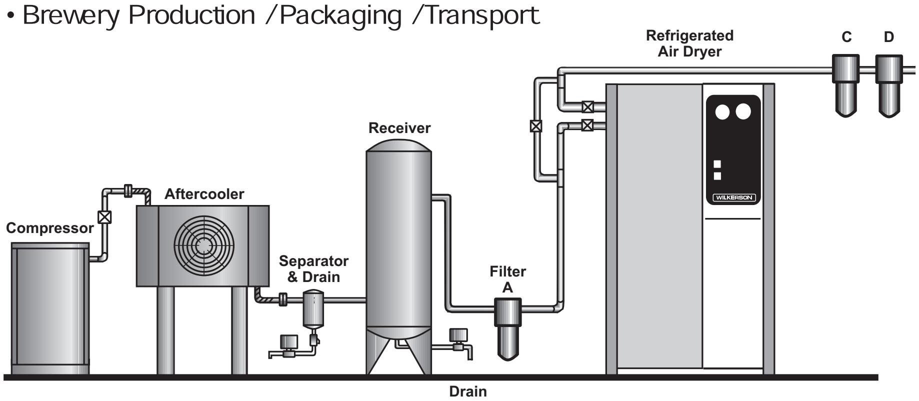
- General Compressed Air System Protection
- Liquid and Solid - Bulk Contamination Removal
- Particle Removal in “Dry” Systems
- Large Pneumatic Tools
- Shot-blasting Air
- Low Cost Automation—cylinders and valves
- Pre-Filtration for Refrigeration Air Dryers
- Pre-Filtration to High Efficiency Dryers
- Pre-Filtration to Adsorption Air Dryers in “Oil-Free” Systems
- Pre-Filtration to Air Sterilization Filters in “Oil-Free” Systems
- High Speed and /or Miniature Pneumatic Tools
- Air Gauging
- Air Conveying
- Air Motors
- Pipeline Purging
- Pre-Filtration to Adsorption Air Dryers in Oil Contaminated Systems
- Pre-Filtration to Air Sterilization Filters in Oil Contaminated Systems



Critical Applications — Clean and "Oil-Free"

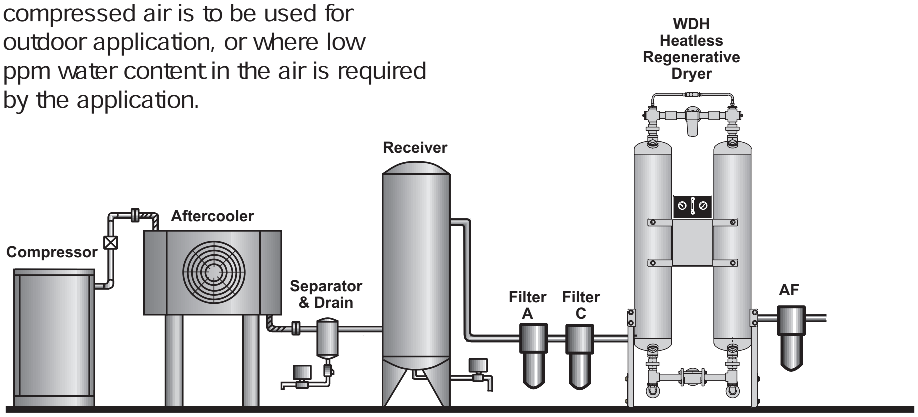
Where dew point is not required to be less than 36-40°F (2.2-4.4°C). Ambient temperature should not be below 45°F (7.2°C). For example, interior of factories.

- Highest Quality - Clean, Oil and Odor Free Air
- Blow Molding of Plastic e.g. P.E.T. Bottles
- Film Processing
- Critical Instrumentation
- Advanced Pneumatics
- Air-Blast Circuit Breakers
- Decompression Chambers
- Cosmetic Production
- Foodstuffs Production / Packaging
- Pharmaceutical Production
- Dairy Production / Packaging / Transport
- Brewery Production / Packaging / Transport
- Robotics
- Air Logic
- Instrumentation
- Air Bearings
- Spray Painting
- Temperature Control Systems



Extremely Low Dew Point System

Where dew point must be below 32°F (0°C). For example, indoor factory installation of dryer, but where compressed air is to be used for outdoor application, or where low ppm water content in the air is required by the application.



When Making Your Selection

Always try to obtain as much information as possible including flow rates, inlet pressure, temperature and pipe size.

Select filtration air quality required to the application to be protected. Remember, it is better to over-specify than not provide enough protection.

Select size of filters by flow rate and inlet pressure at the point of filtration. Also keep in mind pressure drop, if this is critical it may be advisable to oversize the filters. Generally, for operating costs, it is best never to undersize filters. The higher pressure drop caused by undersizing actually increases system operating cost.

Be careful to consider working pressure drops. Although all filters start dry, in time they become wetted with liquid (a normal condition) and this increases pressure drop. Select filters for the highest flow rate and lowest working pressure they will operate under.

Check the pipe size of the installation. If possible, match pipe sizes. This may involve increasing the size of the filter. Never reduce the pipe size of the installation to match the filter. The restriction caused by this is expensive in terms of pressure drop and operating costs and is ongoing. Increasing the size of the filter on the other hand reduces pressure drop and increases the time between element changes. This more than offsets the initial higher costs.

Pneumatic Division
Richland, Michigan
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How You Read Flow Charts

A

Using Filter Graphs

1) From the graph select one of the inlet pressure curves to be used. 35 PSIG, 60 PSIG, etc.
2) Decide upon the air flow rate requirement for this application. (Refer to the horizontal air flow rate scale located at the bottom of the graph.)
3) To find the initial pressure drop draw a vertical line from the flow rate selected to a point where it crosses the inlet pressure curve. From this intersection draw a horizontal line to where it intersects the vertical pressure drop scale.

EXAMPLE:

At 15 SCFM flow rate and 60 PSIG inlet pressure, pressure drop is about 4.3 PSID.

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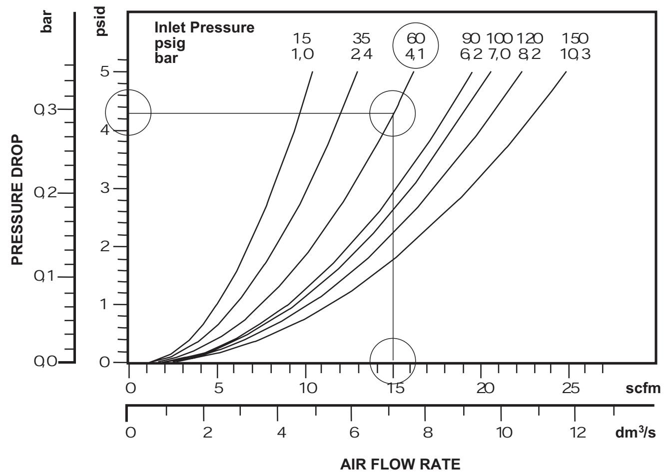

Using Regulator Graphs

NOTE: Regulator graphs are based upon an inlet pressure of 100 PSIG.

Maximum flow capacity is measured at a point that is 75% of the initial secondary pressure setting. * (NFPA)

EXAMPLE:

Inlet Pressure = 100 PSIG,

Secondary Pressure @ 0 SCFM = 90 PSIG,
Secondary Pressure @ 21.5 SCFM = 75 PSIG,
Pressure Drop @ 21.5 SCFM = 15 PSID.

1) Using a graph selected by product family and pipe size pick the secondary pressure curve that fits
2) Determine the air flow rate required from the air flow rate scale located at the bottom of the graph.
3) To find the pressure drop for this regulator draw a vertical line from the air flow rate selected to a point where it crosses the secondary pressure curve. From this intersection draw a horizontal line to where it intersects the vertical secondary pressure line. This is the secondary pressure at the flow rated selected to determine full pressure drop. Subtract this pressure from the original secondary pressure used.
The Difference = Pressure Drop

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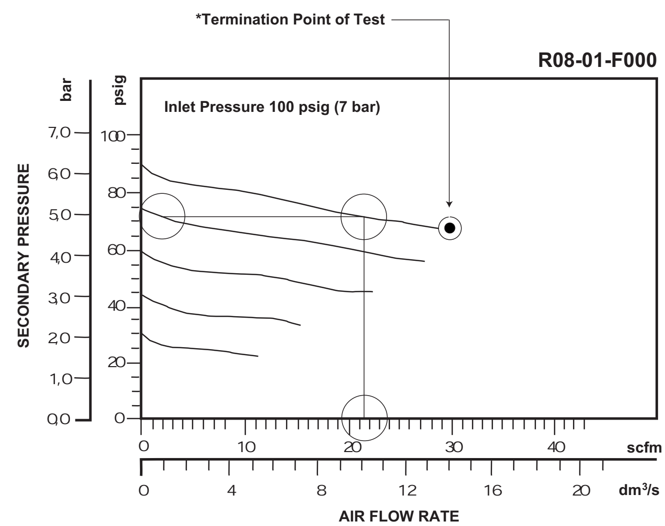

Using Lubricator Graphs

1) From the graph select one of the inlet pressure curves to be used. 35 PSIG, 60 PSIG, etc.
2) Decide the air flow rate requirement for this application. (Refer to horizontal air flow rate scale located at the bottom of the graph.)
3) To determine pressure drop draw a vertical line from the flow rate selected to the point where it crosses the inlet pressure curve used. From this intersection draw a horizontal line to where it intersects the vertical pressure drop scale.

NOTE: Pressure drop value should not be less than 0.8 PSID.

L08-01-LK00