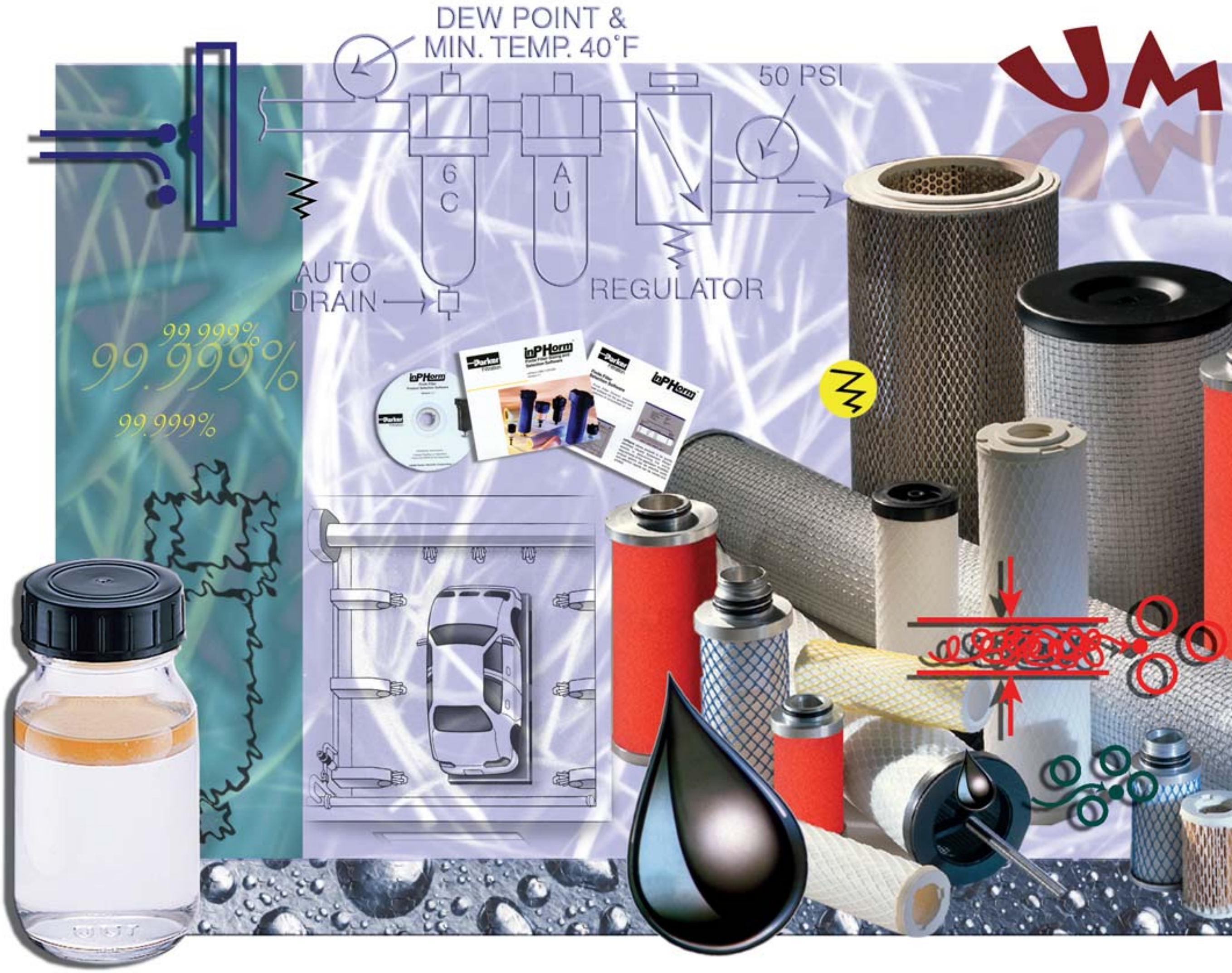
# The Basics of Coalescing

## Compressed Air & Gas Filtration

Bulletin 1300 - 700/USA




**Finite®**

# Finite®

*The Basics of Coalescing is intended to familiarize the user with all aspects of coalescing filtration from the basics to advanced technology.*

*It is dedicated as a reference source with the intent of clearly and completely presenting the subject matter to the user, regardless of the individual level of expertise.*

*The selection and proper use of filtration devices is an important tool in the battle to decrease production costs.*

*This handbook will help the user make informed decisions about coalescing filtration.*

For more information regarding coalescing filtration, please call **Finite®** at 1-800-521-4357

# table of contents



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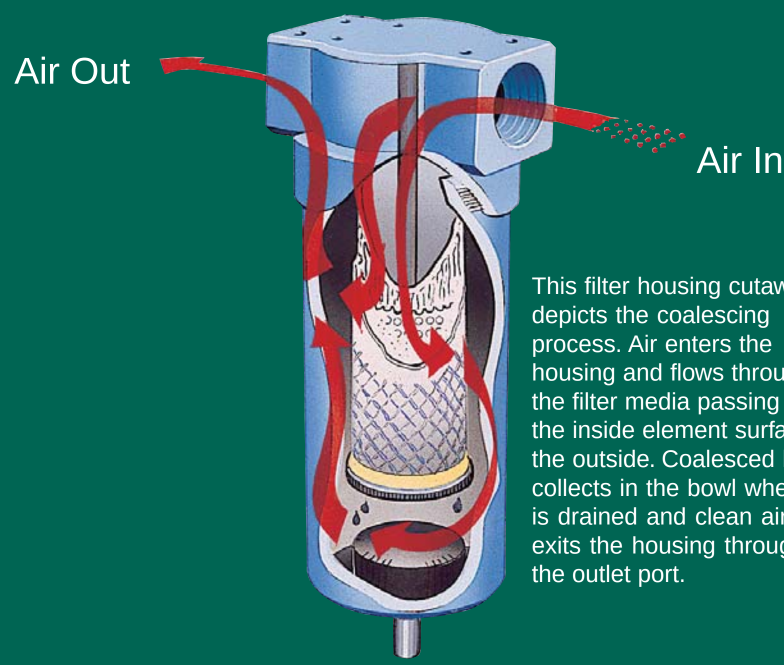
# what is

## a dictionary definition

**co·alesc·ing \ko-ə-les\ co·alesce; co·alesced;**
1. to grow together 2. to unite as a whole
3. to unite for a common end: join forces

**fil·tra·tion \fil-tra-shən**
1. the process of filtering 2. the process of passing through or as if through a filter

**co·alesc·ing fil·tra·tion**
A steady state process whereby aerosols are caused to agglomerate (come together) into even larger droplets as they pass through the filter element's fiber matrix, eventually becoming large enough to be gravitationally drained away.




This filter housing cutaway depicts the coalescing process. Air enters the housing and flows through the filter media passing from the inside element surface to the outside. Coalesced liquid collects in the bowl where it is drained and clean air exits the housing through the outlet port.

# co·alesc·ing filt·a

# why filter compressed air?

fact

Look for these exciting filtration facts throughout the handbook.

## coalescing filters are specifically designed to remove submicronic contamination from compressed air

Standard nominal five micron inline filters cannot remove submicronic contaminants as required in critical applications. The lowest particle removal limit for these general purpose filters is 2 µm. Eighty percent of aerosol contaminants are under 2 µm in size. Coalescing filters, however, are specifically designed to remove submicronic oil, water and solid contamination from compressed air. Standard graded-porosity coalescing filters remove over 99.97% of all aerosols in the 0.3 to 0.6 µm range. In addition, these filters are over 99.98% effective at removing all aerosols and solid particles larger than 0.3 µm. Thus, oil aerosols at a 20 ppm contamination level are reduced to a 0.004 ppm concentration – acceptable for virtually all pneumatic applications.

-tion?

Submicronic contaminants in compressed air systems plug orifices of sensitive pneumatic instrumentation; they wear out seals, erode system components, reduce the absorptive capacity of desiccant air/gas dehydrators, foul heat transfer surfaces, reduce air tool efficiency, and damage finished products. The results include: product rejects, lost production time and increased maintenance expense. For example, trace amounts of submicronic oil can cause serious fish eye blemishing in automotive finishing operations. Water left in air lines can freeze during exposure to cold, blocking flow or rupturing pipes. Compressor lubricant not captured in a coalescing filter will eventually collect in pneumatic components, causing premature component repair or replacement. Environmental concerns will be raised if oily, compressed air is continually discharged into the atmosphere through a pneumatic muffler.

# the compressed air environment

## coalescing filters provide clean air for a variety of applications

Clean compressed air is essential in such industries as food processing, electronics, health care, photography, dairy and instrumentation. Compressed air and other gases are widely used to convey materials, provide and control energy and protect equipment or personnel. Clean air in these and other critical applications must be free of both solid particulate contamination and liquid aerosols. These oil and water aerosols are beyond the control of conventional filter systems and can only be removed with coalescing filters.


- A Compressor Room/Controls
- B Medical/Dental
- C Food Packaging/Beverage Bottling
- D Microelectronics
- E Plastic Blow Molding
- F Spray Painting/Powder Coating
- G Packaging/Printing

## other typical applications:

- Pneumatic conveyors
- Beverage dispensers
- Spray paint equipment
- Gas separator systems
- Pneumatic power systems
- Air logic and control circuits
- Laboratory and process gas usage
- Air gauging in manufacturing processes
- Breathing air (fixed or portable systems)
- Cooling and protecting sensitive instruments
- Air bearings for mechanical power transmission
- Aeration in pharmaceutical and chemical processes



**Parker Hannifin Corporation**
Filtration and Separation Division
Oxford, MI

# submicronic contamination

## why submicronic contamination is a problem

Most process and lab gas applications require a high degree of purity. Most compressed air applications also work better if the air is clean and dry. The four classes of contaminants in compressed air are water, oil, solid (particulate) and unwanted gases. Typically the first three are in the form of aerosols. An aerosol is a suspension of small solid or liquid particles in a gas. Typically, the particles are between 0.1 and 10 microns in diameter. A micron, identified by the symbol "$\mu m$" and also known as a micrometer, is one millionth of a meter (or about 0.000039 inches) in size. A typical strand of human hair is approximately 80 microns in diameter, while a grain of table salt is approximately 100 microns in size. The lower level of visibility to the human eye is 40 microns.

OSHA regulations state that air may not contain more than five milligrams (mg.) of oil mist particles per cubic meter of plant air, or one ounce of oil in 200,000 cubic feet – yet another reason why clean compressed air is a concern in industrial applications.

Air contamination is particularly threatening in precision applications where the cleanliness of the workplace and the purity of the product are critical. In close-tolerance systems where extremely fine orifices and parts clearances are the norm, it is vital for the system air to be free of all suspended liquid aerosols as well as solids.

### Relative Sizes of Particles

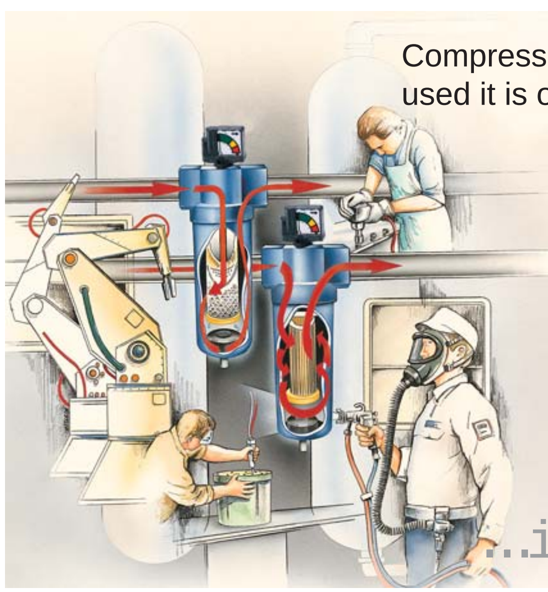
| Substance | Microns | Inches |
|---|---|---|
| Grain of table salt | 100 | .0039 |
| Human Hair | 80 | .0032 |
| Lower limit of visibility | 40 | .0016 |
| Milled Flour | 25 | .0010 |
| Red Blood Cells | 8 | .0003 |
| Bacteria | 2 | .0001 |

fact

Did you know that a micron is also known as a micrometer, which is one millionth of a meter?

fact

The symbol for a micron is: $\mu m$



Compressed air is so widely used it is often called the...

...industry's fourth utility.

# water, oil and solids are three contaminant threats

water

Possible Contaminants:

water vapors
water emulsions
condensed moisture

## water

The contaminants of greatest concern in precision compressed air systems are water, oil and solids. Water vapor is present in all compressed air; it becomes greatly concentrated by the compression process. In fact, compressed air is saturated with water until it is dried. A 25 hp compressor delivering 100 standard cubic feet of air per minute (SCFM) at 100 PSIG can produce 18 gallons of water per day.

Water aerosols in compressed air range from 0.05 to 10 $\mu m$. While air dryer systems can be used effectively to remove water from compressed air, they will not remove the second major liquid contaminant – oil.

## oil

Oil is also present in compressed air systems. It is largely introduced into the air stream by the air compressor. The amount of oil introduced in this fashion varies by the type of compressor used. Estimates of the hydrocarbon content of discharge air from typical compressors are expressed in parts per million (ppm):

- Screw – 25 to 75 ppm at 200°F.
- Reciprocating – 5 to 50 ppm at 350°F.
- Centrifugal – 5 to 15 ppm at 300°F.

At a concentration of 25 ppm, a typical compressor flowing 100 SCFM for 35 hours will introduce **eight ounces of oil into the pneumatic system.**

Even if an oil-less compressor is used, oil contamination of the air stream remains a problem because ambient air contains 20-30 ppm of hydrocarbon aerosols from industrial and automotive sources. Oil-less compressors can condense approximately 10 ppm of hydrocarbons during the compression cycle. This is enough oil to gum-up air line components and to collect in air dryer systems. A majority of the oil aerosols emitted by air compressors are 2 $\mu m$ and smaller.

oil

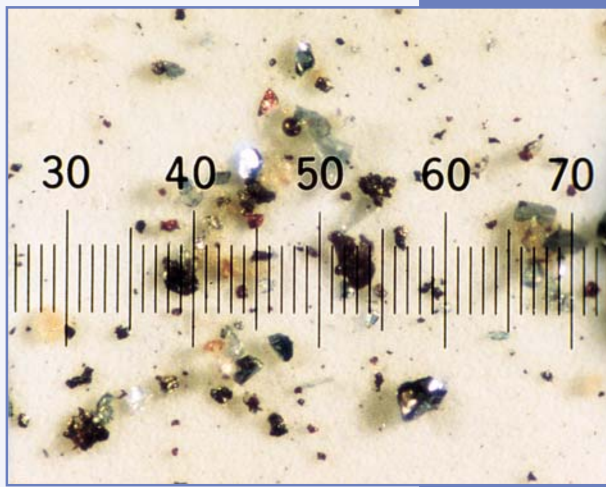
Possible Contaminants:

oil vapors
paint vapors
volatile solvent vapors
compressor lube oils
condensed oils
carbonized oils (varnish)
solutions of dissimilar oils
mixes of all the above

three contamination

# solid

The third contaminant found in compressed air is solid matter including rust and scale. Solid particulates, combined with aerosol water and oil, can clog and shorten the life of air system components as well as filter systems. Most rust and scale contaminants typically found in compressed air systems are 0.5 to 5 $\mu m$ in size.

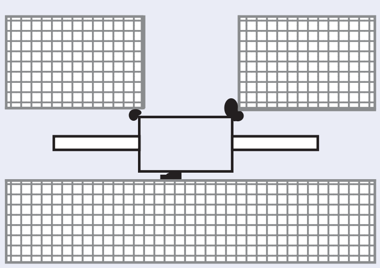



Actual pictomicroraph of particulate contaminants
(Magnified 100x Scale: 1 division = 20 microns)

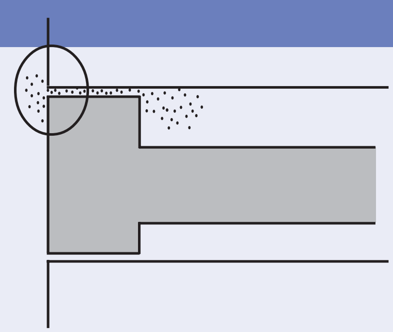
solid

**Possible Contaminants:**

pipe scale / rust
rocks
pollen
yeast cells
airborne carbon
mold
welding flash
penicillin



Submicronic particle buildup can interfere with movement and cause wear



Oil and water contamination increase silting

threats

# three mechanisms of the coalescing process

Separation of aerosol and solid contaminants from air is primarily dictated by gravity. Contaminants greater than 10 *µm* in size settle out of the air stream fairly quickly. However, extremely small aerosol particles remain suspended, particularly in flowing – as opposed to still – air. Most coalescing filters are designed to cause combining of smaller aerosols into larger droplets. The enlarged droplets are now susceptible to the effects of gravity. "Coalescing" is the term given to this combining process.

The coalescing process can be visualized as the atmospheric conditions at work in a thunderstorm – many small water vapor molecules present in turbulent moisture-laden air condense into aerosols which then collide or come together to form increasingly larger droplet masses until they gain enough weight to react to gravity and fall to earth as raindrops.

Coalescing filters eliminate submicronic contamination through three concurrent processes, depending on aerosol size:

1. Diffusion: Aerosols .001 to .2 *µm*.
2. Interception: Aerosols .2 to 2 *µm*.
3. Direct Impact: Aerosols over 2 *µm*.

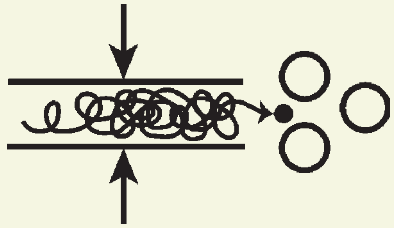
fact

Did you know that in 1994 Finite Filter joined C.A.G.I. - Compressed Air and Gas Institute, an organization committed to the development of the industry?

## diffusion

.001 to .2 µm

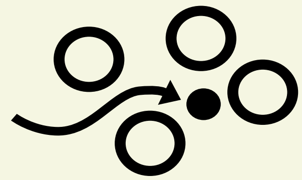
BROWNIAN MOTION PATH



Aerosols and solids in the 0.001 to 0.2 *µm* range are subject to rapid random Brownian motion, moving completely independently of the bulk air stream as extremely small aerosols in flowing air. This motion causes them to migrate from the air stream and to collide with exposed filter surfaces. Solid contaminants adhere permanently to these surfaces via intermolecular forces. Liquid droplets, however, migrate gravitationally down the filter fibers, joining other droplets to form larger masses of liquid which can be drained from the system. While the rate of diffusion activity increases with heightened temperature and pressure, contaminants of this size exhibit random motion – and are subject to diffusion coalescing – even under non-turbulent, low velocity flow conditions.

coalescing mecha

## interception

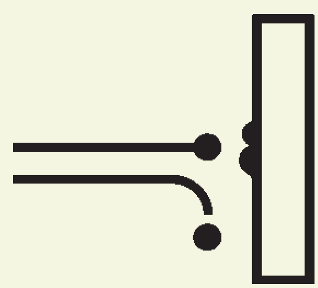


.2 to 2 *µm*

AEROSOLS FOLLOW SLIP-STREAM

For contaminants 0.2 to 2 *µm* in size, interception is the predominant coalescing mechanism. These contaminants conform to the stream line of the air flow and are the most difficult to remove because they can pass around filter fibers and escape from the filter uncollected. In general, efficiency of the “intercept” mechanism increases as pore size (or fiber diameter) decreases. Fibers with an average diameter of 0.5 *µm* are used to optimize performance in this range. When aerosols approach a fiber within 1/2 of their diameter in the filter matrix, their inertial forces are overcome and they are captured.

## direct impact



2 µm and Larger

IMPACT AREA

Contaminants 2 *µm* and larger are removed by the direct impact method because they have sufficient mass and develop enough momentum to leave the air flow stream line. These contaminants collide with the filter media, a coalescing process termed inertial or direct impaction.

# nisms

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# coalescing filters flow from the inside of the element out

Unlike standard inline filters, coalescing filters carry air flow from the inside out; contaminants are captured in the filter matrix and collect together into larger and larger droplets through collisions with the glass microfibers. These droplets eventually emerge on the outside of the filter tube where they collect and are drained away by gravity.

Modern coalescing filters use a graded-porosity filter medium with fine glass fibers in the interior and larger fibers on both the inside and outside surfaces. By varying the fiber size distribution in the filter manufacturing process, filters can be tailored to meet specific application requirements.

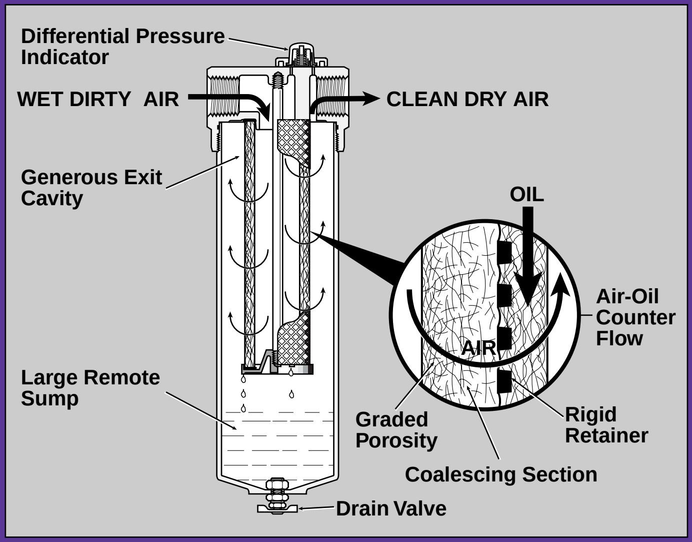
Typical filter elements have 8 to 10 $\mu m$ pores on the inner surface, reducing to 0.5 $\mu m$ pores in the interior of the element, and widening to 40 to 80 $\mu m$ pores on the outer surface.

The inner element surface acts as a prefilter to remove large contaminants while the internal pores are small enough to remove submicronic aerosols and solids from the air stream. The reduced density of the exterior surface enhances aerosol growth by forcing the aerosols to collect into larger droplets susceptible to the forces of gravity. The larger outside pores also allow the air stream to pass freely, minimizing pressure drop.

A drain layer conducts collected contaminants from the outer filter element surface to the sump in the bottom of the filter housing where it can be periodically drained away. The larger outer pores of the filter element reduce air turbulence, preventing reentrainment of oil or other contaminants due to excessive turbulence.

Coalescing filters are typically longer in shape than standard inline filters. This length helps assure filter efficiency by diverting the air stream flow from passing through the filter wet zone – generally the lower 1/2 to 2 inches of the filter (air passing through the wet zone could reentrain liquids, carrying them downstream and defeating the coalescing process).

Also important in the design of coalescing filters is the relationship between the filter element outside diameter and the housing's inside diameter. The spacing between these two surfaces must be sized so that air velocity is minimized, thus reducing the possibility of oil or water vapor carryover.




*This coalescing filter depicts how the air flows from the inside out. This housing contains a coalescer with a built in prefilter.*

# coalescing filter design

# percentage of a particular micron size measures filter efficiency

Filter efficiency is measured by the percentage of contaminants of a particular micron size that are captured by the filter. Filter efficiency is important because it affects not only contaminant removal performance, but also filter life (higher efficiency requires greater contaminant-holding capacity).

Filter efficiency ratings for contaminant removal vary from 90% to more than 99.99%, providing a range of capabilities to fit the needs of a variety of systems. Since more efficient filter media may have shorter service lives, it is sometimes desirable to sacrifice some efficiency in the interest of economy.

In applications where high efficiency and extended filter service life are critical, a prefilter is used to remove large quantities of solid particles before they reach the coalescing filter. This can increase the coalescer's service life by up to six times. For optimum performance, select a prefilter with a 3 µm absolute rating.

The table above shows, by grade, typical contaminant removal efficiency and operating characteristics of various coalescing filters.

Efficiency ratings are valid for flows from 20% to 120% of rated flow at 100 PSIG. At flows below 20%, or in non-continuous flow systems, aerosols do not agglomerate as efficiently into larger droplets, allowing more to pass through the filter uncollected. At flows above 120% of rated flow, air velocity is so high that some contaminants can be reentrained into the air system.

## **Finite**® media specifications

(Grades 2, 4 and 6 are .01 micron filters)

| Grade Designation | Coalescing Efficiency .3 to .6 Micron Particles | Coalescing Filters - C, Q, H, 7CVP Maximum Oil Carryover[1] PPM w/w | Particulate Filters - G, S, F, T, 3P Micron Rating | Pressure Drop (PSID) @ Rated Flow | |
|---|---|---|---|---|---|
| | | | | Media Dry | Media Wet With 10-20 wt. oil |
| 2 | 99.999% | .001 | .01 | 1.5 | 4-6 |
| 4 | 99.995% | .003 | .01 | 1.25 | 3-4 |
| 6 | 99.97% | .008 | .01 | 1.0 | 2-3 |
| 7CVP | 99.5% | .09 | .5 | .25 | .5-.7 |
| 8 | 98.5% | .2 | .5 | .5 | 1-1.5 |
| 10 | 95% | .85 | 1.0 | .5 | .5 |
| 3PU | N/A | N/A | 3.0 | .25 | N/A |
| AU | 99%+ | N/A | N/A | 1.0 | N/A |

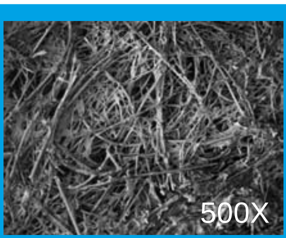
## fact

MYTH: Coalescers only remove liquid contaminants.

TRUTH: Coalescing filters are designed with submicronic pores so that they can capture tiny liquid contaminants. However, since solids cannot change shape, like liquids can, coalescers can capture them at an even higher efficiency.

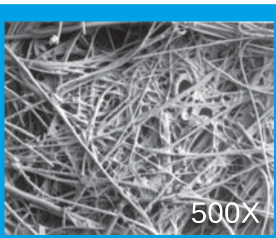
# filter efficiency

## grade 2



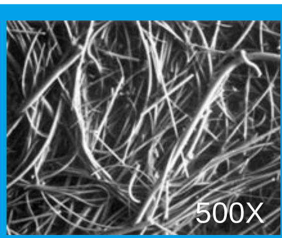

Grade 2 filters are used for extremely fine particulate and “last trace” aerosol coalescing filtration; for lighter molecular weight gases and aerosols at higher pressures.

## grade 4




Grade 4 filters are very high efficiency coalescers; for elevated pressures or lighter weight gases.

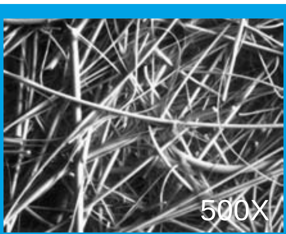
## grade 6




Grade 6 filters are used when “total removal of liquid aerosols and suspended fines” is required. Because of its overall performance characteristics, this grade is most often recommended.

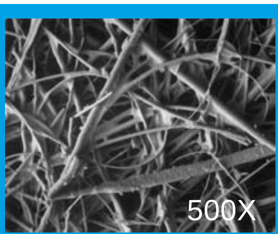
# finite’s media grades are suitable for most applications

## grade 8



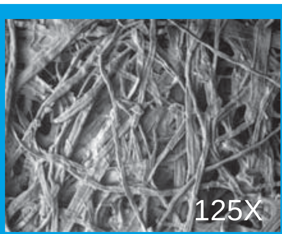

Grade 8 filters provide high efficiency filtration in combination with high flow rate and long element life.

## grade 10



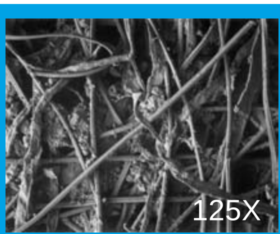

Grade 10 filters are used as prefilters for grade 6 to remove gross amounts of aerosols or tenacious aerosols which are difficult to drain.

## grade 3P




Grade 3P pleated cellulose filbers are used for particulate interception where very high dirt holding capacity and relatively fine pore structure are required.

## grade A




Grade A adsorption filters are used to remove hydrocarbon vapor and as preparation for breathing air when preceded by a coalescer.

# finite medi

# grade 7 CVP

**Finite's** innovative

## coalescing filter

media eliminates compressor lubricator oils,

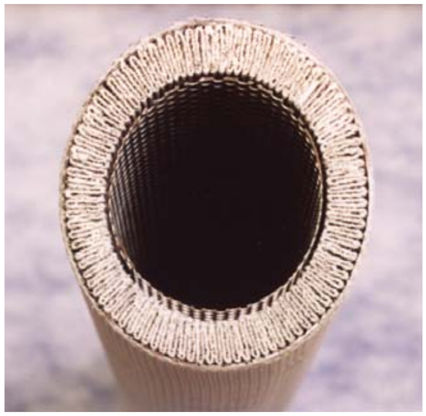
bulk water and particulate contamination

## with extremely low pressure drop.

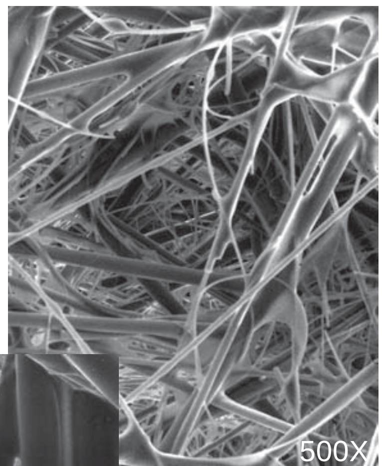
With only 0.25 PSID of pressure drop, it

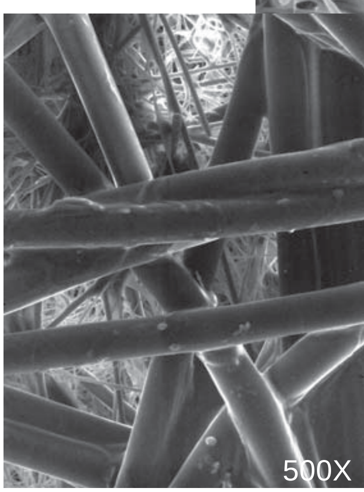
## has an efficiency of 99.5%.

Grade 7 filters are used in bulk coalescing applications when relatively high efficiency and low pressure drop are required.



Right: This outer layer of the 7CVP consists of a dense matrix of glass fibers. The coalescing outer layer provides highly efficient aerosol removal with very low pressure drop.




Left: This inner layer of the 7CVP effectively traps dirt particles, protecting and extending the life of the outer layer.

a grades

## type C

coalescing

Flow: Inside to Out

Coalescing element composed of an epoxy saturated, borosilicate glass micro-fiber tube with intimate interlocking contact with rigid seamless retainer. Surrounded by a coarse fiber drain layer, retained by a synthetic fabric safety layer.

## type CVP

Flow: Inside to Out

Coalescing element made of pleated glass media. Metal retained for added strength. Includes metal end caps and gasket for proper sealing.

type DVP = High Temperature Option

## type H

Flow: Inside to Out

Coalescing element similar to type "C," however no rigid retainer is used. Typically for lower pressure or higher temperature applications.

## type Q

Flow: Inside to Out

Coalescing element with the same configuration as "C" tube, but with "3P" type pleated cellulose prefilter built-in. Includes molded polyurethane end seals.

## type G

particulate

Flow: Out to Inside

Particulate removal element constructed of the same fiber matrix as type "C," but with no rigid retainer or drain layer.

## type T

Flow: Out to Inside

Particulate removal element like "G" tube, except high temperature fluorocarbon saturant replaces epoxy.

## type F

Flow: Out to Inside

Particulate removal element like "G" tube, except fluorocarbon saturant replaces epoxy.

## type 3P

Flow: Out to Inside

Pleated cellulose particulate removal element. Includes molded polyurethane end seals.

## type A

adsorber

Flow: Out to Inside

Hydrocarbon vapor removal element. Ultrafine grained, highly concentrated, activated carbon sheet media. Includes molded polyurethane end seals.

## Finite media types

Coalescing = type C, CVP, H, Q

Particulate = type G, T, F, 3P

Adsorber = type A

# finite media types

# choosing the right filter for your application

If the coalescing filter equipment is sized in standard cubic feet per minute (SCFM), select a filter for a particular application on the basis of airflow and system pressure rather than pipe size.

The "real" capacity of a coalescing filter can be elusive since excessive air flow through the filter element raises pressure drop and, by increasing throughput velocity, increases the chance of contaminant reentrainment.

Select a filter large enough to ensure that the air exits the filter at low velocity and does not carry over coalesced liquid.

Economic factors are also important in the selection of a coalescing filter. As discussed earlier, a balance between performance and economic considerations will be required in the selection process.

Filter service life, which has a major impact on the cost of a coalescing filter system, is discussed under "Maintenance," on page 20.

# inPHorm™

## our sizing and application software

Inphorm, our selection software is an extremely useful tool in the selection and specification of the proper filtration unit. With computer aided selection, the user can quickly determine the pressure loss across a given element, and/or housing combination, within specific operation parameters. InPhorm can also predict system performance and element life. This feature is ideal for predictive maintenance programs.

# filter housing selection

The filter housing is the pressure vessel which contains the filter element. It usually consists of two or more sub-assemblies, such as a head (or cover) and a bowl to allow access to the filter element. The housing has inlet and outlet ports allowing it to be installed into a compressed air system. Additional housing features may include mounting holes, automatic drains and element condition indicators.

The primary concerns in the housing selection process include mounting methods, porting options, draining options, indicator options, and pressure rating. All, except the pressure rating, depend on the physical system design and the preferences of the designer. The pressure rating of the housing is far less arbitrary. This should be determined before the housing style is selected.

## pressure ratings

Location of the filter in the system is the primary determinant of pressure rating. Most industrial applications use pressures in the 90-125 PSIG range. At natural gas compressor booster stations, pressures can reach up to 5000 PSIG. It is essential to analyze the system for frequent pressure spikes as well as steady state conditions. Some housings have restrictive or lower fatigue pressure ratings. In systems with frequent high pressure spikes, a different housing style may be required to prevent fatigue related failures.

# filter housings

# filter installation

installation can have a considerable impact on the cost and effectiveness of your system

Proper installation of a coalescing filter system can have a considerable impact on the cost and effectiveness of the system.

If all air within your operation does not require purification to the same degree, install coalescing filters providing the desired efficiency and performance at points of use. Air flow through point-of-use filters will be lower than through a central filter system, allowing the use of a smaller filter and extending filter service life. What's more, each point of use will receive air meeting specific cleanliness specifications. In addition to point-of-use filters, mainline filters can be installed at junctions in the air system where air purity needs change significantly.

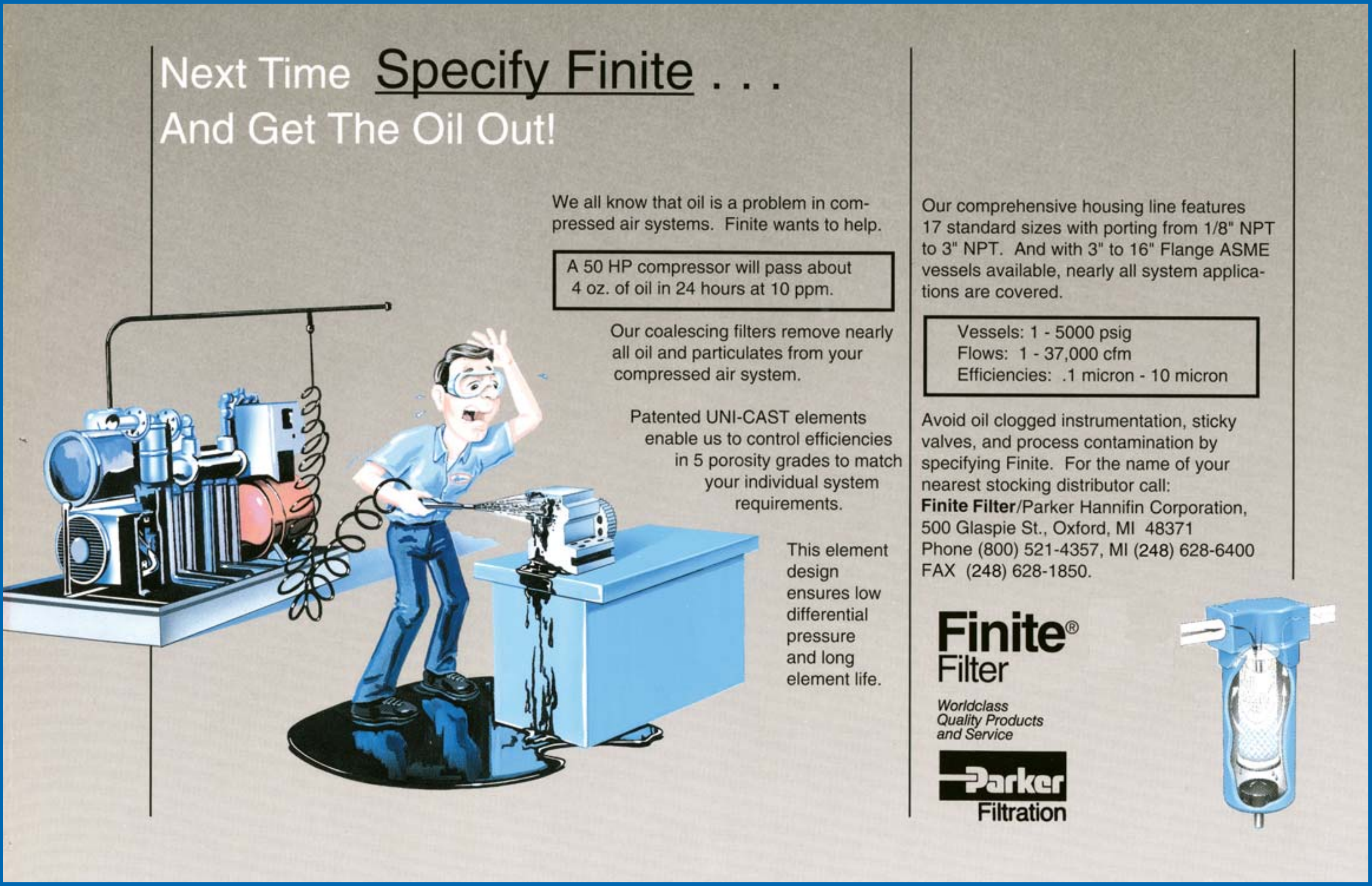
Where required by especially contaminated air, and/or the need for higher coalescing filter efficiency, install conventional 3 µm prefilters upstream from each coalescing filter to remove large quantities of contaminants. This will lengthen the coalescer's service life.

When installing coalescing filters at work stations, the additional 2-6 PSID pressure drop contributed by the filter at rated flow through its life should be factored into equipment selection and distribution system sizing.

When installing any filter, position it in a visible place where it will not be overlooked by maintenance personnel. Affix a label or tag to each filter detailing the installation date, the recommended filter element replacement date and the replacement element number. Inspection intervals should also be formalized and confirmation of inspections indicated on the label or tag.

Finally, make sure coalescing filters are plumbed so that air flows from the inside of the element to outside. Coalesced liquid will drip from the outside of the element tube to the sump of the filter housing. If plumbed incorrectly (outside to inside), liquid will not drain properly. This will result in reentrainment of oil and a dramatic reduction in coalescing performance.

The diagrams on pages 24-27 show typical industrial compressed air systems. The location of coalescing filters in these systems is also indicated.




*This advertisement appeared in trade journals in the '80s. The cartoon depicts the headache of having oil in your compressed air lines.*

# maintenance

Filter element replacement cycles are an important factor in the design of a coalescing filter system. Generally speaking, more efficient filters will need to be replaced more often because they will entrap more contaminants, hastening clogging. The amount of solid contaminants in the air stream determines filter life. While liquids agglomerate and subsequently drain to the filter sump, solid contaminants become entrapped in the filter element, restricting air flow and increasing pressure drop. Use of a built-in prefilter, such as Finite "Q" media to remove solid particulate matter can reduce dirt loading in the coalescer and prolong filter life.

# filter element life profile

*the UNI-CAST microglass elements provide a longer life profile than cellulose media and single layer fiberglass*

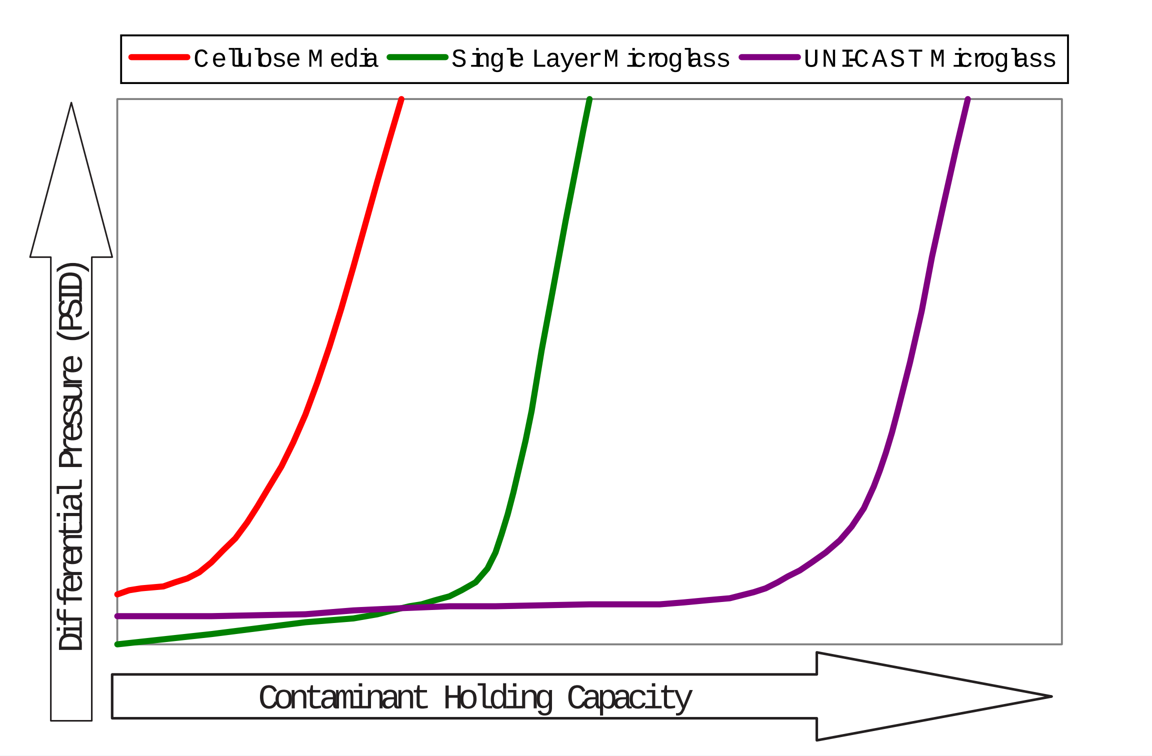
**fact**

Finite's unique UNI-CAST design was developed to optimize filter performance, resulting in a filter element with lower differential pressure and a higher dirt loading capacity.

Every filter element has a characteristic pressure differential versus contaminant loading relationship. This relationship can be defined as the "filter element life profile." The actual life profile is obviously affected by the system operating conditions. Variations in the system flow rate affect the clean pressure differential across the filter element and have a well-defined effect upon the actual element life profile.

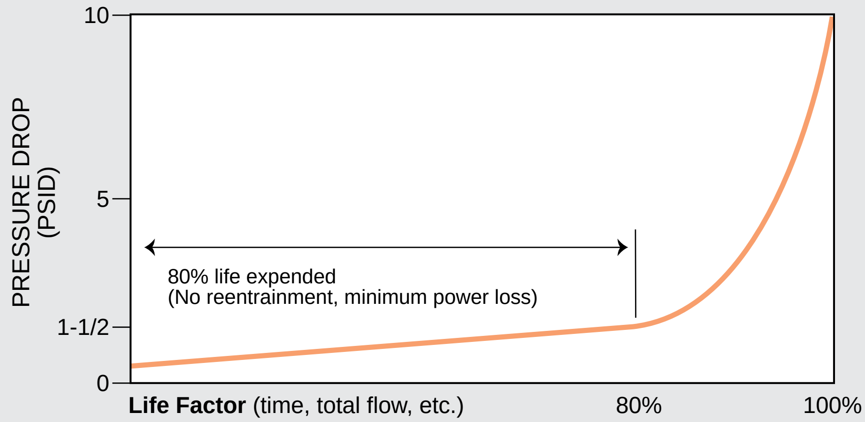
The quanity, size, shape and arrangement of the pores in the filter element determine the characteristic life profile. Filter elements that are manufactured from cellulose media, single layer microglass media and UNI-CAST microglass all have a very different life profile. The graphic comparison of three most common media configurations clearly shows the life advantage of the UNI-CAST microglass filter element.

## Element Types Life Comparison



# coalescing filter loading curve

## pressure drop vs. life factor




Loading curve for a standard graded-porosity coalescing filter shows the classic relationship between pressure drop and life. Dirt loads into the filter element fairly constantly over the first 75% of a filter's life; thus, pressure drop remains fairly constant over this period. Over the last part of a filter's life, pressure drop increases drastically and oil reentrainment begins. Typically, a filter should be replaced when pressure drop reaches 8 to 10 psig.

*Increasing pressure drop is a sign that the filter is becoming clogged and its efficiency could become impaired*

Pressure drop is the "early warning" indicator of coalescing filter failure. Increasing pressure drop is a sign that the filter is becoming clogged and its efficiency is becoming impaired. Flow rate, operating pressure, and the amount and type of contaminants in the air stream all affect the rate of pressure loss across a coalescing filter.

When a pressure drop of 8-10 PSID is indicated, the filter should be replaced.

The chart above shows a typical pressure drop curve for a coalescing filter system designed to provide optimum cost/efficiency.

The initial low reading remains nearly constant for the first 75% of the filter's life. Theoretically, no reentrainment of aerosols should occur in the first 80% of the filter's life.

Ignoring pressure drop can be costly, both in terms of reduced air quality due to contaminant reentrainment and the power costs associated with forcing compressed air through an obstructed filter. Page 23 illustrates the point.

Between replacements, drain the filter bowl daily to remove coalesced liquid and prevent reentrainment, or install an optional automatic drain.

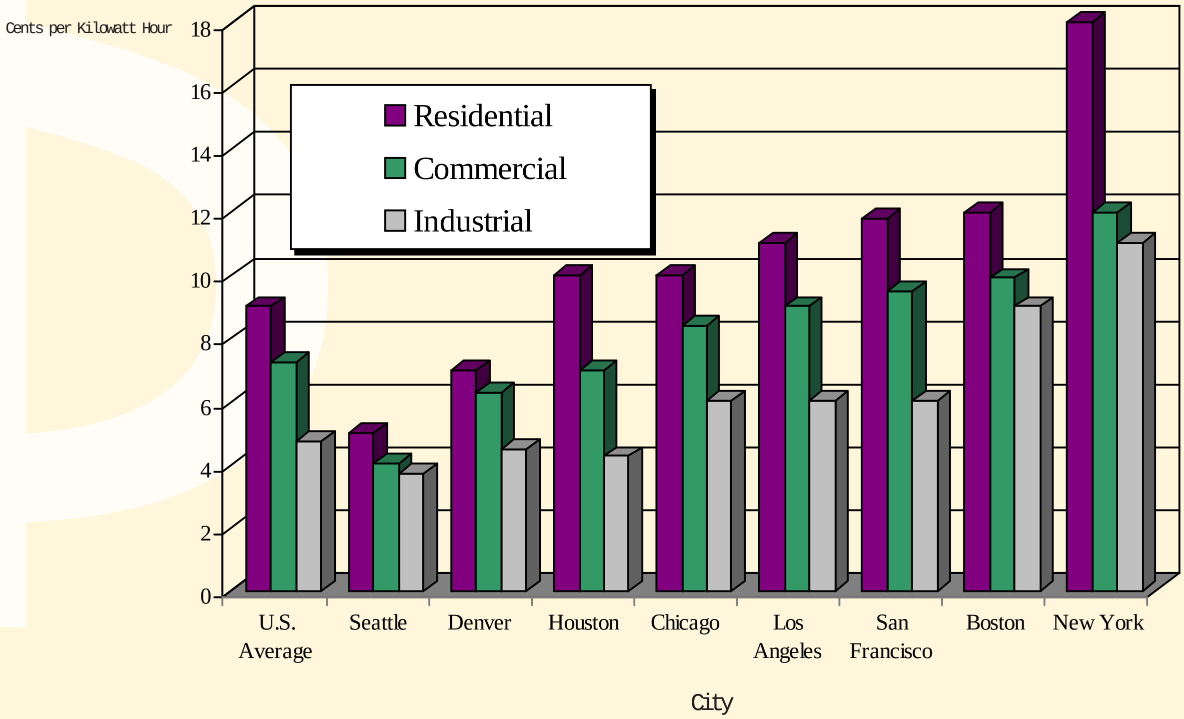
# the direct cost of pressure drop

As solid contaminant loads in a filter element, pressure drop builds in the compressed air system. This increases electrical consumption, as the compressors are forced to work harder or longer to deliver the compressed air needed. This increased usage of electricity manifests itself in higher utility bills, as more electricity needs to be purchased to run the compressors.

This is one reason the selection of the filter media and the sizing of the filter are so important.

The chart below shows that electrical costs vary widely between geographical areas in the United States. Compare the rate for your area to the 9 cents per kilowatt-hour rate used in the example. That will give you a good idea of how much it would cost to operate your compressed air system with excessive pressure drop.

Many times it is a more economical choice to change out a dirty filter element than it is to continue to operate with that element's associated elevated pressure drop.




## Use

the following calculation to identify pressure drop cost in your application:

Example Calculation:
9¢/KW HR = .03¢/ft$^3$ @ 100 PSIG
.03¢/ft$^3$ @ 100 PSIG = 30¢/1000 ft$^3$ @ 100 PSIG
30¢/1000 ft$^3$ @ 100 PSIG = 1.5¢/1000 ft$^3$ @ 5 PSID

Add: .5¢ for fixed charges, repair, operating cost.
2¢/min. @ 1000 SCFM, while dissipating 5 PSID
i.e. 2¢/min. = $1.20/HR = $9.60/shift = $28.80/day.

At an electrical rate of 9 cents per KW hour. . .

...If a filter element is allowed to generate an extra 5 PSID of pressure drop operating in a 1000 SCFM system. . .

...the cost of generating that lost pressure is $28.80 every day.

# applicatio

*In this application above, a Finite filter is used on a respiratory breathing system. The filters makes the air clean and safe for breathing.*

From aeration in pharmaceutical and chemical processes to pneumatic power systems, the possibilities for applications are endless. Finite has some suggested applications that may fit your needs. Let one of Finite's application engineers find a system that is right for you.

## General Notes:

**1.** This application data applies to all types of compressors so long as air-oil separators and aftercoolers (where indicated) are in good working order.

**2.** All systems are 100 PSIG at the compressor.

**3.** Systems with high water content or excessive oil carry-over should employ grade 10C to coalesce. In addition, it would be a good choice to oversize the filter.

**4.** If system pressure is reduced by 1/2 immediately downstream of a coalescer (which successfully removed all condensed water) the pressure dew point can be reduced by 15°F to 18°F artificially "drying" the air stream.

**5.** Uncontrolled, compressed air contaminants are extremely abrasive, corrosive and acidic with pH values from 4.5 to 6.0 due to hydration of carbon dioxide, nitrogen oxides and chlorinated solvents.

*Finite offers outstanding point-of-use protection to expensive analytical instruments, such as chart recorders in a food processing plant.*

*In this textile application, Finite filters are used to protect sensitive moving parts on this loom.*

## quality

International ISO Standard ISO8573-1 is fast becoming the industry standard method for specifying air cleanliness. The following diagrams describe various systems in terms of their corresponding ISO classification.

### International ISO Standards

**Notification as specified in ISO8573 - 1**

| | Solid | | Water | Oil |
|---|---|---|---|---|
| Class | Maximum particle size* (um) | Maximum Concentration** mg/m³ (ppm) | Maximum Pressure Dewpoint °F (°C) | Maximum Concentration** mg/m³ (ppm) |
| 1 | 0.1 | 0.1 (.08) | -94 (-70) | 0.01 (.008) |
| 2 | 1 | 1 (.8) | -40 (-40) | 0.1 (.08) |
| 3 | 5 | 5 (4.2) | -4 (-20) | 1 (.83) |
| 4 | 15 | 8 (6.7) | 37 (+3) | 5 (4.2) |
| 5 | 40 | 10 (8.3) | 45 (+7) | 25 (21) |
| 6 | - | - - | 50 (+10) | - - |

* Particle size is based on a filtration ratio $b$20. The minimum accuracy of the measuring method used is 20% of the limiting value of the class.
** At 14.7 psi (1 bar) absolute pressure, +70°F (+20°C) and a relative humidity of 60%.
It should be noted that at pressures above atmospheric, the contaminant concentration is higher.
Notes:
1. The quality of the air delivered by non-lubricated compressors is influenced by the quality of the intake air and the compressor design.
2. The minimum accuracy of the measuring method used is 20% of the limiting value of the class.

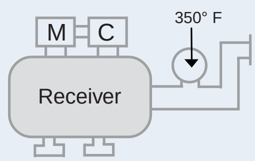


**Parker Hannifin Corporation**
Filtration and Separation Division
Oxford, MI

ns

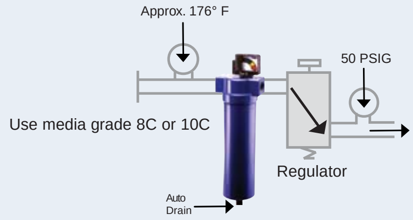
## ISO Class 2 □ 4

**Compressor Room (Source) Air Preparation Equipment:**




Any small compressor with no aftercooler, air intended for intermittent, general use.

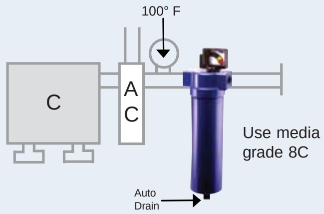
**Point-Of-Use Air Preparation Equipment:**




Place this point-of-use filter as far from compressor as possible to facilitate heat radiation

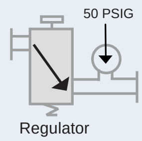
## ISO Class 2 □ 3

**Compressor Room (Source) Air Preparation Equipment:**




Any compressor with aftercooler. Air intended for use with lubricated air tools, air motors, cylinders, shot blasting, non-frictional valves.

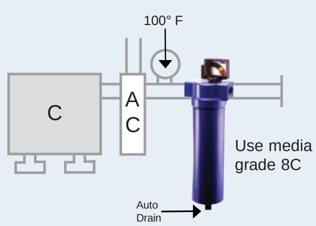
**Point-Of-Use Air Preparation Equipment:**




**OTHER SPECS MET:** Compressed Air & Gas Institute: CGA – G7.1 (Grades A & Ba1),

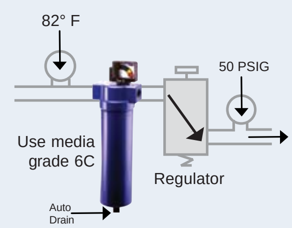
## ISO Class 1 □ 1

**Compressor Room (Source) Air Preparation Equipment:**




Any compressor with aftercooler & 2-stage coalescing. Air intended for use with lubricated control valves, cylinders and parts blow-down, etc.

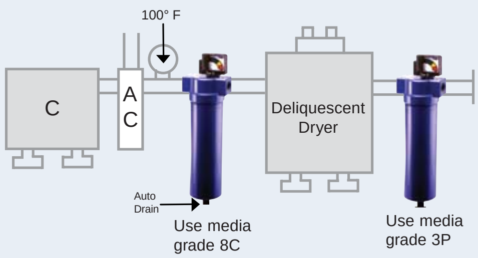
**Point-Of-Use Air Preparation Equipment:**



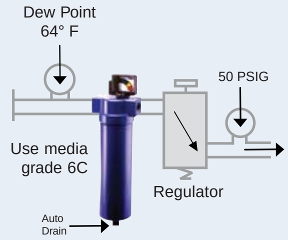

**OTHER SPECS MET:** Mil. Std. 282 H.E.P.A.
U.S.P.H.S. 3A
Accepted particles for milk

## ISO Class 1 □ 1

### Compressor Room (Source) Air Preparation Equipment:




### Point-Of-Use Air Preparation Equipment:

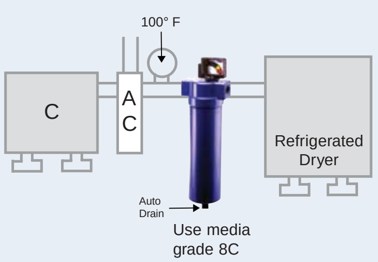



Any compressor with aftercooler, 2-stage coalescing & deliquescent dryer. Air intended for use with general pneumatic systems, body shop spray painting and components sensitive to high moisture content.

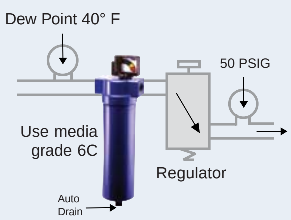
**OTHER SPECS MET:** CGA – G7.1 (Grade C)

## ISO Class 1 4 1

### Compressor Room (Source) Air Preparation Equipment:




### Point-Of-Use Air Preparation Equipment:

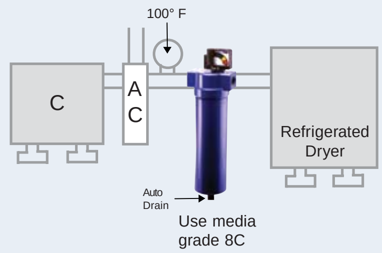



Any compressor with aftercooler, 2-stage coalescing & refrigerated dryer. Air intended for use with air-gauging, air conveyors, spray-painting, food processing, instrumentation, blow molding, cosmetics, film processing, bottling, pharmaceuticals, dairy, breweries, medical, robotics & close tolerance valves.

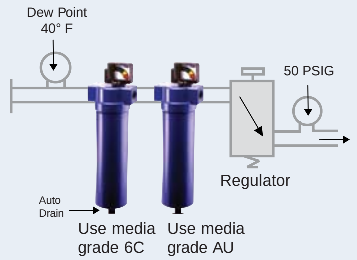
**SPECS MET:** CGA – G7.1 (Grade D & E) ISA S7.3 Fed. Std. 209 (Class 100)

## ISO Class 1 4 1

### Compressor Room (Source) Air Preparation Equipment:




### Point-Of-Use Air Preparation Equipment:

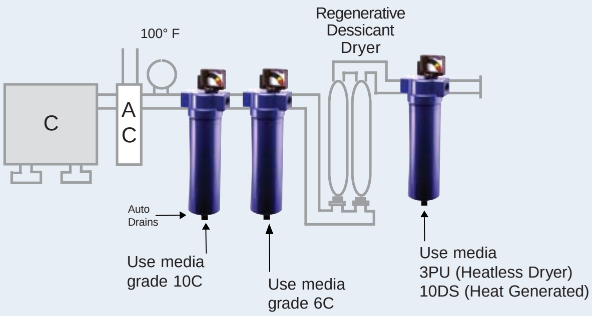



Any compressor with aftercooler, 2-stage coalescing, refrigerated dryer & carbon absorber. Air intended for use as industrial breathing air & decompression chambers. CAUTION: Always use high temperature synthetic lubricants & monitor (alarm for carbon monoxide concentrations exceeding 20ppm). This system will not eliminate toxic gases!

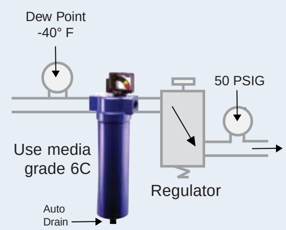
**OTHER SPECS MET:**
O.S.H.A. 29CFR 1910.134

## ISO Class 1 2 1

### Compressor Room (Source) Air Preparation Equipment:




### Point-Of-Use Air Preparation Equipment:




Any compressor with aftercooler, two-stage and double coalescing and a regenerative-type desiccant dryer. Air intended for use in applications involving rapid expansion of compressed air, critical instrumentation, high purity gases, computer chip drying, etc. CAUTION: This air is too dry for respiratory use.

**SPECS MET:** CGA – G7.1 (Grade F),

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