# Filters for the Natural Gas Industry

ENGINEERING YOUR SUCCESS.

# Why Filter Natural Gas?

More than 60 million homes and businesses in the US and Canada use natural gas for heating, power, cooking, fireplaces and gas grills. New developments and improvements are constantly being made to increase the use of this clean burning, efficient fuel.

Natural gas comes from underground, and more than one million miles of pipeline exist in North America to transport the gas. Compressor stations located along the length of pipeline move the gas from the wellhead to consumer distribution points. However, the raw gas from the ground requires processing and refining before it is ready for use.

The installation of Finite filters make it possible to improve process efficiency and provide optimal process protection. The rigid, graded-density structure of Finite filter products efficiently removes solids and contaminants that would quickly plug competitive filters. Details of these products are discussed in the following application and product overview.

The figure below identifies the stages of natural gas processing and distribution. Finite can provide a positive impact on efficiencies in each of these processes.

## Gas Production Flow Process

1

### Production

Natural gas comes from the ground. Once a gas site has been identified, a well is drilled and the gas is extracted from the ground.

Natural Gas Production, page 3

2

### Treatment

Raw natural gas exists in mixtures with hydrocarbons, water vapor, acid gas, and other contaminants. It is best practice to treat this mixture.

Amine Sweetening, page 3

Desiccant Dehydration, page 4

Glycol Dehydration, page 4

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### Pipeline

Natural gas is transported to high demand areas via an elaborate network of pipelines, and is stored when it is not required.

Fuel Gas, page 5

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### Distribution

Pipeline quality natural gas is ready to be delivered to consumers for use in homes and businesses.

Booster Station, page 5

# Natural Gas Production

## The Application

Once a natural gas well has been drilled, the gas is extracted from the ground via natural pressure and sent through a compressor prior to treatment.

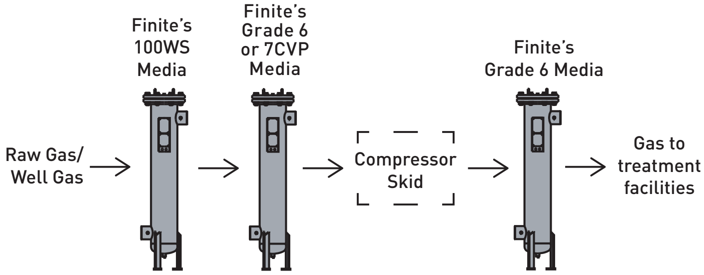
## The Solution

Two-stage coalescing prior to the gas entering the compressor should take care of any solids and liquids that could damage it. A coalescing filter placed after the compressor skid will eliminate compressor lube oil from the exiting gas before it is sent out for treatment.

## The Problem

Raw natural gas, as it exists underground, contains liquid slugs, hydrogen sulfide, oil and other contaminants. The wells from which the gas is extracted are dirty. Sometimes these wells are also treated with acids or gases to promote movement of the gas to the surface. Common problems include:

- Compressor fouling
- Fouling of gas treatment processes
- Equipment corrosion
- Unnecessary maintenance due to lack of filtration




# Amine Sweetening

## The Application

In a natural gas treatment facility, a process referred to as "sweetening" occurs in which amines are used to remove acid gas (mainly hydrogen sulfide and carbon dioxide) from inlet gas streams. Natural gas is fed into a contactor tower where it contacts the amine. The "sweet" gas then makes its way through a carbon bed to remove trace hydrocarbons before entering a stripper section.

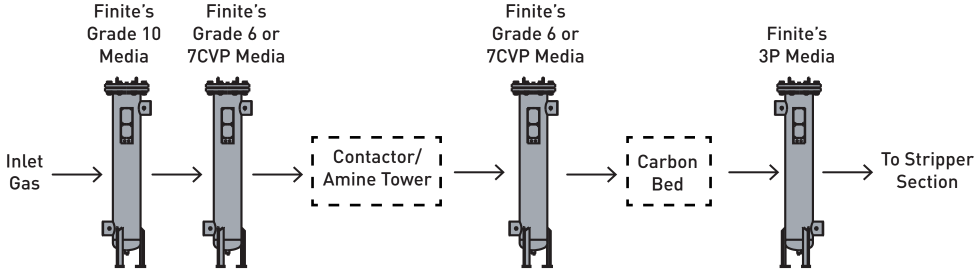
## The Solution

Two-stage filtration of the incoming natural gas will eliminate bulk liquids and solids prior to entering the amine sweetening process, reducing amine foaming and carryover. A coalescer should be placed downstream of the contactor tower to remove entrained amine solvent before it reaches the carbon bed. Downstream of this bed, a particulate filter will prevent carbon fines from migrating back into the gas stream.

## The Problem

Contaminants include condensed gas liquids at the inlet, pipeline solids and dirt, amine carryover and liquid slugs, all of which contribute to:

- Contact tower foaming and fouling, resulting in less acid gas being adsorbed and amine migrating downstream
- Carbon bed fouling
- High maintenance costs due to makeup solvent, equipment repair and replacement
- Increased energy usage



# Desiccant Dehydration

## The Application

Desiccant dehydration is the primary form of natural gas "drying." Wet gas enters and passes through the desiccant, where the water is adsorbed and retained, and the gas exits. Two or more towers, filled with a solid desiccant such as silica gel or molecular sieve, can usually be found in the system so that as the desiccant in one tower becomes saturated with water, it can be shut down and the desiccant regenerated while another tower is on-line. The natural gas is then sent through a regeneration cycle. In this cycle, dry gas exits the bed, is cooled, and wet gas is diverted back to the wet inlet gas stream.

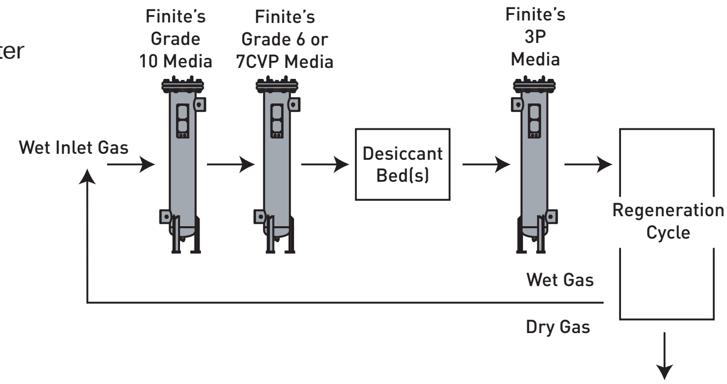
## The Problem

Contaminants that cannot be removed by desiccant, such as compressor lube oils (entering the system through regeneration), liquid hydrocarbons, corrosion related solids and amines will cause:

- Decreased water holding capacity of desiccant due to pore plugging
- Release of trace desiccant
- Compressor fouling
- Corrosion of downstream equipment resulting in increased costs

## The Solution

Installing coalescers upstream and a particulate filter downstream of the desiccant beds will prevent unwanted solid and liquid contaminants from interfering with desiccant adsorption.




# Glycol Dehydration

## The Application

Glycol dehydration is an adsorption process in which glycol, a liquid solvent, is used to remove water vapor from natural gas. Glycol is brought into contact with the wet gas stream in a contactor tower, and then dry natural gas is transported out of the tower and into a carbon bed to remove hydrocarbons from the gas before further processing.

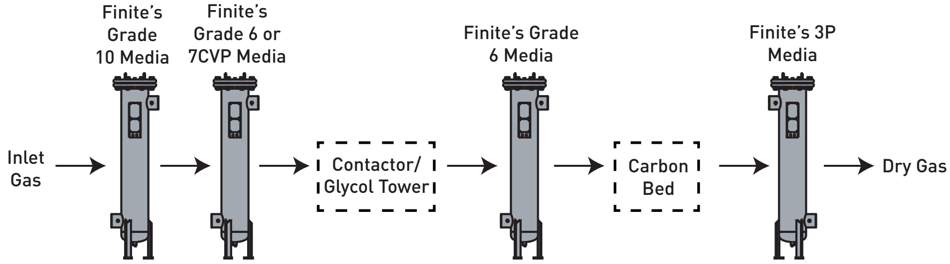
## The Problem

Solid and liquid contaminants in the wet natural gas cause or contribute to:

- Glycol foaming in the contactor tower, resulting in less water vapor being adsorbed
- Carbon bed fouling and downstream equipment failure
- Product that does not meet specification
- Increased maintenance costs and energy usage

## The Solution

Two-stage coalescing for removal of liquids and particles prior to the wet natural gas entering the contactor tower will prevent foaming and downstream equipment failure. A coalescing filter upstream of the carbon bed will help to extend its life, and a particulate filter downstream of the unit will remove carbon fines and further protect downstream equipment.



# Fuel Gas

# Pipeline

## The Application

Pipeline and/or stored natural gas is sent through a compressor and heated, preparing it for use as a fuel gas. This gas supplies the energy needed to operate heavy duty machinery and various tools employed throughout a factory.

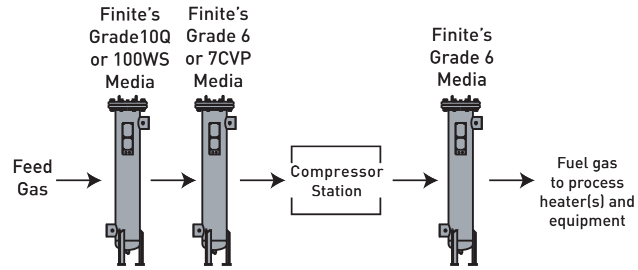
## The Solution

Two-stage filtration of the feed gas prior to entering the compressor station will eliminate any solids and liquids that could otherwise contribute to compressor failure. A coalescing filter should be used after compression to eliminate compressor lube oil prior to the gas being introduced into the rest of the factory.

## The Problem

In general, pipeline natural gas does not receive adequate filtration prior to entering a factory for use as fuel gas. This gas can contain solids such as sand, clay and iron; condensed gas liquids, water vapor and additives such as odorizers and corrosion inhibitors used in the gas pipeline, leading to:

- Compressor and burner fouling
- Instrument wear
- Frequent maintenance and repair




# Compressor Booster Station

# Distribution

## The Application

As natural gas flows through a pipeline, it loses pressure due to friction against the inside of the pipe. The gas needs pressure to continue moving. Compressor booster stations located along the pipelines keep the pressure high enough to allow the gas to flow. Additionally, these lines are subject to periodic pigging (cleaning) processes which can dislodge solid and liquid contaminants that have accumulated over time.

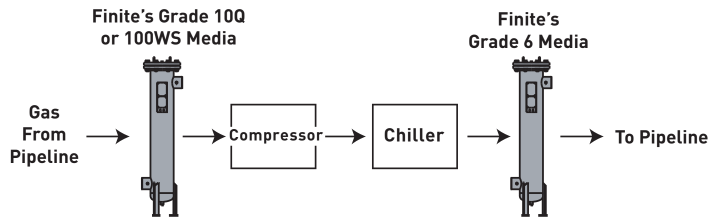
## The Problem

Natural gas traveling the length of a pipeline can pick up contaminants such as pipe scale, compressor lube oil, water and chemicals used to reduce pipe corrosion, causing:

- Compressor damage
- Chiller coil damage
- Increased pipeline maintenance
- Significant decrease in gas flow

## The Solution

Sending the natural gas through Finite's 10Q or 100WS media prior to entering the compressor station will eliminate any solids and liquids that would otherwise contribute to compressor failure. A coalescing filter should be used after compression to eliminate compressor lube oil prior to the gas being introduced back into the pipeline.



# Landfill Gas Filtration

## The Application

Landfill waste decomposes and produces what is known as landfill gas. This gas is composed mainly of methane and carbon dioxide, with small amounts of other gases, organic (non-methane) and inorganic compounds. Landfill gas has proven to be a reliable energy source for both industrial and residential use, and its conversion reduces greenhouse gas emissions, pollution and energy costs.

Landfill gas is collected in underground wells, brought to the surface and compressed before being sent out for resale and delivery.

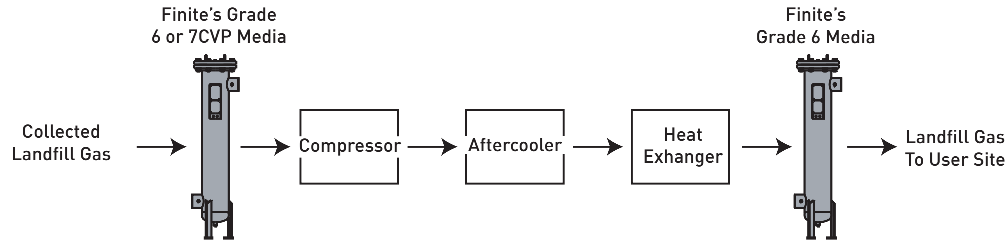
## The Problem

Landfills are naturally dirty and retain particulate and moisture. Temperature changes increase the amount of condensate at both the heat exchanger outlet and gas collection point. Inadequate filtration of produced gas will lead to:

- System compressor damage
- Heat exchanger fouling
- Unpleasant odors
- Safety hazards and other problems at energy usage sites

## The Solution

Filtration of collected landfill gas entering into the compressor will eliminate particles, liquid slugs and aerosols that could otherwise damage downstream equipment. A coalescer should be placed downstream of the heat exchanger to collect any compressor lube oil and condensed liquids.




# Digester Gas

## The Application

Anaerobic digestion involves converting organic materials such as animal waste and food processing waste into what is known as digester gas, or biogas. The waste material is put into an airtight container, called a digester, where temperature, pH levels and the amount of time spent in the container are closely monitored. The waste is then decomposed and broken down into smaller molecules. The decomposed matter is converted to organic acids.

Finally, the acids are converted to digester gas. The gas can then be used as an energy source for various process components such as engines and turbines, or can be stored for future use.

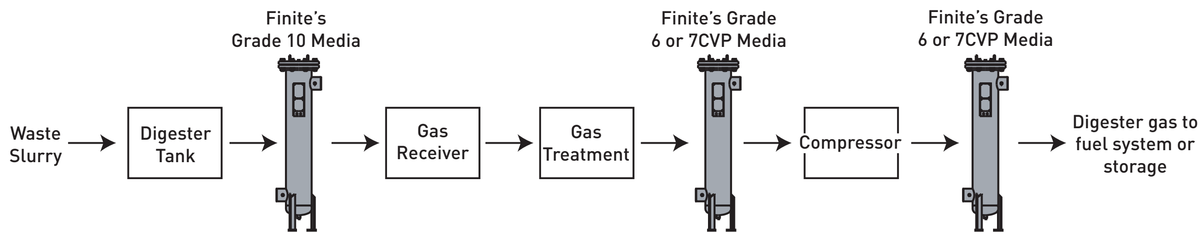
## The Solution

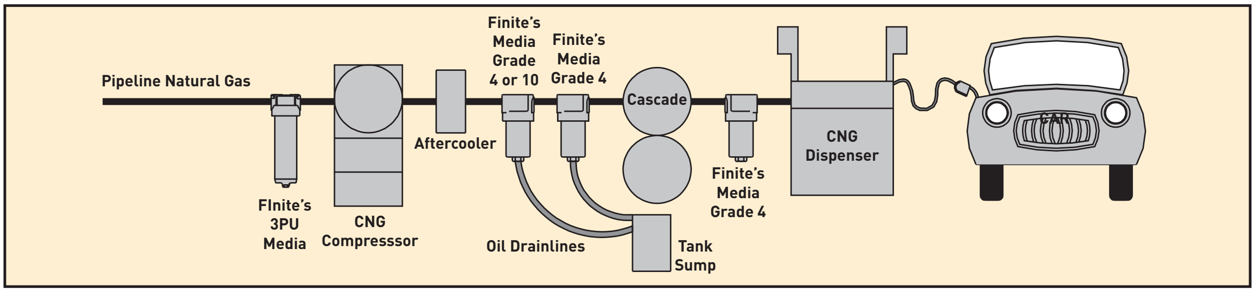
The gas coming off of the digester should be filtered prior to entering a gas receiver to eliminate contaminants generated by digestion. Gas leaving treatment should be filtered to remove any liquids carried over from the process. A coalescing filter is also recommended after compression to get rid of any compressor oils that may be transported downstream.

## The Problem

Once the waste material has been placed in the digester, mixed, and converted to gas, the resultant gas will contain impurities generated by and left over from the actual digestion process. This includes water, condensed gas liquids, hydrocarbons, and acid gas that must be removed prior to transport for use or storage. Unfiltered gas will lead to:

- Cause compressor damage
- Foul gas scrubbers, valves and other instrumentation equipment






# Alternative Fuels - Fuel Dispensing

## The Application

Compressed Natural Gas, or CNG, is a leading alternative to traditional fuel for the automotive industry. CNG is used in passenger vehicles, pickup trucks, in transit and on school buses. It can be less expensive than gasoline, and is more environmentally friendly – it reduces the amount of carbon monoxide, carbon dioxide and hydrocarbon vehicle exhaust emissions.

Natural gas is gathered from a pipeline and travels to a connecting compressor station. The gas is elevated to pressures ranging from 2000 psig up to 5000 psig and the resultant CNG is stored in large tanks. The CNG then makes its way to a gas dispenser where it is ready for use in natural gas vehicles.

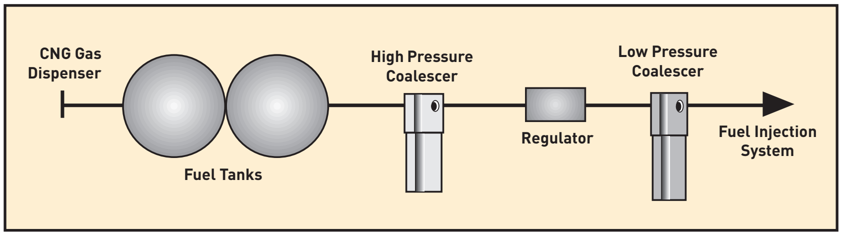
## The Problem

CNG is prone to the same types of contamination that is present in traditional fuels – solids that collect during handling, water that condenses in tanks and compressor lube oils that carry over into the CNG stream. During its transport to the dispenser, the CNG will also have contaminants that are generated within the delivery system. This leads to:

- Compressor fouling
- Vehicle fuel system repair
- Liquids in storage tanks
- Gas dispenser replacement

## The Solution

Installing a lower pressure particulate filter before the compressor station will remove pipe scale to prevent compressor damage. Before the gas is transported from storage to the dispenser, pre-filtration of the gas with two-stage coalescing will eliminate solids, oil and water generated during underground transit. For extra protection, a high efficiency coalescer should be placed at the gas dispenser to protect sensitive dispenser metering equipment and prevent oil from making its way into the vehicle.




# Alternative Fuels - On Board Applications

## The Application

Efficient operation of a CNG vehicle requires protection of the fuel system to prevent premature failing of the fuel injectors and precision components. The gas is dispensed from the filling station to the vehicle fuel tank, finally entering the fuel injection system.

## The Problem

Contaminants such as lube oil carryover from compressors, condensed liquids in fuel tanks and solids buildup during gas handling contributes to:

- System downtime
- Component repair and failure
- Increased maintenance costs

## The Solution

Filtration is the key to guarding against damaging contaminants that could ruin the fuel system. Installing a coalescer upstream of the high pressure regulator extends the system's life and reduces maintenance costs. A low pressure filter can also be used downstream of the regulator to protect other fuel injection system components.

# Filters for Natural Gas Applications

## Housings

Finite offers an array of filters sized to handle any natural gas flow and several media choices to meet natural gas application demands. ASME filter housings are constructed from carbon steel. Choices of filter media types include glass fiber for coalescing liquids, cellulose for particulate removal and activated carbon materials for oil vapor and hydrocarbon removal. Filter element ratings are available from 100 micron down to 0.01 micron.

- Pressures to 185 PSIG
- Coalescing, particulate and adsorption elements available
- Connections from 3" to 16"
- Flows from 1500 to 37,000 SCFM
- Temperatures to 450˚F
- Optional indicators, gauges and drains
- Design: ASME Code/Canadian Registration
- Available Options: High Temperature, High Pressure, All Stainless Construction
- Media types available: C+Q (grades 4, 6 and 10), 7CVP, 3P & 100WS (See below)

| Grade Designation | Coalescing Efficiency .3 to .6 Micron Particles | Maximum Oil Carryover[1] PPM w/w | Micron Rating | Pressure Drop (PSID) @ Rated Flow[2] | |
|---|---|---|---|---|---|
| | | | | Media Dry | Media Wet With 10-20 wt. oil |
| 4 | 99.995% | .003 | .01 | 1.25 | 3-4 |
| 6 | 99.97% | .008 | .01 | 1.0 | 2-3 |
| 7 | 99.5% | .09 | .5 | 0.25 | 0.5 - 0.7 |
| 10 | 95% | .85 | 1.0 | 0.5 | 0.5 |
| 100WS | N/A | N/A | 100 | <0.25 | 0.25 |
| 3P | N/A | N/A | 3.0 | 0.25 | N/A |

[1]Tested per ISO 12500-1 at 40 ppm inlet.

[2]Add dry + wet for total pressure drop.

### H-Series

- Pressures to 500 PSIG
- Coalescing, particulate and adsorption elements available
- Connections from 1/4" to 3"
- Flows from 10 to 1600 SCFM
- Temperatures to 450˚ F
- Optional indicators, gauges and drains
- Media types available: C or Q (grades 4, 6 and 10), 7CVP, 3P & 100WS

### M-Series

- Pressures to 800 PSIG
- Coalescing, particulate and adsorption elements available
- Connections from 1/4" to 2"
- Flows from 78 to 2500 SCFM
- Temperatures from 175˚ F
- Media types available: C or Q (grades 4, 6 and 10), 7CVP, 3P & 100WS

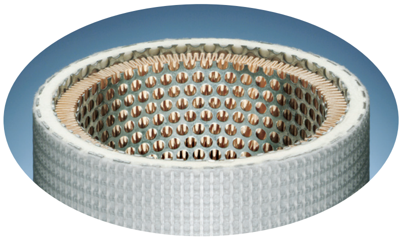
### J-Series

- Pressures to 5000 PSIG
- Coalescing, particulate and adsorption elements
- Connections from 1/2" to 1 1/2"
- Flows from 30 to 18,000 SCFM
- Temperatures from 350˚ F
- Media types available: C (grades 4 and 10 only), 3P & 100WS

### ZJ-Series

- Pressures to 6000 PSIG
- Coalescing, particulate and adsorption elements
- Connections from 3/4" to 2"
- Flows from 90 to 25,000 SCFM
- Temperatures from -40˚C/F to 350˚F
- Media types available: C (grades 4 and 10 only), 7CP, 3P, A, & WS

# Elements



### Media type C or Q

Available in grades 4, 6 or 10
Air Flow: Inside to Outside

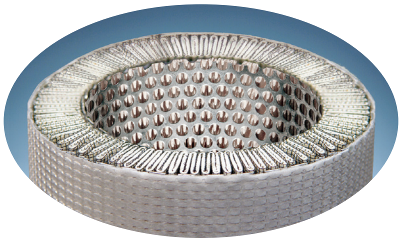
Media type Q is shown here. Media type C has the same coalescing outer layer, without the inner pleated layer.

This coalescing element is composed of an outer layer epoxy saturated, borosilicate glass micro-fiber tube. Type Q has a pleated cellulose inner layer as a built-in prefilter. This element is metal retained for added strength, and includes a synthetic fabric safety layer.

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

**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.

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

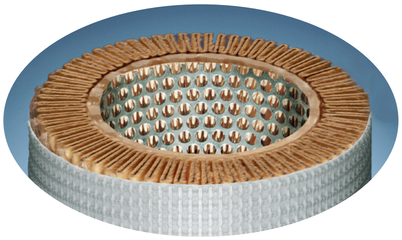


### Media type 7CVP

Air Flow: Inside to Outside

Finite’s 7CVP media consists of two layers. The outer layer consists of a dense matrix of glass fibers. This coalescing layer provides highly efficient aerosol removal and very low pressure drop. The inner layer effectively traps dirt particles, protecting and extending the life of the outer layer. A metal retainer in this element is used for strength and stability.

This media is used in bulk coalescing applications and when relatively high efficiency and low pressure drop are required.

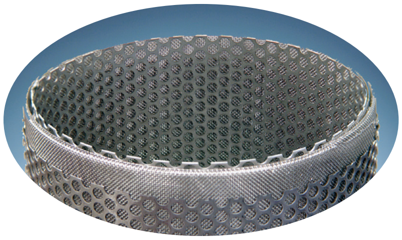


### Media type 3P

Air Flow: Outside to Inside

3P Particulate interceptor elements are used where very high dirt holding capacity and relatively fine pore structure are required.

This pleated element is constructed of pleated cellulose with a 3 micron rating.



### Media type 100WS

Air Flow: Inside to Outside

This rolled stainless steel mesh element has two metal retainers with rolled mesh steel in between. It is an extremely robust design.

This media is used for the reduction and elimination of excess liquids in gas streams. Excellent prefiltration for coalescing grades 6 and 10 when extreme quantities of liquid contaminants are present.

### Par-Fit Conversion Elements

- Over 2000 competitor interchanges available
- Custom element designs to fit your OEM requirements
- Special UNI-CAST design
- Coalescing, particulate and adsorption elements available
- High efficiency filtration, low operating costs, long life, high quality

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**Bioscience Engineering Filtration Division EMEA**
Birtley, United Kingdom
+44 (0) 191 410 5121

**Engine Mobile Filtration Division EMEA**
Dewsbury, United Kingdom
+44 (0) 1924 487 037

**Gas Separation & Filtration Division EMEA**
Team Valley, United Kingdom
+44 (0) 191 402 9000

**Gas Turbine Filtration Division**
Alton, United Kingdom
+44 (0) 1420 541188

**Hydraulic & Industrial Filtration Division EMEA**
Arnhem, Netherlands
+31 (0) 26 376 0376

**Australia Filtration Division**
Castle Hill, Australia
+61 2 9634 7777

**China Filtration Division**
Shanghai, China
+86 21 2067 2067

**India Filtration Division**
Chennai, India
+91 22 4391 0700

**Korea Filtration Division**
Hwaseon City, Korea
+82 31 359 0852

**Latin America Filtration Division**
Sao Paulo, Brazil
+55 12 4009 3500



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Parker Hannifin Corporation
**Industrial Gas Filtration and Generation Division**
242 Neck Road
Haverhill, MA 01835
Phone 800 343 4048
www.parker.com

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